**DEPARTMENT OF WATER AND SANITATION**
REPUBLIC OF SOUTH AFRICA

DUE AT **11:00** ON

**22 DECEMBER 2017**

# BID NO. W11268

# NGQAMAKAWE REGIONAL SUPPLY SCHEME PHASE 5

# CIVIL/MECHANICAL/ELECTRICAL CONTRACT

# BUTTERWORTH EMERGENCY SUPPLY SCHEME

## VOLUME 3: SCOPE OF WORKS : PART A

SUBMIT BID DOCUMENTS

TO

**POSTAL ADDRESS:**
DIRECTOR-GENERAL: DEPARTMENT WATER AND SANITATION
PRIVATE BAG X313
PRETORIA, 0001

**OR**

**TO BE DEPOSITED IN:**
THE BID BOX AT THE ENTRANCE OF ZWAMADAKA BUILDING
157 FRANCIS BAARD STREET
PRETORIA, 0002

**ATTENTION:**
DIVISION: PROCUREMENT AND PSP ADMINISTRATION
ZWAMADAKA BUILDING
ZWAMADAKA ENTRANCE

**BIDDER:** (Company address and stamp)

# NGQAMAKAWE REGIONAL SUPPLY SCHEME PHASE 5

## BID NO. W11268

## BUTTERWORTH EMERGENCY SUPPLY SCHEME

## LIST OF VOLUMES

VOLUME 1:

**THE TENDER**



VOLUME 2, This volume comprising::

**THE CONTRACT**

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**NGQAMAKWE REGIONAL SUPPLY SCHEME PHASE 5**

**BID NO. W11268 BUTTERWORTH EMERGENCY SUPPLY SCHEME**

**VOLUME 3**

# PART C3 – SCOPE OF WORKS

# PART C3: SCOPE OF WORKS

## PART A:

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C3.2: Amendments to the Particular Specifications

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# PART C3.1: PROJECT SPECIFICATIONS

# C3.1: PROJECT SPECIFICATIONS

The Project Specifications (PS) form an integral part of the contract and supplements the Standard and Particular Specifications. They contain a general description of the works, the site and the requirements to be met.

In the event of any discrepancy between a part or parts of the Standard or Particular Specifications and the Project Specifications, the Project Specifications shall take precedence. In the event of a discrepancy between the Standard and/or Particular Specifications and the drawings and / or the Bill of Quantities, the drawings take precedence, thereafter the Bill of Quantities. In all events, the discrepancy shall be brought to the attention of the Employer's Agent before the execution of the work under the relevant item.

DEPARTMENT OF WATER AND SANITATION

CONTRACT NO: W11268

FOR

NGQAMAKAWE REGIONAL SUPPLY SCHEME PHASE 5:
BUTTERWORTH EMERGENCY SUPPLY

# C3.1 PROJECT SPECIFICATIONS

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# PS 1 DESCRIPTION OF THE WORKS

## PS 1.1 PROJECT DESCRIPTION

The implementation of Phase V of the Ngqamakwe Regional Water Supply Scheme (RWSS) has been fast-tracked by the Amathole District Municipality (ADM) since Butterworth was declared a disaster area due to the current drought. The emergency project (referred to as the "Butterworth Emergency Water Supply Scheme") will transfer raw water from the Tsomo River to the upper reaches of the Xilinxa River Dam catchment to augment the water supply to Butterworth. The existing water treatment works (WTW) downstream of the Xilinxa Dam will be used to supply treated water to Butterworth.

Raw water will be abstracted from the Tsomo River though a river abstraction works that forms part of the new Tsomo WTW being constructed on the western side of the river on the outskirts of Tsomo. Tsomo is located approximately 100km North of East-London in the Eastern Cape. The completion date for Tsomo WTW project is projected at May 2018.

The Butterworth Emergency Water Supply Scheme (WSS) project will be entirely integrated into the Ngqamakhwe RWSS and will be used to distribute potable water once the Tsomo WTW has been commissioned and the balance of the Ngqamakhwe RWSS infrastructure has been constructed. In the interim, the scheme will supply raw water to the Xilinxa Dam. Refer to 106777-0504-DRG-CC-0003 for the block flow diagram of the project.

## PS 1.2 SCOPE OF THE CONTRACT

### PS 1.2.1 Overview

This Contract provides for the construction of an approximately 14 km DN700 rising main which will connect to a 900 m DN 400 PVC gravity main that feeds into the Xilinxa river catchment. River protection and pedestrian crossing structures will also form part of this Contract.

The Contract also includes the construction and equipping of a 3.6 MW pump station (across the river from Tsomo WTW), along with associated facilities, a 5.0 Mℓ concrete suction reservoir, an access road, bulk power supply and connection to the Tsomo WTW.

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

| 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 – Pump Station | **Contractor** |
| PS11 to PS12 - Bulk Power Supply | Employer |
| General Works (PS 1.2.2) | **Contractor** |
| Civil Works - Workshop drawings: structural steel | **Contractor** |
| Civil Works - Workshop drawings: miscellaneous items such as gratings, walkways, guardrails and ladders | **Contractor** |

### PS 1.2.2 The Works

This Contract includes all of the following:

**Civil Works**

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

a) Setting out of the Works.

b) Site clearance.

c) Pipelines

d) Connecting to the supply pipeline from the Tsomo abstraction pump station and WTW, as part of the construction of the Suction Reservoir.

e) Restricted excavation and backfilling of trenches for pipes up to DN 700 and for chambers, all up to depths of 3.5 m.

f) The installation of a welded DN 700 rising main steel pipeline, rated up to PN 63 with associated concrete reinforced valve chambers, pipe specials and valves.

g) The installation of a DN 400 gravity main PVC pipeline.

h) Pipe jacking with a DN 1350 concrete sleeve below road crossings

i) Concrete encasement of pipelines through river crossings

j) Dealing with traffic at road crossings and where work is scheduled alongside a road.

k) Temporary relocation of fences and minor structures.

l) Dealing with the crossing of existing services such as high-voltage overhead power lines, fibre optic cables, water and sewer pipelines, and constructing the pipeline adjacent to these existing services.

m) Dealing with water in trenches and structures (groundwater and surface run-off).

n) Testing of the pipeline, manholes and joints.

o) Water tightness testing of structures

p) River channel discharge

q) Reinforced concrete discharge chamber

r) River erosion protection measures such as revetment mattresses and gabion structures.

s) Pedestrian and low level vehicle river crossing structures.

t) Pump station and reservoir site

u) Bulk excavation at the reservoir, pump station and electrical substation sites.

v) The construction of a 5.0 Mℓ reinforced concrete reservoir.

w) Inlet, outlet, scour and overflow pipework for reservoirs up to DN 600 (steel pipes), including isolating valves.

x) Reinforced concrete pump station building, complete with brick infill between concrete columns, doors, steel roof, steel platforms and staircases as well as general civil works.

y) The construction of reinforced watertight concrete structures such as inlet, outlet and scour valve chambers.

z) Stormwater drainage at the pump station and reservoir site, including headwall and culvert structures.

aa) Access roads at the pump station and reservoir site.

bb) Fences and gates at the pump station and reservoir site.

cc) General landscaping of reservoir and pump station sites, including retaining walls.

dd) Dealing with water in trenches and at structures.

ee) Water tightness testing of structures.

ff) Access road to the pump station and reservoir site.

gg) The liaison with the ward councillors of the local communities.

hh) Correction of defects in the Works in accordance with the General Conditions of Contract.

In accordance with Sub-Clause 4.1.1 of the General Conditions of Contract, the Contractor is responsible for the following portion of the Works.

a) Gratings, walkways, guardrails and ladders.

b) Concrete plinths for the pump station.

Reference to the standard and particular specifications including amendments to these standards for the above listed Civil Works, is provided in sections C3.2 to C3.5. This shall be read in conjunction with C3.1: Project Specification and Volume 5: Drawings.

## Mechanical and Electrical Works – Pump Station

In accordance with Sub-Clause 4.1.1 of the Conditions of Contract, the Contractor is responsible for the design of this portion of the Works.

This portion of the Contract includes the mechanical and electrical equipping of the Ngqamakwe pump station, which are collectively defined as Mechanical and Electrical Works – Pump Station. The Contract includes the following in respect of the Mechanical and Electrical Works – 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 – 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 – 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 Volume 5: Drawings where further requirements concerning the associated items of the Works are specified.

## Bulk Power Supply

The bulk power supply under this portion of the Contract includes the following work:

a) A new 66 kV overhead line

b) A new 66 kV / 11kV substation adjacent to the pump station

The overhead line and substation shall be built to Eskom's requirements under a self-build agreement. Refer to PS11 and PS12.

## 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 both the Civil Works and the Mechanical and Electrical Works:

a) Environmental management of the construction area during construction.

b) Compliance with the requirements of the OHS Act and health and safety specifications.

c) The liaison with the ward councillors of the local communities.

d) All Temporary works required to construct the Permanent Works

### PS 1.2.3 Temporary Works

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

The Contractor shall not construct any alternative temporary access road to the Ngqamakwe Pump Station Site, but shall restrict access routes to the alignment prescribed by the Employer for the main access road to be constructed under this Contract.

The contractor shall be responsible for the design of a retaining wall at the Ngqamakwe Pump Station Site as indicated on the Drawings.

## PS 1.3 WORK TO BE CARRIED OUT BY OTHERS

The following construction work will be carried out on or adjacent to the Site by others, under separate contracts, concurrently with the construction of the Works:

- The supply pipeline from the Tsomo abstraction pump station and WTW, which will be constructed through the Tsomo River and terminate at the end of the abstraction weir.
- Cable ducts will be provided by others at the Tsomo River abstraction weir to sleeve power and communication cables from the Ngqamakwe Pump Station Site to the Tsomo WTW through the Tsomo River.
- A potable water pipe connection point will be provided to connect to the potable water system at the Pump Station.

## PS 1.4 THE SITE

### PS 1.4.1 Location

The proposed Ngqamakwe Pump Station Site is situated east of the Tsomo WTW and on the eastern bank of the Tsomo River. The approximate co-ordinates are 32° 2'10.43"S; 27°49'38.77"E. The approximate coordinates of the rising main discharge point are 32° 5'55.29"S; 27°56'16.70"E.

The location of the works is shown in the Drawings.

### PS 1.4.2 Access

There is currently no formal access to the Ngqamakwe Pump Station Site. Only a local informal access road exists, which can be accessed via the R409 road. The proposed access road starts at the approximate co-ordinates 32° 2'42.34"S, 27°49'25.81"E, close to the Tsomo River Bridge.

The Contractor shall maintain this existing local informal road for the duration of construction period, and shall upgrade the road as required within the Scope of Works towards the collective completion of construction of the Ngqamakwe Pump Station Site and the electrical substation.

Access to the pipeline route is only possible at certain locations. The use of any other private roads to gain access to the pipeline servitude shall only be with the prior written approval of the Engineer and the landowner(s). The Contractor shall be responsible for all claims from the landowner(s) arising out of any such agreement.

Notwithstanding that access to these sites is limited as described above, the Contractor will be held to have satisfied himself with regard to existing access roads, and shall make suitable provision for the accessibility to the sites.

### PS 1.4.3 General Conditions

The Site is currently undeveloped, with small shrubs in some areas, and heavily vegetated in others. Much of the Site is on steep slopes, which may become unstable during construction.

The topography for the pipeline varies from generally flat to steep and also crosses river streams and stormwater channels.

The following climatic and related site conditions shall be taken into consideration in the design and selection of the plant and equipment:

| | | |
|---|---|---|
| Altitude above sea level | : | 780 to 1 200 m |
| Maximum Temperature | : | 40°C |
| Minimum Temperature | : | -10°C |
| Maximum Relative Humidity | : | 98% |
| Corrosion Conditions | : | Severe |
| Lightning | : | Frequent |
| General | : | The climate in the area is a hot and humid summer with summer rainfall. Winters are generally moderate with little rainfall, though exceptional and high rainfall in winter months has occurred in the past. |

## PS 1.4.4 **Ground and Subsoil Conditions**

### PS 1.4.4.1 General

A geotechnical investigation was undertaken by Controlab South Africa (Pty) Ltd along the proposed pipe route and at the respective reservoir and pump station sites. The fieldwork was carried out during May - June 2017.

The field investigations included the following:

a) Excavation of test pits, using a TLB, up to depths of 3.5 m or depth of refusal for the pipeline.

b) Excavation of test pits, using a 20 ton excavator, up to depths of 5.5 m or depth of refusal for the pump station and reservoir.

c) Profiling of test pits.

d) Laboratory testing of the soil samples from the test pits, which included soil indicator, compaction, tri-axial and consolidation testing including dispersiveness classification.

e) Soil resistivity survey

The geotechnical report including all trail pit logs and laboratory results are included in C4: Site Information

### PS 1.4.4.2 Results of geotechnical investigation

(a) <u>Pump Station and Suction Reservoir site</u>

The material generally consists of transported clayey or sandy silt. The moisture conditions are slightly moist, the consistency soft becoming firm and the structures varies between intact, slickensided and fissured.

Residual material was encountered at all trial pit positions varied between sandstone and shale. The moisture conditions were slightly moist, the consistency hard and the structure shattered.

Average refusal on hard rock was recorded at 2.0 m with minimum at 0.8 m and maximum at 3.4 m.

No water seepage was recorded in any of the trial pit positions. However, the horizon of ferricrete nodules within the clayey silt was an indication of fluctuating water tables.

(b) <u>Pipeline</u>

The material along the pipeline route varies. The transported material is generally sandy or silty material. The residual material varies between sandstone, mudstone and shale. The excavations indicated that plated sandstone was encountered close to the surface.

Residual material was encountered at all trial pit positions varied between sandstone and shale. The moisture conditions were slightly moist, the consistency hard and the structure shattered.

Post depositional dolerite intrusions are present as well. The dolerite intrusions may occur as either, horizontal sills and lenses or vertical dykes which cut through the sedimentary layers. Furthermore, the vertical dykes cut through the horizontal sills.

The excavated material was analysed to determine the suitability of being used for pipe bedding material. Some material results indicated compliance with certain of the project specifications, however several the tests did not qualify and will require on site screening if the Contractor chooses to use the material.

### PS 1.4.4.3 Disclaimer

The reports will be provided to the Contractor in good faith, however the Employer does not take responsibility for the correctness of the information contained therein, and it therefore remains the Contractor’s responsibility to determine the true nature of the geotechnical/ subterranean material.

The information given herein regarding the geotechnical/ subterranean material and conditions, and the materials investigation reports, are provided in good faith for the Contractor's convenience as an indication of the conditions likely to be encountered. The Employer does not take responsibility for, and there is no guarantee of, the information being correct or representative of the whole area of the Works. The provision of such information shall not be regarded as in any way limiting, or detracting from the Contractor's responsibilities in terms of the General Conditions of Contract or the Specifications.

The Contractor will be held to have satisfied himself as to the subsurface conditions to be encountered on Site and to have allowed accordingly in his tendered rates.

# PS 2 PROCUREMENT

## PS 2.1 PREFERENTIAL PROCUREMENT PROCEDURES

The Contractor shall comply with the Employer's preferential procurement requirements as stated in Part T1. - Tender Data, and with the Employer's Preferential Procurement Policy / Supply Chain Management System. The latter is available from the Employer on request.

## PS 2.2 BROAD-BASED BLACK ECONOMIC EMPOWERMENT PARTICIPATION

The Contractor shall comply with the B-BBEE requirements set out in the Part T1.3 – Tender Data and Part C1.2 – Contract Data.

## PS 2.3 PROVISIONAL SUMS

Where Provisional Sums have been included in the Bill of Quantities and the work is to be done by a subcontractor, the procedure to be followed is that the Contractor shall obtain three quotes for the work.

The Provisional Sum for the 66kV sub-station and 66kV high voltage line part of the works shall be dealt with as per PS11 and PS12.

The quotes shall include full technical descriptions as well as a breakdown of prices, which shall be submitted to the Engineer for approval. The Contractor shall be responsible for the sub-contractor's work in accordance with Clause 4.4 of the General Conditions.

# PS 3 CONSTRUCTION

## PS 3.1 CONTRACTOR'S CAMP ESTABLISHMENT

Refer to SANS 1200 A including amendments thereof.

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 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 Contactor are no longer required, the Contractor shall remove them and clear away all surface indications of their presence.

## PS 3.2 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. The Contractor shall remove the fencing and rehabilitate the camp site areas on completion of the Contract.

## PS 3.3 SITE SERVICES

No water, sanitation, electrical power supply, telephone, or internet connection services are available on Site. The Contractor shall make his own arrangements and pay all charges related to the supply of such services that he may require, including any installation and later removal charges. The provision of these services and the Contractor's responsibility for bearing the cost thereof shall include for all activities related to the Works up to the issue of the Practical Completion Certificate.

Once the permanent power supply to the Site has been provided under this Contract, and the Contractor has connected to this, the electrical power for commissioning tests and trial operation may be drawn from the main power supply to the Site. The Contractor shall however bear the cost of all consumption charges.

The Contractor shall comply with all prevailing legislation in respect of the generation and distribution of electrical power and shall, when required by the Engineer, produce proof of such compliance.

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

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

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

## PS 3.4 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.

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.

## PS 3.5 RAIL FACILITIES

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

## PS 3.6 LIFTING FACILITIES

The Contractor shall make his own arrangement for lifting facilities.

## PS 3.7 SANITARY 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.

## PS 3.8 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 make good any damage resulting from the Contractor's activities on Site. This includes making good any damage to the Site, civil and building constructions and any of the Employer's and the Engineer's property.

## PS 3.9 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.

## PS 3.10 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.

## PS 3.11 DEALING WITH WATER

The Contractor shall deal with water, whatever its origin, on the Site so that the Works are kept sufficiently dry for their proper execution. In general, the Contractor shall:

a) Keep all completed Works or portions thereof properly drained.

b) Not inhibit surface drainage

c) Comply with the environmental specifications as stipulated in Clause 4.12

d) Protect all parts of the Works against damage and erosion caused by rain and surface, as well as sub-surface water.

e) Manage and dispose of water; which shall include for by-pass arrangements, temporary earthworks, cofferdams, pumping equipment, well-pointing, de-watering equipment etc, and for dealing with all possible flows whether or not the existing flow path is being interfered with during construction.

f) Note that and allow for the fact that in addition to work in and around the river, it is anticipated that some pipe trench excavations and excavations for structures, could be below the water table; and that it shall therefore be necessary to dewater the relevant sections of the Works, as required, for the duration of the Contract.

## PS 3.12 SAFEGUARDING OF EXCAVATIONS

The Contractor shall excavate and safeguard the excavations as set out in his method statements in accordance with the Health and Safety Specification and approved by the Engineer. The approval of the Contractor's method statements by the Engineer shall not relieve the Contractor of his responsibility in terms of SANS 1200 D, SANS 1200 DB, DWS 1110 and Amendments thereof, nor shall any departure from the method statements (whether approved or not) due to the Contractor having to employ a different method of excavation, safeguarding or dewatering than that proposed, be grounds for any claim for additional costs.

## PS 3.13 BLASTING

Refer to the Amendments to SANS 1200 D.

## PS 3.14 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.

## PS 3.15 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.

## PS 3.16 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. Refer to PSA 5.4 of the SANS 1200 Amendments.

## PS 3.17 PERMITS AND WAYLEAVES

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

The Contractor shall abide by any conditions imposed by such wayleaves, permissions or permits.

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

The Contractor shall also ensure that any wayleaves in respect of electricity services are renewed timeously every three months. All wayleaves which has lapsed the allowed time period shall be renewed by the Contractor who shall also bear the cost any subsequently delays as such thereof.

## PS 3.18 CONSTRUCTION AREA

The Site and the construction areas contained within this is shown on the Drawings. 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. 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.

## PS 3.19 ACCESS TO PROPERTIES

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

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

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

## PS 3.20 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.

## PS 3.21 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:

The number of days per month on which work is expected not to be possible as a result of normal rainfall, and for which the Contractor shall make provision in his tendered rates, prices and programme, are listed in the table below. Only the number of days lost as a result of abnormal rainfall, exceeding the number of days listed in table, will qualify for consideration of extension of time.

EXPECTED NUMBER OF WORKING DAYS LOST PER MONTH DUE TO NORMAL RAINFALL

| Month | Expected Number of Working Days Lost due to Normal Rainfall | Month | Expected Number of Working Days Lost due to Normal Rainfall |
|---|---|---|---|
| January | *4 | July | 1 |
| February | 3 | August | 2 |
| March | 3 | September | 2 |
| April | 2 | October | 3 |
| May | 2 | November | 3 |
| June | 1 | December | *1 |

*The number of working days lost for December and January allows for the builders' holidays.

During the execution of the Works, the Engineer's Representative will certify a day lost due to abnormal climatic conditions only:

a) if no work was possible on the relevant working day on any item which is on the critical path according to the latest approved construction programme; or

b) if less than 20% of the total work force and plant on site could work during that specific working day.

Extension of time as a result of abnormal climatic conditions shall be calculated monthly being equal to the number of working days certified by the Engineer's Representative as lost due to rainfall to abnormal climatic conditions, less the number of days allowed for as stated in the table above, which could result in a negative figure for certain months. The total extension of time as a result of abnormal climatic conditions for which the Contractor may apply, shall be the cumulative algebraic sum of the monthly extensions. Should the sum thus obtained be negative, the extension of time shall be taken as nil.

The Contractor shall provide a rain gauge close to the office of the Engineer or as directed by the Engineer and precautions shall be taken to restrict access to the rain gauge. Whenever it rains the Contractor shall record the rainfall daily and present it to the Engineer daily to be signed off.

## PS 3.22 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:

a) The pump station shall be complete; including that all doors shall be lockable.

b) For water-retaining structures, the structure shall have passed any required water tightness test, unless otherwise approved by the Engineer.

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

## PS 3.23 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

## PS 3.24 TESTING AND QUALITY CONTROL

### PS 3.24.1 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 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" (as defined in subclause PSA 7.2) which is not under the management or control of the Contractor and in which the Contractor has no financial interest, nor which has any control or financial interest in the Contractor.

PS 3.24.2 **Additional testing required by the Engineer**

In addition to the provisions of subclause PS 3.24.1, 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 subclause PS 3.24.1 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.

PS 3.24.3 **Costs of testing**

PS 3.24.4 **Tests in terms of subclause C3.4.2.5(b)(i)**

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 subclause PS 3.24.1.

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.

PS 3.24.5 **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.

PS 3.25 **TIME LAPSE RECORDING OF CONSTRUCTION PROGRESS**

The Contractor shall monitor the construction progress using a remote control drone with camera and fixed camera located on a high point. The camera shall be at least a 5 megapixel wide angle fixed camera. The Engineer shall instruct the Contractor on the suitable method of monitoring (fixed pole or drone, or both) and the specifications required for the monitoring equipment.

## PS 3.26 WORKMANSHIP AND QUALITY CONTROL

### PS 3.26.1 General

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, surveyors, materials technicians, other technicians and technical staff, together with all transport, instruments and equipment to ensure adequate supervision and positive control of the Works at all times.

The cost of supervision and process control, including testing 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.

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

### PS 3.26.2 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.

### PS 3.26.3 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).

# PS 4 MANAGEMENT

## PS 4.1 MEETINGS

The Contractor shall attend the following meetings during the Contract:

a) 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.

b) Monthly Site Meetings, on Site or as called by the Engineer, from the order to commence the Works until the issue of the Completion Certificate.

c) Ad hoc meetings called by the Engineer to discuss programming and coordination with other contractors.

d) A HAZOP study.

e) Design workshops as specified elsewhere.

f) Other meetings to discuss and agree on technical details specified elsewhere or as called by the Engineer.

g) Quarterly meetings during the Defects Notification Period as called by the Engineer – at the Engineer's offices in East-London, 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).

## PS 4.2 PLANNING, PROGRAMMING AND REPORTING

### PS 4.2.1 Detail to be shown on Programme

The Contractor's programme, required in terms of C1.2: Contract Data, shall be in a bar chart form (Gantt Chart), and shall show:

a) 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.

b) Critical path activities and their dependencies.

c) 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.

d) 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.

e) Other key dates in respect of work to be carried out by others, such as connection to pipelines provided by others.

f) 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 and bending schedules for major components of each of the concrete structures are required.

g) Submission of the documentation required in terms of Clause 5.3.1 of the General Conditions of Contract

### PS 4.2.2 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) Centreline survey of the pipeline as detailed in SANS 1200 A Amendments

j) Pipeline road and river crossings

k) The requirements and programmes of those responsible for the work carried out by others.

l) The environmental requirements as specified in the Environmental Management Specification.

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

PS 4.2.3 **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.

PS 4.2.4 **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.

PS 4.2.5 **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.

PS 4.2.6 **Progress Reporting**

The Contractor shall submit a comprehensive progress report at least 48 hours prior to each Site meeting. The progress report shall consist of at least the following documents:

a) Approved programme indicating the actual versus scheduled progress for each item on the programme, the aggregate progress and including the "time now" line;

b) A written summary of the progress to date;

c) Updated realistic cash flow;

d) Any delays encountered or anticipated;

e) An information required schedule indicating any information or drawings required;

f) A 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.

g) Plant and Labour Report; and

h) Subcontractor/s progress.

i) Progress Photos

j) Updated Contractor Document Register

## PS 4.3 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.

## PS 4.4 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.

## PS 4.5 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.

## PS 4.6 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.

## PS 4.7 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.

## PS 4.8 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

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.

## PS 4.9 OCCUPATIONAL HEALTH AND SAFETY

### PS 4.9.1 General Statement

The Contractor shall comply with the requirements of the Project Health and Safety Specification included in Volume 4: Site Information.

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.

### PS 4.9.2 Appropriate Supervision and Equipment

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.

### PS 4.9.3 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 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.

### PS 4.9.4 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.

### PS 4.9.5 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.

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.

PS 4.9.6 **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 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

PS 4.9.7 **Health of Contractors Staff**

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

a) 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.

PS 4.9.8 **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.

PS 4.9.9 **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.

## PS 4.10 ENVIRONMENTAL MANAGEMENT

PS 4.10.1 **General**

The Contractor shall comply with the requirements of the Environmental Management Plan included in Volume 4: Site Information.

PS 4.10.2 **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.

## PS 4.11 TARGETED LABOUR AND ENTERPRISE CONTRACT PARTICIPATION

PS 4.11.1 **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%**.

PS 4.11.2 **Definitions**

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

"**Target area**" means the Amathole District Municipal and Chris Hani District Municipal areas. It must be noted that representation from the local communities within Intsika Yethu and Mnquma 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.

"**Threshold value**" is R350.00 per day as 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.

PS 4.11.3 **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.

PS 4.11.4 **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.

Any difficulty experienced by the Contractor in identifying candidates though 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

PS 4.11.5 **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.

No credits shall be accorded should the Contractor (or sub-contractors):

a) 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;

b) fail to enter into written contractual agreements with the relevant targeted enterprises.

c) make use of targeted enterprises that that do not adhere to statutory labour practices.

d) make use targeted enterprises engaged on work in respect of provisional sums or prime cost items.

e) 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.

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.

PS 4.11.6 **Penalties**

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:

Penalty = [(Cg - Ca) + (Lg – La)] x P

Where Cg = the specified minimum combined targeted labour and enterprises contract participation goal (expressed as a percentage).

Ca = the combined targeted labour and enterprises contract participation goal achieved (expressed as a percentage).

Lg = the targeted labour contract participation goal achieved (expressed as a percentage).

La = the specified minimum targeted labour contract participation goal achieved (expressed as a percentage).

P = the value of the contract.

# PS 5 ENGINEERING: DESIGN OF THE WORKS

## PS 5.1 DESIGN RESPONSIBILITIES

Where the Contractor is required to design the Works:

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.

## PS 5.2 DESIGN BY THE EMPLOYER

### PS 5.2.1 Drawings for Tender Stage

The design prepared by the Employer and the drawings included in Part C6 are provided for tendering purposes. The drawings must be regarded as provisional and preliminary for Tenderers to generally assess the extent of the Works.

### PS 5.2.2 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.

### PS 5.2.3 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 pump station building as shown on the tender drawings.

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.

## PS 5.3 DESIGN BY THE CONTRACTOR

### PS 5.3.1 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 civil and building details relating to equipment requirements.

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:

   i) C3: Scope of Works.

   ii) The drawings prepared by the Employer and included in C5, and any subsequent revisions issued to the Contractor by the Engineer.

   iii) Any other design 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.

### PS 5.3.2 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.

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 (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, maloperation.

g) Machines with nonoverloading characteristics shall be selected wherever possible; e.g.: motors shall be sized so that they cannot be overloaded by the driven machine.

### PS 5.3.3 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.

### PS 5.3.4 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.

### PS 5.3.5 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.

### PS 5.3.6 Fail Safe Operations and Protections

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 failtosafe (i.e. shall return to a safe condition where no further damage can be done in the event of a failure, malfunction, maloperation, 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.

The Contractor shall highlight equipment limitations which can be exceeded during operation and cannot be guarded against.

### PS 5.3.7 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 selflubricating 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.

### PS 5.3.8 Arrangement and Mounting

The Contractor shall design the Works in accordance with the following in respect of equipment 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.

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

### PS 5.3.9 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.

## PS 5.4 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 ten one-day design workshops, which shall be held in Cape Town. 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 4 representatives of the Engineer.

## PS 5.5 HAZOP STUDY

The Contractor shall conduct a HAZOP study.

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 East-London 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 eight 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.

## PS 5.6 AS BUILT DRAWINGS

The Contractor shall ensure that accurate as built records are kept of all infrastructure (pipelines, interconnecting pipework and cable ducts) installed during the Contract. The position of rise bends, junction boxes, duct ends and all other underground infrastructure shall be given by either co-ordinates or stake value and offset. Where necessary, levels shall also be 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.

# PS 6 ENGINEERING: CONTRACTOR'S DOCUMENTS

## PS 6.1 GENERAL

### PS 6.1.1 Definition

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.

### PS 6.1.2 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:

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.

## PS 6.2 CONTRACTOR'S DOCUMENTS IN RESPECT OF MECHANICAL AND ELECTRICAL WORKS – PUMP STATION

### PS 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.

### PS 6.2.2 General Arrangement Drawings

General Arrangement Drawings of the proposed designs. The drawings shall include layout details of pipework and pipe supports, dosing stations 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.

### PS 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.

### PS 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.

### PS 6.2.5 Corrosion Protection

a) Technical data sheets for all coatings proposed.

b) Blast material.

c) Pickling and passivating products.

### PS 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) BTU sizing calcs

m) PFC calcs by specialist

PS 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)

e) FAT test report of motor

PS 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

PS 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

PS 6.2.10 **Earthing and Lightning Protection**

a) Earthing survey report and design

b) Earth resistivity test results after installation

PS 6.2.11 **Actuators**

a) Actuator list (including failsafe positions)

b) Quality control procedures for actuators and junction boxes

PS 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

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

PS 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

PS 6.2.14 **Electrical Building Services**

a) Updated single line diagrams

b) Lighting samples for approval

PS 6.2.15 **Training**

a) Training Schedule

b) Operator Training Manual (this may be identical to the operator's Training Manual specified in Aur 0002).

PS 6.2.16 **As-Built Documents**

a) 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.

PS 6.2.17 **Operation and Maintenance Manuals**

a) Contents List.

b) Two draft copies of the Operation and Maintenance Manual.

c) Six copies of the Operation and Maintenance Manual, which shall comply with the requirements of Aur 0002.

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.

PS 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.

PS 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.

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 an 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

PS 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

## PS 7 ENGINEERING: TESTS ON COMPLETION FOR MECHANICAL AND ELECTRICAL WORKS - PUMP STATION:

### PS 7.1 PREPARATION

The Contractor shall have completed and obtained acceptance for the following from the Engineer prior to commissioning:

a) All installation work, including repair to coatings and testing of all anchor fasteners.

b) Manual.

c) 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.

### PS 7.2 STARTING UP

The Contractor shall arrange for the Engineer to be present at initial startup 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.

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

### PS 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 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.

### PS 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.

## PS 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 three 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.

Setpoints 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.

## PS 7.6 COMMISSIONING

### PS 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.

### PS 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.

## PS 7.7 TRAINING

### PS 7.7.1 General

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.

### PS 7.7.2 Operational and Maintenance Tuition

The Contractor shall provide the following tuition to eight operational staff members and eight 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 Aur 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.

### PS 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.

## PS 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.

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.

## PS 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.

## PS 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.

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.

## PS 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.

## PS 8 ENGINEERING: PROCESS DESCRIPTION

The process is described under the subclause “Process and Control” in PS9.

# PS 9 ENGINEERING: THE MECHANICAL AND ELECTRICAL WORKS – PUMP STATION

**PREAMBLE**

The Mechanical and Electrical Works for the Ngqamakwe pump station shall comply with this clause. This clause does not apply to the remainder of the Works.

## PS 9.1 SCOPE

### PS 9.1.1 General

The proposed layout and configuration of the "PS9" part of the Works are indicated on the drawings in Volume 5.

Drawings of the process flow diagram, P&ID and the preliminary electrical single line diagrams are also included in Volume 5.

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:

a) Project Specifications (Mechanical).

b) Project Specifications (Electrical).

c) Project Specifications (Electronic).

d) Standard Specifications.

### PS 9.1.2 Scope

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

- Pump station isolation butterfly valve on downstream side of pump station.
- Multistage, ringsection centrifugal pumps with 11 kV motors, baseframe and coupling.
- Suction side isolating butterfly valves on each pump leg.
- Discharge side plunger valves on each pump leg.
- Discharge side isolating wedge gate valves on each pump leg.
- Pipework, including flange adaptors.
- Corrosion protection of pipework.
- Pipework supports.
- Lifting equipment.
- Access ladders
- Ventilation equipment.
- Fire safety design
- Liaison with the Eskom (the supply authority) to coordinate power supply
- 11kV switchboard (incl. motor starters).
- 11kV overhead line to supply the WTW
- 100 kVA 11 kV / 420 V transformers.
- Power Factor Correction for each motor.
- ZORC surge protection for each motor.
- 400V MCC.
- MV cables, LV cables and cable support systems.
- Bonding and earthing.

- Lightning protection
- Certificates of compliance.
- PLCs, HMIs and programming.
- SCADA station at Pump Station.
- SCADA station at Tsomo WTW.
- Field Instrumentation.
- Control and instrumentation cables including data communications cables and associated peripherals.
- Earthing and surge protection for power, instrumentation and control components.
- Electrical building services.
- Electronic building services (including fire and intruder detection).
- Functional Design Specification.
- Operating and Maintenance Manual.
- Spares.
- Signage.
- Labelling
- Inspections.
- Testing.
- Commissioning.
- Trial Operation Period.
- Training.
- Rectification during Defects Notification Period.
- Maintenance during Defects Notification Period.
- Inspection and report during Defects Notification Period.

PS 9.1.3 **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.

PS 9.1.4 **Witness Testing and Factory Inspections**

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

## PS 9.2 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.

PS 9.2.2 **PFDs and P&IDs**

The P&IDs shown on drawings 106777-PP-501 and 106777-PP-502 explains the overall system.

PS 9.2.3 **Water Network**

PS 9.2.3.1 Overall

The Tsomo abstraction pump station and WTW will feed water to the Suction Reservoir. In future the Ngqamakwe Pump Station will pump water from the Suction Reservoir to the Command Reservoir. The Command reservoir gravity feeds into the distribution network.

As part of emergency water supply, the pump station shall transfer water from the Suction Reservoir to the upper reaches of the Xilinxa River Dam catchment to augment the water supply to Butterworth.

Both of these functions shall be provided by the Contractor's equipment.

The locality plan is shown on the drawings.

PS 9.2.3.2 Suction Reservoir

The water level in the Suction Reservoir will be maintained by operators from the control room at the Tsomo WTW by starting and stopping the abstraction works pumps.

The Suction Reservoir will have an operating range of approximately 4.95 metres.

PS 9.2.3.3 Discharge point – Future Scheme

For the future scheme the destination reservoir is the Command Reservoir.

The Command Reservoir will have an operating range of approximately 5.5 metres

PS 9.2.3.4 Discharge point – Emergency Scheme

For the Emergency Scheme the discharge point is the upper reaches of the Xilinxa Dam with GPS coordinate as per PS 1.4.

PS 9.2.4 **Pump Control**

PS 9.2.4.1 Modes of operation (future and emergency)

The 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

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.

PS 9.2.4.2 Pump Station Operation (for future demand)

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.

In addition to control of the pumps based on water levels in the Suction and Command reservoir, the Contractor shall also allow for operation of the pump station in accordance with flows measured by the ultrasonic flow meter.

The plunger valve on the discharge side of each pumpset shall be used for flow control during start up and shutdown of the pumps. It shall also act as the check valve for each pump line and shall be provided with a weighted lever arm to close the valve upon electrical power failure. This valve shall be shut before a pump is started and shall start to open when a start signal has been sent to the corresponding pump motor. In this duty it shall be subject to the pressure difference between the pump shut-off head and the Command Reservoir elevation (static head). For the emergency supply scheme it shall be subject to the pressure difference between the pump shut-off head and the static head of the emergency supply pipeline. No pumps shall be allowed to start when any plunger valve is open and its associated pump is off.

The plunger valve shall also be used to regulate the flow during filling of the pipeline at commissioning and, thereafter, whenever the line has been scoured. In this duty, it will initially be subject to the full shut-off pressure of the pump.

The position indication signals from the electric actuators on the isolation valves shall be used to ensure that a pump shall operate only when the appropriate valves are fully open. The position indication signals from the plunger valves shall be used to ensure that a pump shall operate only when its plunger valve is not in the closed position. The discharge manifold check valve shall be provided with a proximity switch to indicate no flow and shut down the pump(s) should the check valve not open within a predefined period of time.

Under controlled shut-down when three pumps are operating, the second pump shall be prevented from shutting down within 60 seconds of the first pump shutting down in order to prevent surge superposition. The third pump shall be prevented from shutting down within 60 seconds of the second pump. Under uncontrolled shutdown, simultaneous shut down of operating pumpsets is acceptable in terms of the pipeline hydraulic design on condition that the plunger valves are operating correctly.

PS 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:

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%).

PS 9.2.4.4 Normal Start Up

A pumpset shall start direct on line with the suction side and discharge side isolation valves open and the plunger valve closed. The plunger 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's plunger valve is fully open.

A third pumpset shall also start in this manner but only once the second plunger valve is fully open.

The three 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.

The plunger valve opening action shall be a continuous ramp without steps.

PS 9.2.4.5 Normal Shut Down

During a normal shut down procedure for one pump, the release orifice for the hydraulic system of the plunger valve shall open and this shall cause the valve to close in the period specified elsewhere. The pumpset shall stop once the valve has closed.

During a normal shut down procedure for two pumps, the above procedure shall occur sequentially; i.e. one pumpset shall shut down fully before the other pumpset starts its shut down procedure. The initiation of the second pump stop procedure shall occur 60 seconds, or longer, after the initiation of the first pump shut down. The initiation of the third pump stop procedure shall occur 60 seconds, or longer, after the initiation of the second pump shut down.

PS 9.2.4.6 Electrical Power Failure

"Electrical power failure" refers to both loss of supply for a substantial period as well as an unsustainable voltage dip.

Upon electrical power failure, all operating pumpsets shall lose power and the release orifice for each plunger valve shall open which shall cause the plunger valves to close simultaneously over the period specified elsewhere.

The pump station shall continue to shut down and shall remain dormant for a period of 400 seconds even if the electrical supply is restored during this period. After this 400 second period, the pump station shall be allowed to re-start itself once the electrical supply has been available and stable for a continuous period of at least 400 seconds.

PS 9.2.4.7 Single Pump Trip

If more than one pumpset is operating, and one of the pumpsets trip, the other pumpset(s) shall be tripped simultaneously.

Following this occurrence, any serviceable pump shall only be allowed to re-start after a time delay of 400 seconds.

PS 9.2.4.8 Emergency Stop

If any pump's emergency stop is pressed, all operating pumps shall be stopped immediately.

Following this occurrence, any serviceable pump shall only be allowed to re-start after a time delay of 300 seconds.

PS 9.2.4.9 Manual Operation

It shall be possible to start and stop each pumpset manually from the MV control panel in the LV room or from the control desk. This facility shall be used during maintenance operations and filling of the pipeline.

When a pumpset is started manually the associated plunger valve shall also be started and operated manually.

Manual operation of the release orifice shall also be provided. Complete closure shall be followed by pump shut down.

PS 9.2.5 **Pumpset Protection**

PS 9.2.5.1 Pump Shut Down 1

Under the following equipment conditions, a pump shall shut down (or prevented from starting) and all other operating pumps shall shut down:

a) Suction and/or discharge isolation valves not fully open.

b) Low pump flow.

c) High pump flow.

d) Low Discharge Pressure.

e) High Discharge Pressure.

f) High motor windings temperature.

g) High pump bearing temperature (drive end and non-drive end).

h) High motor bearing temperature (drive end and non-drive end).

i) Pumpset casing temperature

j) Excessive pumpset vibration (vibration intensity measured).

k) Plunger valve remains closed for 5 seconds (to be confirmed during Commissioning) after its pump receives a start signal.

l) Pump prevented from starting up it its plunger valve is in the open position.

PS 9.2.5.2 Pump Shut Down 2

Under the following system conditions, a pump shall shut down and automatic control of the remaining pumps shall cease; i.e. the pump station shall stop:

a) Low level in Suction Reservoir.

b) Closed pump station inlet isolation valve (downstream side of Suction Reservoir).

c) Closed pump station outlet isolation valve.

d) Low pump station flow (in accordance with the number of pumps operating).

e) High pump station flow (in accordance with the number of pumps operating).

PS 9.2.5.3 Inhibit Pump Start

In addition to the protections listed above, a pump under automatic operation shall only be allowed to start under the following condition:

a) The manifold pressure indicates that the rising main is full.

b) Pump plunger valve is fully closed.

If the rising main pressure is too low, only manual starting of any one pump, with its plunger valve closed, shall be allowed. This is the action required in order to prime the discharge line at commissioning and whenever the line has been scoured and requires re-filling.

PS 9.2.5.4 Pump and Motor Protection

See Electrical and Electronic Specifications.

PS 9.2.6 **High level in pump room**

A float level switch shall be provided inside the pump room to raise a flooding alarm and trip the main 11kV incomers. The float switch shall activate when the water level is 200 mm below the top of the pumpset concrete plinth level.

PS 9.2.7 **General Requirements**

The control system shall provide the following:

a) Protection systems shall be designed to prevent damage to equipment.

b) Each of the four pumps shall become the first duty pump in accordance with the number of operational hours per pumps.

c) A maximum of three pumps shall operate simultaneously.

d) Switching from automatic to manual for any pump shall cause the pump to switch off if it is operating and the other pumpset(s) shall switch off simultaneously.

e) The operation of the ventilation fan is specified elsewhere.

f) The operation of the lifting equipment is specified elsewhere.

PS 9.2.8 **Line Filling**

When the pipeline is not full of water and it is necessary for the pump station to be made operational, any one of the four pumps shall be able to fill the pipeline safely via its plunger valve.

The pump shall be started from the MV control panel.

The hydraulic actuator of each plunger valve shall be manually operated (position controlled) from the hydraulic unit itself. The Contractor shall also allow for operation of the hydraulic unit from the MCC.

The pumpset chosen shall be started against its closed plunger valve and the valve shall be opened partially, by manual control, to maintain the pressure upstream of the plunger valve. The pressure shall be equal to the Guarantee Point head of the pump, specified elsewhere, and therefore allow a flow equal to the Guarantee Point flow into the pipeline. This filling operation is expected to take place over a period of approximately fifteen hours. The valve will require frequent manual adjustment of the position of the plunger valve in order to maintain the upstream pressure and as the pressure downstream of the valve increases.

This procedure shall be accomplished by manual operation of the equipment. Only one pump shall be allowed to operate during line filling.

During this procedure, the process interlocks via the PLC shall be out of operation. The electrical protection and safety interlocks shall be functional. The pump and the pump station protections shall be temporarily suppressed by a switch control at the 11 kV motor starter control panel. Once the pipeline is full, it shall be possible to revert to normal pump station operation. These actions shall be manual.

This line filling procedure is expected to be done once every six months on average although it might occur more than once during commissioning if snags are experienced.

### PS 9.2.9 Instrumentation

Instrumentation shall be provided as per Electronic Specification

## PS 9.3 GENERAL MECHANICAL REQUIREMENTS (Aur 0001)

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

- Materials
- Castings
- Fabrication of steels
- Welding
- Installation
- Civil and building works
- Pipework supports
- Baseframes
- Machine guards
- Shaft couplings
- Gearboxes
- Bearings
- Lubrication
- Gauges
- Fasteners
- Machine vibration
- Noise control
- Spares
- Signage

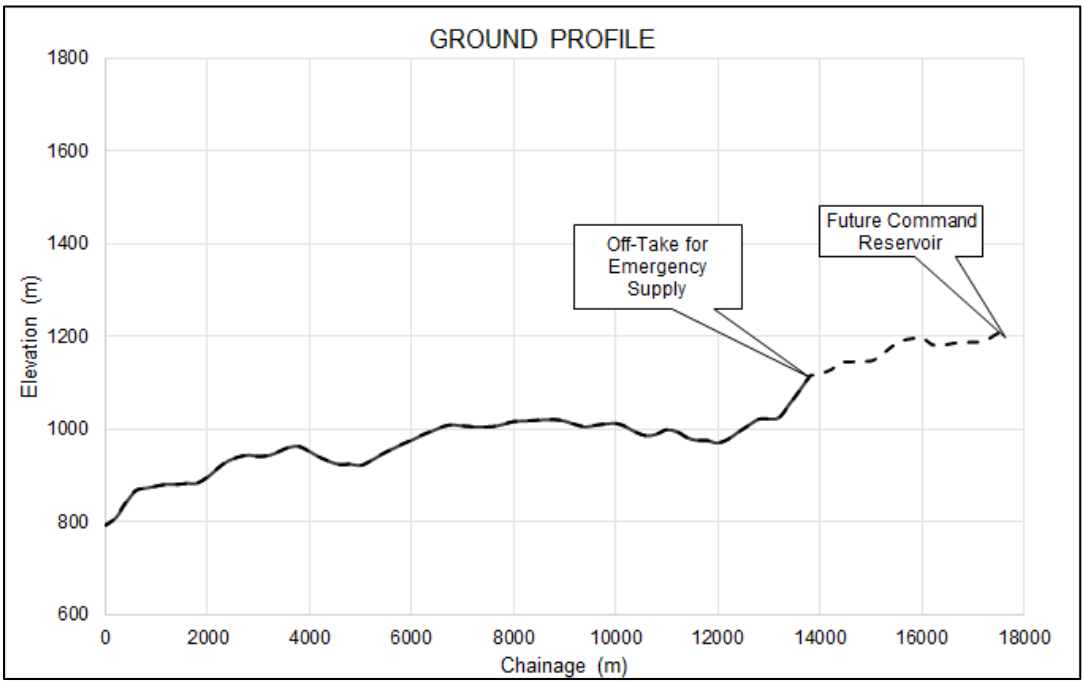
## PS 9.4 MULTI-STAGE CENTRIFUGAL PUMPS (Aur 10 010)

### PS 9.4.1 Specification

The pumps shall be multi-stage, ring-section centrifugal units with horizontal shaft and shall comply with Aur 10 010.

The fluid to be pumped will initially be raw river abstracted water as part of the emergency supply scheme and later potable water.

The ground profile of the discharge pipeline is as shown below.




The Suction Reservoir is as shown on the drawings and the full supply level is 797.75 masl.

The Command Reservoir is as shown on the drawings and the full supply level is 1217.60 masl.

The emergency supply discharge point is shown on the drawings and the level is 1123 masl.

The elevations of the various levels in the pump station are as shown on the drawings. The pump station pump room floor level is at 790.20 masl.

### PS 9.4.2 Amendments, Additions and Detailed Requirements (Aur 10 010)

PS 9.4.2.5 Scope (Clause 2)

The Contractor shall provide four pumpsets as shown on the drawings.

The Contractor shall provide all items specified for each pumpset, including the following:

a) Pump.

b) Pump motor.

c) Baseframe 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 butterfly valve.

g) Discharge isolation gate valve

h) Plunger valve.

i) Electrical and control equipment.

PS 9.4.2.6 Performance Requirements (Clause 5)

The pump station duty with three pumps operating is expected to be 370 litres per second at a head of 445 metres. The characteristic system curves are shown in the figure below.

Each of the four pumps shall perform in accordance with the following performance requirements:

a) The pump guarantee point (i.e. the point at which the Contractor shall test in order to confirm the tender guarantee for head, flow, efficiency and power demand) is 124 litres per second at a differential head of 445 metres. This is the pump duty point with three duty pumps.

b) The pump shall be capable of operating continuously without damage (i.e. the pump shall be within the manufacturer's recommended operating range) when only one pump is operating. This will be at an estimated differential head of 427 metres but the tenderer/Contractor shall use both system curves (future and emergency) to calculate the operating conditions for the pump.

As part of the emergency demand the pumps shall initially be installed with a number of dummy (empty) stages to provide a minimum flow of 150 litres per second at a differential head of 333 metres when one pump is in operation. The maximum flow with 2 duty units shall not exceed 290 litres per second. The emergency supply shall consist of two duty units and two standby units. The impeller diameter shall however be selected for the future demand as per the performance requirements described above.

PS 9.4.2.7 Operation and Control (Clause 6)

Control of the pumpsets is specified elsewhere in PS9 and, where differences exist, the requirements of Aur 10 010 are secondary.

PS 9.4.2.8 Pumps (Clause 8)

The pump shut off head (with impeller size for guarantee point) shall not be less than 475 metres.

The pumpsets shall have an operating speed of 1 500 rpm.

The pump casing shall be designed for a PN 63 rating. This applies to the full casing and seals as it is possible that a pump casing will be subjected to the full operating pressure developed by one of the other pumps.

The pump impellers' diameter selected in order to produce the performance requirements shall be no greater than 95 percent of the maximum allowable impeller diameter for the pump model and no smaller than 5 percent above the minimum diameter.

An abrasion resistant coating is not required in this application.

The seals shall be mechanical seals of the cartridge type.

The contractor shall provide a means of removing air from the pump. This shall include at least one tapping on the suction casing and one tapping on the discharge casing.

Automatic air release valve shall be provided with the pump.

The additional impellers and diffusers shall be provided in protective wooden boxes.

PS 9.4.2.9 Motors (Clause 11)

The pump motors shall comply with the electrical specification for MV electrical motors.

A motor power margin of at least twenty percent in excess of the highest designed power requirement of the pump to be provided by the Contractor.

PS 9.4.2.10 Instrumentation (Clause 14)

Pressure gauges and pressure transmitters shall be connected to a ring manifold with pressure tappings (on blank flanges bolted to DN100 flanged) in accordance ISO 9906 and the specified pump testing grade.

Flow sensors shall be provided on DN100 flanged stubs.

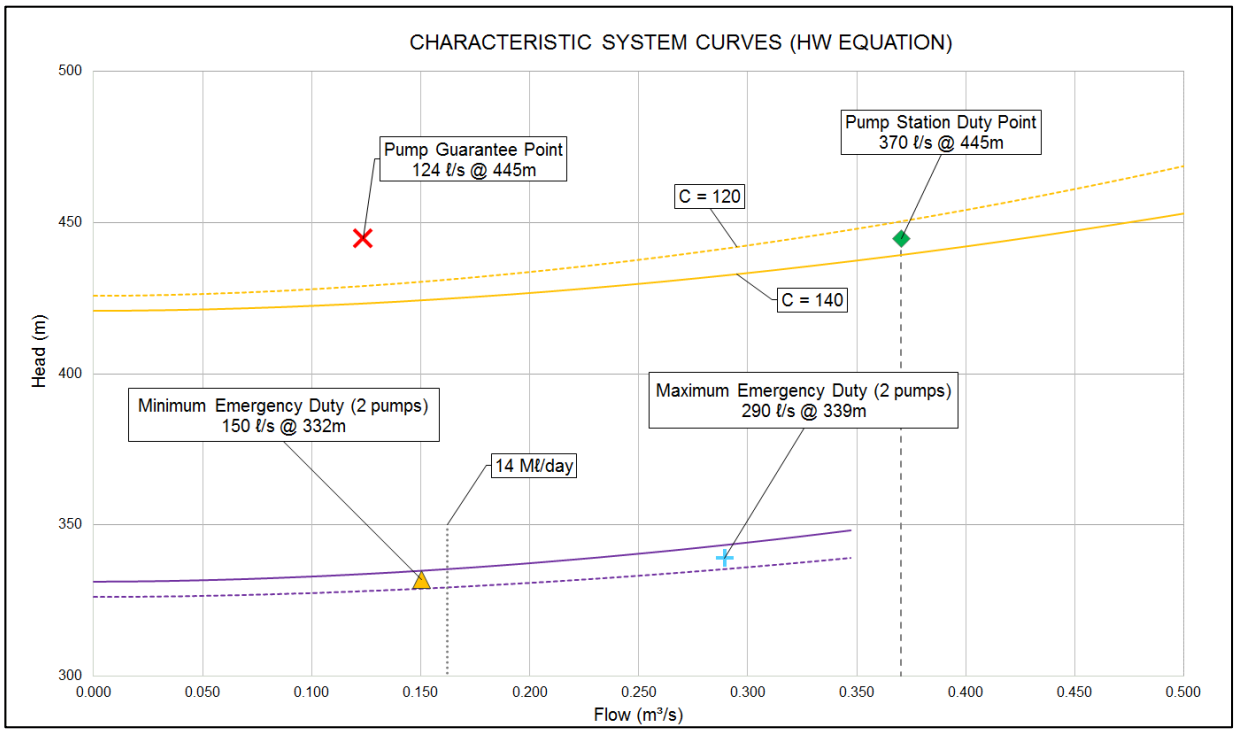
PS 9.4.2.11 Testing (Clause 25)

Each of the four pumps shall be tested in the factory in accordance with ISO 9906. The acceptance grade shall be Grade 1E. Testing shall be done for flow, head, efficiency and $NPSH_{REQUIRED}$. The pumps shall be tested with all stages and then dismantled to remove impellers and diffusers as required for the emergency supply scheme.

These factory tests shall be witnessed by the Engineer and one representative plus another two persons from the Employer. The Contractor shall make all arrangements and carry all costs for transport and accommodation for the Engineer and one representative as well as two persons from the Employer.

Casings shall be pressure tested to confirm the PN 63 rating.

Each of the four pumps shall be tested on Site in accordance with ISO 9906 Grade 2B. Pump performance curves shall be provided to confirm that the guaranteed head, flow and efficiency are met.



## PS 9.5 ECCENTRIC AXIS BUTTERFLY VALVES (DWS 2510.04 )

### PS 9.5.1 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 Aur 0001.

### PS 9.5.2 Scope

One DN600, PN 63 rated suction side isolation butterfly valve shall be provided for each of the four pumps.

One DN500, PN 63 rated pump station isolation butterfly valve shall be provided on the discharge manifold.

One spare DN400, PN 63 rated butterfly valve shall be provided

One spare DN500, PN 63 rated butterfly valve shall be provided

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 it 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 it 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.

### PS 9.5.3 Amendments, Additions and Detailed Requirements (DWS 2510.04 )

#### PS 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.

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-torqueing.

Motor driven gearboxes shall comply with the requirements for motor driven gearboxes in Aur 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 Aur 0001.

PS 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:

c) 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.

d) Valves shall have the manufacturer's name, size, working pressure and flow direction integrally cast with the valve body.

Manually operated gearboxes shall be provided with a stainless steel grease nipple.

PS 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 Aur 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.

## PS 9.6 METAL SEATED WEDGE GATE VALVES (DWS 2510.03 – Gate Valves)

### PS 9.6.1 Specification

Metal seated wedge gate valves shall comply with DWS 2510.03 – Gate Valves.

Electric actuators shall comply with DWS 2510.02.

Corrosion protection shall comply with DWS 9900 C7.

Installation work shall comply with Aur 0001. The valves shall be positioned at least 1500mm downstream from the plunger valve on each respective pump line.

### PS 9.6.2 Scope

One PN 63 rated discharge side isolation metal seated wedge gate valve shall be provided for each of the four pumps.

One spare DN400, PN 63 rated metal seated wedge gate valve shall be provided

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 it 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 it 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.

### PS 9.6.3 Amendments, Additions and Detailed Requirements (DWS 2510.03 – Gate Valves)

PS 9.6.3.4 General (Clause 1)

The valves shall be suitable for the flow, internal pressure and differential pressure conditions of the pumping system.

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. The spindle seal shall not leak.

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

Motor driven gearboxes shall comply with the requirements for motor driven gearboxes in Aur 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 Aur 0001.

PS 9.6.3.5 Construction and Operational Requirements (Clause 2)

The body shall incorporate a drain with a stainless steel plug.

Handwheels shall be clockwise closing.

A slipping clutch shall be provided to prevent damage. Shear pins and other torque limiting devices which have to be replaced after activation are not acceptable but mechanisms equivalent to a slipping clutch will be acceptable.

Clear indication of current valve position shall be provided.

The thrust surfaces shall be outboard of the spindle seal and shall not be wetted by the fluid. The thrust housing shall be provided with a stainless steel greasing nipple or other facility for lubrication.

Fixing lugs for end of travel limit switches shall be provided.

The body shall incorporate storage feet.

Manually operated valves shall be provided with handwheels of a size and construction which permit easy opening of the wedge gate when subjected to a differential pressure equal to the rated pressure difference across the wedge gate. 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). Suitable gearboxes shall be fitted to achieve this.

Valves of DN 250 and larger shall comply with the following additional requirements:

e) Valves shall be provided with a bypass. The bypass pipework shall be flanged pipework and a flanged isolating wedge gate valve shall be provided on the bypass.

f) Valves shall have the manufacturer's name, size, working pressure and flow direction integrally cast with the valve body.

g) A threaded tapping shall be provided both upstream and downstream of the wedge gate valve.

Manually operated gearboxes shall be provided with a stainless steel grease nipple.

PS 9.6.3.6 Material (Clause 3)

Guides and wedge shoes shall be of a copper based alloy or of engineering plastic or of stainless steel.

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

Handwheels shall be of cast metal or shall be of stainless steel.

All fasteners shall be of EN Grade 1.4401 (316) stainless steel

All other external metal components shall be of EN Grade 1.4401 (316).

Electrolytically applied plating of ferrous materials is not acceptable.

The application shall be taken into account in the corrosion protection of valves.

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

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.

Materials shall comply with the requirements for material in Aur 0001.

## PS 9.7 PLUNGER VALVES (Aur 7030)

### PS 9.7.1 Specification

The plunger valves shall comply with Aur 7030.

### PS 9.7.2 Amendments, Additions and Detailed Requirements (Aur 7030)

PS 9.7.2.1 Scope (Clause 1)

One PN 63 rated plunger valve shall be provided for each of the four pumps.

The valves shall incorporate the valve itself, a weighted lever, hydraulic ram and power pack for opening and a fail to safe (close upon power failure) system. Hydraulic power shall be provided by an electric motor driven hydraulic power pack. One power pack shall be provided per valve and these shall be located at the valves.

The valves shall be installed as shown on the drawings.

The plunger valves shall have a lever arm with closing weight

PS 9.7.2.2 Performance Requirements (Clause 5)

The equipment shall be selected and sized in order to achieve the functions specified in sub-clause “Process and Control”.

The valve shall be closed when a pump starts and shall open in order to control flow into the full pipeline.

As specified in sub-clause “Process and Control”, the valve shall be suitable for occasional regulation of flow for filling of the pipeline whilst its upstream side is subjected to the full shut-off head of the pump and the pressure on the downstream side is initially negligible. The design requirements for line filling must be adequately addressed. During line filling the valve shall operate without cavitation damage.

The valve’s operating condition, however, is in the fully open position with pumped flow passing through it.

PS 9.7.2.3 Operation and Control (Clause 6)

Hydraulic pressure to the actuator shall be held by a release orifice which is held closed by an electric solenoid; i.e. a normally open arrangement. During all equilibrium and intermediate states of the valve and pumpset, the release orifice shall open immediately upon power failure. Upon opening of the release orifice, the weighted lever arm shall close the valve. This action shall perform the check valve duty. The release orifice shall be sized to provide a closing time from fully open to fully closed in maximum 4 seconds (this period is critical and shall be confirmed on Site for all four valves).

PS 9.7.2.4 Valve Design and Construction (Clause 7)

The valves shall have a nominal rating of PN 63.

The valves shall be designed to optimise the operating conditions described above in “Performance Requirements”.

The complete system including the valve, actuator, power pack, linkages, etc. shall be provided by the valve manufacturer and shall not be built from separately sourced components by the Contractor.

PS 9.7.2.5 Actuator (Clause 9)

It is not necessary that the actuator complies with Aur 6004.

The complete actuation system shall be provided with the valve as a package by the valve manufacturer.

The actuator shall incorporate hydraulic operated opening and weighted lever arm closing systems. The hydraulic system shall be powered by an electric motor operated hydraulic power pack.

The shaft for the actuator and lever arm shall be provided with two bearings; i.e. one at each end. The lever arm shall not be supported by the valve shaft.

In addition to, and in conjunction with, the operational requirements of the sub-clause "Process and Control", the valve actuator shall be provided with a panel at the valve which allows the operator to both open the valve at the specified ramp rate as well as operate the solenoid for the release orifice.

PS 9.7.2.6 Materials and Coatings (Clause 12)

Corrosion protection shall comply with DWS 9900 C7.

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.

PS 9.7.2.7 Spares (Clause 15)

The Contractor shall provide the following:

a) three spare sets of all elastomer seals and gaskets shall be provided by the Contractor.

b) Three hydraulic oil filter elements.

c) Three hydraulic pump and motor/ram seals.

PS 9.7.2.8 Installation (Clause 16)

The valves shall be oriented with the lever arms on the side of the pipework as shown on the drawings in order to provide adequate separation between the four pump lines.

The valve shall be installed at least 2000mm from the pump discharge flange.

PS 9.7.2.9 Inspections (Clause 19)

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

## PS 9.8 NOZZLE CHECK VALVE (Aur 7012)

### PS 9.8.1 Specification

Nozzle check valves shall comply with Aur 7012.

Corrosion protection shall comply with DWS 9900 C7.

### PS 9.8.2 Amendments, Additions and Detailed Requirements (Aur 7015)

PS 9.8.2.1 Scope of Works (Clause 2)

One DN500, PN 63 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 shown on the drawings.

PS 9.8.2.2 Performance Requirements (Clause 5)

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

PS 9.8.2.3 Design and Construction (Clause 6)

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

The valve shall be designed for non-slam closure.

PS 9.8.2.4 Materials and Coatings (Clause 8)

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.

PS 9.8.2.5 Installation (Clause 11)

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.

PS 9.8.2.6 Testing Requirements (Clause 14)

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.

## PS 9.9 PIPEWORK (DWS 1130)

### PS 9.9.1 Specification

Design and manufacture of pipework shall comply with DWS 1130.

Flanges shall comply with DWS 1130.

### PS 9.9.2 Amendments, Additions and Detailed Requirements (DWS 1130)

PS 9.9.2.1 Scope (Clause 1)

The Contractor shall provide the pipework within the pump station buildings as indicated on the drawings.

Pipework shall be flanged unless shown otherwise.

The Contractor shall provide the following:

a) Pipework, including flanges.

b) Flange fasteners.

c) Pipework supports.

d) Pipework couplings and coupling restraints.

e) Nozzles for instruments, drains and air release.

The suction and discharge manifold tees shall be of the lateral tee configuration.

Pipework configuration shall comply generally with Aur 0001 Clause 11.

Each pump discharge line shall be provide with a DN100 flanged stub with blank flange, DN25 threaded nipple and DN25 isolation ball valve for drainage of the respective pump line.

DN100 flanged stubs shall be provided on the suction and discharge side of the pump for pressure transmitters, pressure gauges and flow switches.

Pipework upstream of each pump line's suction isolation valves shall have a pressure rating of PN 10 or higher.

Pipework downstream of each pump line's suction isolation valves shall have a pressure rating of PN 63 or higher.

PS 9.9.2.2 Interpretations (Clause 2)

*Replace the first sentence in the first paragraph of sub-clause 2.2 with:*

"This specification contains clauses that are generally applicable to the design, manufacture and supply of steel pipes, specials and fittings for duties up to 6.3 MPa.

PS 9.9.2.3 Materials (Clause 3)

Pipework shall be of carbon steel and shall be of API 5L steel grade X52 or higher.

Puddle flanges shall comply with Aur 0001.

The Contractor shall provide one puddle pipe on the discharge manifold and one puddle pipe on the suction manifold as shown on the drawings.

Puddle pipes shall be of EN Grade 1.4162 (LDX 2101) duplex stainless steel or higher.

The discharge manifold puddle pipe shall not be designed as thrust support for the discharge manifold.

The Contractor shall provide four insulating flange kits and shall install one at each end of each of the two puddle pipes.

*Replace the first sentence of the last paragraph of sub-clause 3.1 with:*

Mild steel flanges shall be manufactured from steel plate conforming to BS 4360 or SANS 1431 Grade 300W for working pressures up to PN 25. Flanges rated more than PN 25 and up to PN 60 shall be made from steel manufactured in accordance with BS EN 10222 Grade 460 or as approved. Flanges for pressures exceeding PN 60 and up to PN 250 shall be special flanges and gaskets manufactured by Hydro Power Engineering or equal approved.

*Replace the last paragraph of sub-clause 3.3. with:*

Asbestos gaskets in accordance with BS 1832 Grade B, and having a minimum thickness of 1,5 mm, shall be supplied for working pressures not exceeding PN 16.

Where working pressures exceed PN 16, and for DN 400 and over, rubber "O" rings dimensioned in accordance with BS EN 1092 Section 3.1, Fig. 4 for Types G and H flanges, shall be supplied to suit appropriately machined flanges.

Where flanges have not been machined in accordance with the above, spiral wound gaskets, style CG to BS 3381 shall be used. The external ring shall be made of carbon steel and electro plated. The metal windings shall consist of Grade 316 L stainless steel with asbestos filler.

Where flanges with flat faces are jointed, the gaskets shall be of the type manufactured by HPE and as specified below:

The gasket shall consist of a seal ring made from ultra high molecular weight polyethylene (UHMWPE) (section 10 mm x 5 mm minimum) which fits snugly inside a 3 mm thick x 30 mm wide (minimum) flat steel outer ring. The reuse of UHMWPE seal rings is inadmissible.

The outer ring shall consist either of:

a) A mild steel ring, hot-dip galvanized in accordance with SANS 121 to a minimum mean coating thickness of 65 µm. The finish shall be of even thickness to ensure that the ring bears evenly throughout between the two flanges.

Or

b) A 3CR12 steel ring

PS 9.9.2.4 General Requirements (Clause 5)

*Replace sub-clause 5.3.1 with the following:*

Only qualified welders, certified as having passed the qualification tests as specified in Clauses 6.1 to 6.7 inclusive of API Standard 1104 or alternatively, SANS 10044: Part IV, shall be used to do all welding required. Copies of the certificates shall be made available to the Engineer.

Welding and inspection of welds shall be in accordance with Clauses 7 to 11.4 inclusive of API Standard 1104 or alternatively, SANS 10044: Part III. Where radiographic inspection is specified in the Amendments, the procedure followed shall be in accordance with Clause 11.1 of API Standard 1104. Only qualified radiographers as specified in API Standard 1104 shall be employed to do the radiography.

Internal reinforcement in the form of backing rings at weld seams shall not be permitted.

The internal weld bead/upset metal and flash on the inner surface shall not exceed 1 mm. For pipes and specials to be joined by butt welding, the internal weld bead shall not protrude more than 1 mm into the bore of the pipe or special. For electric resistance welded pipes, the height of upset metal and flash on the inner surface shall not exceed 1 mm. For pipes and specials to be joined by butt welding, the internal weld bead shall be ground flush with the pipe body for a length of 200 mm from the ends to be jointed. For pipes and specials to be coupled by flexible couplings, external weld reinforcement or upset metal and flash shall be ground flush with the pipe body for a length of 250 mm from the end to be coupled and shall be free from indentations projections or roll marks

Where automatic submerged-arc welding is employed, at least one pass shall be made on the inside and at least one pass on the outside. This shall apply for double jointing of pipes in the factory as well. The number of longitudinal weld seams shall not exceed:

(a) 1 for pipes up to 1 000 mm nominal diameter;

(b) 2 for pipes larger than 1 000 mm and up to 2 220 mm nominal diameter.

For pipes to be joined by flexible couplings the pipe manufacturer is required to weld steel plates not less than 50 mm x 50 mm x 16 mm thick to each end of all pipes during the pipe manufacturing process, (i.e. before priming, lining and coating). Steel plates shall be located far enough from each pipe end so as not to interfere with the installation of the flexible coupling.

*Add the following to sub-clause 5.3.2*

Specials which require joints to be butt welded on site shall be supplied with ends bevelled in accordance with the requirements of SANS 719, Clause 5.1.5.

*In sub-clause 5.3.3.2, replace the last sentence of the first paragraph with:*

Bend radii shall be three pipe diameters unless otherwise indicated on the drawings or specified in the Bill or Schedule of Quantities.

*Replace sub-clause 5.3.3.5 with:*

Ends for use with mechanical couplings shall be square cut or bevelled plain ends, cut square to the pipe axis, with all edge burrs, weld splatter and scratches removed. The outside of the pipe shall be free of indentations, projections or roll marks for a distance of

250 mm from each end to permit proper make-up of the coupling. Longitudinal or spiral welds on the outside of the plain end shall be ground to plate or sheet surface for a minimum distance of 250 mm.

Flexible couplings for plain-ended steel pipe and adaptor couplings shall be either of the slip-on type complying with Clause 15 of BS 534 or of the slip-on type without centre register conforming to the drawings, as scheduled. Slip-on flange adaptors for steel pipes shall conform to the relevant drawings.

A coupling shall be able to withstand without failure a hydrostatic test pressure of twice the working pressure specified for the pipe for which the coupling is required, and coupling flanges shall be capable of withstanding without damage all stresses caused by proper tightening of the bolts. Rubber rings shall comply with the relevant requirements of SANS 974: Part I and shall have a hardness of 66 to 75 IRHD.

All grinding off of welds shall conform accurately with the profile of the rolled section and so that no flats occur on surfaces that are supposed to be curved. The centre register (where present) shall be ground off on either side of the weld in such a manner that all sharp edges which would result in weakening of the protective coating are removed. Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings.

*Replace the first sentence of sub-clause 5.3.3.7 with:*

Except where specified to the contrary in the Project Specification or on the drawings, all flanges shall be steel-plate for welding and shall conform to BS EN 1092.

All flanges shall be machined overall with gramophone finish in accordance with SANS 1123.

PS 9.9.2.5 Marking of Pipes and Specials (Clause 6)

Upon fabrication, each special shall be hard stamped with a unique reference number to ensure traceability. The stamp is to be 100mm from the pipe end and next to a weld. On completion of the contract or at reasonable intervals during the contract, the following pipe information shall be supplied to the Engineer in Microsoft Excel ® format:

a) Pipe reference number
b) Contract number
c) Date of manufacture
d) Outside diameter
e) Wall thickness/pressure rating
f) Grade of steel
g) Coating type and nominal thickness
h) Lining type and nominal thickness
i) Mass of uncoated and unlined special in kg/m
j) Applicable drilling tables stamped on the periphery of all flanges
k) Bends shall have their “centre plane” marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends during laying.

PS 9.9.2.6 Storage, Handling and Transport (Clause 7)

*Replace clause 7 with the following:*

Specials shall be protected against damage at all stages from manufacture to delivery. Particular care shall be taken to protect the ends of all specials against denting.

In the transportation, loading and unloading of specials, an adequate fleet of vehicles shall be operated and maintained at all times to ensure that specials and their protective linings and coatings are not damaged.

Specials shall be so transported, stored and handled that they are not overstressed at any time and fittings are not damaged in any way. Access for delivery on site might be restricted by poor weather conditions and the Contractor shall make due allowance for such disruption. Unless otherwise specified the pipes shall be off-loaded adjacent to the laying position. All thin-walled and soft-coated specials shall be handled with particular care and shall be so stored that they are not subjected to concentrated pressure from stones or other objects. Specials damaged or cracked in any way shall be removed from the Site at no cost to the Employer.

If cradles are used to transport the specials they must be rubber lined to avoid damage to the coating. During transportation specials shall be safely secured.

The Contractor shall be responsible for dispatching and transporting of the pipes to site and off-loading.

Temporary end covers shall be provided for the protection of the ends of all pipes and specials to protect pipe linings from damage during transport and during storage and handling on site. Suitable access along the pipeline route must be provided by the Contractor.

PS 9.9.2.7 Inspections and Methods of Test (Clause 8)

All welds that can be radiographically (X-ray) tested shall be radiographically tested (X-rayed) over 100% of the weld length.

All welds that cannot be radiographically (X-ray) testes shall be dye-penetrant tested.

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

*Remove the last sentence of sub-clause 8.2.4*

*Add the following to sub-clause 8.3.*

If a special fails to pass any of the tests specified, it will be rejected but the Engineer may permit repairs or alterations to be made to enable the special to pass the test.

Repairs of welded joints will be permitted during the process of manufacture. Where repairs are required the defective weld metal shall be cut out, and the parent metal prepared by grinding, and re-welded, to the satisfaction of the Engineer.

Each repair weld shall be marked with the welder's identifying stamp.

When the repair has been made, it shall be radiographically tested (X-rayed) over the full length of the repair.

On discovery of defective welds the Engineer may, at his discretion, call for additional radiographic examination until it is shown that the necessary standard is being maintained.

Should a weld repair be required on a special subsequent to hydraulic testing, the repaired special shall be retested.

*Delete sub-clause 8.4.*

PS 9.9.2.8 Corrosion Protection (Clause 9)

Corrosion protection shall comply with DWS 9900 C7.

Linings shall comply with Clause 8 – Epoxy Coating Systems. The lining shall have a minimum dry film thickness of 600 micron.

Coatings shall comply with Clause 7 of DWS 9900 C7–Rigid Polyurethane Coating System. The coating shall have a minimum dry film thickness of 750 micron.

The straight pipe between each plunger valve and discharge isolation gate valve shall be lined with an abrasion and erosion resistant ceramic lining system designed for the high velocities and turbulent flow conditions on the discharge side of the plunger valve.

PS 9.9.2.9 Measurement and Payment (Clause 10)

*Replace clause 10 with the following:*

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for corrosion protection. The rates tendered will be held to cover the cost of any protection system specified.

The unit rates shall cover the cost of the provision of each special, complete with couplings and/or other jointing materials as appropriate, and for the design of all specials including all drawings and shop drawings.

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for the supply and delivery to Site of any additional couplings and jointing materials which may be required for the connection of the specials.

## PS 9.10 COUPLINGS AND FLANGE ADAPTORS (AUR 7023)

### PS 9.10.1 Specification

Flange adaptors shall comply with Aur 7023.

### PS 9.10.2 Amendments, Additions and Detailed Requirements (Aur 7023)

PS 9.10.2.1 Scope (Clause 2)

The Contractor shall provide flange adaptors for misalignment and dismantling purposes. These shall be in the positions as shown on drawing number 106777-MM-0503.

PS 9.10.2.2 Performance Requirements (Clause 5)

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

PS 9.10.2.3 Construction and Design (Clause 6)

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

PS 9.10.2.4 Corrosion Protection (Clause 10)

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.

PS 9.10.2.5 Inspections (Clause 12)

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

## PS 9.11 PIPEWORK SUPPORTS (AUR 7024)

### PS 9.11.1 Specification

Pipework supports shall comply with Aur 7024.

PS 9.11.2 **Amendments, Additions and Detailed Requirements (Aur 7024)**

PS 9.11.2.1 Performance Requirements (Clause 4)

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.

PS 9.11.2.2 Construction and Design (Clause 5)

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.

PS 9.11.2.3 Corrosion Protection (Clause 8)

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

PS 9.11.2.4 Inspections (Clause 12)

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.

PS 9.12 **LIFTING EQUIPMENT (Aur 1003)**

PS 9.12.1 **Specification**

Lifting equipment shall comply with Aur 1003.

PS 9.12.2 **Amendments, Additions and Detailed Requirements (Aur 1003)**

PS 9.12.2.1 Scope (Clause 2)

The Contractor shall provide one overhead travelling crane incorporating a maintenance platform with access ladder.

The Contractor shall provide the crane with electric long travel, electric cross travel and electric hoisting. The Contractor shall provide the crane rails.

PS 9.12.2.2 Performance Requirements (Clause 5)

The crane shall travel along the full length of the building and including the loading bay as shown on drawing number 106777-MM-0503.

The crane's rail beam shall be mounted on the top surface of the columns as shown on the drawings.

The long travel shall be approximately 42 metres.

The cross travel shall be approximately 13 metres.

The crane shall be suitable for lifting the equipment to be provided by the Contractor but shall, nevertheless, have a Safe Working Load of at least 15 tonnes.

PS 9.12.2.3 Additional Requirements for Steel Gantries (Clause 11)

The rail beam is part of the gantry for the crane and shall comply with this clause.

PS 9.12.2.4 Additional Requirements for Travelling Cranes (Clause 12)

Hoisting, long travel and cross travel shall all be electrically driven.

The crane shall be operated from an infrared wireless control. A separate local control panel shall be provided in case the infrared wireless control fails.

In Sub-Clause 12.1.1, replace "Aur 0003" with "DWS 9900 C7".

PS 9.12.2.5 Additional Requirements for Manual and Electric Hoists (Clause 14)

The electric hoist shall comply with this sub-clause

## PS 9.13 PERMANENT LADDERs (Aur 1001)

### PS 9.13.1 Specification

The ladders shall comply with Aur 1001.

### PS 9.13.2 Amendments, Additions and Detailed Requirements (Aur 1001)

PS 9.13.2.1 Scope

One ladder shall be designed and provided in a suitable position to provide access to the crane from the pump room floor.

One ladder shall be provided for access to the crane service platform from the loading bay floor.

One ladder shall be provided for access to the roof of the electrical rooms from the alley adjacent to the storage room.

One steel access platform with steps shall be provided for each of the four discharge isolation gate valves to allow for easy operation of the electrical actuator and handwheel.

PS 9.13.2.2 Design and Construction (Clause 4)

The upper part of the ladders shall be designed to provide easy and safe access to the crane platform, crane overhead service platform and roof of electrical rooms respectively.

The ladders shall incorporate a cage and, if the total rise exceeds 5 000 mm in length, the Contractor shall provide a platform mounted on the floor and provided with steps for access to the ladder and which will allow the total length of ladder to not exceed 5 000 mm in length.

The ladders for the crane service platform and crane access from the pump room floor, discharge isolation valve access platform and all peripheral fabrications shall be of hot-dip galvanised steel.

The ladder for access to the roof of the electrical rooms shall be of EN Grade 1.4301 (304).

All anchors shall be of EN Grade 1.4401 (316) stainless steel.

Ladders shall be of carbon steel.

In Sub-Clause 4.5, replace “Aur 0003” with “DWS 9900 C7”.

PS 9.13.2.3 Inspections (Clause 7)

The Contractor shall arrange for the Engineer to inspect all fabrications after all fabrication work has been completed but before the fabrications are hot-dip galvanised.

## PS 9.14 VENTILATION EQUIPMENT (Aur 10 014)

### PS 9.14.1 Specification

The ventilation system shall comply with the drawings and shall comply with Aur 10 014.

### PS 9.14.2 Amendments, Additions and Detailed Requirements (Aur 10 014)

PS 9.14.2.1 Scope (Clause 1)

The ventilation system to be provided by the Contractor shall be in accordance with the drawings.

Two ventilation fans, each with an upstream and a downstream sound attenuator shall be provided for ventilation into the pump room. The fans shall be installed on the roof of the electrical rooms. A filter bank shall be provided in the pump room which shall be

accessible from the pump room walkway. Back draught dampers shall be provided to prevent short circuiting of air between the fans.

Two louvre mounted fans shall be provided for positive pressure in the MV switchgear room. The louvres shall be fitted with removable filters.

One louvre mounted fan shall be provided between the pump room and cable gallery for fresh air supply to the cable gallery. One outlet louvre shall be provided between the pump room and cable gallery to discharge the fresh air supplied to the cable gallery. The louvres shall be fitted with removable filters.

PS 9.14.2.2 Performance Requirements (Clause 5)

The pump room ventilation fan system shall be sized for a duty/standby arrangement to supply a minimum flow of 10.3 cubic metres per second into the pump room.

PS 9.14.2.3 Operation and Control (Clause 6)

The pump room ventilation fan system shall operate continuously.

The pump room ventilation system shall supply ambient outside air to a low level in the pump hall. The air shall pressurise the complete pump room and the majority of the air supplied will rise and exit via the apex roof ventilators, carrying the heated air from the motors' energy losses. Secondary paths shall allow air to pass into the 11 kV switchroom, cable gallery, and the control room.

Fan operation shall appear on a suitable SCADA mimic.

PS 9.14.2.4 Design and Construction (Clause 7)

The Contractor shall provide the fan, the attenuators and all ducting and ancillary items such as ducting inlet weather louvres, dampers and duct and fan support structures for the pump room ventilation system.

The fans shall be of the axial flow type.

Ducting and louvres shall be of hot-dip galvanised steel.

All externally mounted inlets shall be provided with stainless steel mesh in order to prevent access by animals.

PS 9.14.2.5 Spares (Clause 11)

The Contractor shall provide the followings spares:

l) Two filter sets for pump room ventilations system

m) Two filter sets for MV switchgear room louvres

n) One filter set for cable gallery inlet louvre

o) One filter set for cable gallery outlet louvre

PS 9.14.2.6 Materials and Coatings (Clause 12)

In Sub-Clause 12.1, replace "Aur 0003" with DWS 9900 C7.

External ductwork shall be painted white on all external surfaces. The primer shall be specifically suitable for hot-dip galvanised surfaces.

Internal ductwork and the inside surfaces of all ductwork need not be painted.

PS 9.14.2.7 Testing (Clause 17)

The Contractor shall demonstrate to the Engineer that the specified air flow is achieved.

## PS 9.15 ELECTRICITY SUPPLY

### PS 9.15.1 General

The Ngqamakhwe Pump Station shall receive power at 11kV from an outdoor Eskom substation adjacent to the pump station via 2 x 10 MVA 66/11 kV transformers. The

Eskom substation and 66kV supply overhead line forms part of this Contract and shall be done as a self-build scheme to Eskom specifications to be operated and owned by Eskom.

The electrical infrastructure downstream from the 11kV terminals of the Eskom substation will belong to the Chris Hani Municipality. The specifications under this section applies to the municipality's infrastructure.

The relevant electrical parameters at the Eskom connection point for the Ngqamakhwe PS are as follows:

a) Supply voltage: 11 kV.

b) Fault level (3 phase): 2.7 kA (min) and 4kA (max)

c) Earth fault: 720A (max)

d) The point of common coupling (PCC) shall be taken as the 66kV busbar of the new substation.

### PS 9.15.2 Eskom 66kV/11kV Substation and 66kV Overhead line

Refer to section PS11 and PS12.

## PS 9.16 DESIGN OF ELECTRICAL AND ELECTRONIC WORKS

The concept design for the electrical and electronic works have been done by the Engineer. This concept design shall be confirmed by the Contractor based on the equipment offered and shall be further developed into detail design and Contractor's Documents.

The list of documents required that constitute the design deliverables are listed in PS 6.

## PS 9.17 GENERAL ELECTRICAL AND ELECTRONIC SPECIFICATIONS

The corrosion protection of the electrical and electronic equipment shall comply with

a) DWS 9900 C8: Corrosion Protection – Electrical Equipment

The colour coding of the electrical and electronic equipment shall comply with

a) DWS Colour Coding for Lights, Buttons and Switches (includes SCADA colour coding)

## PS 9.18 MV CABLE INSTALLATION

### PS 9.18.1 General

The MV cable installation shall comply with the

b) Engineering Standard SPE-EP-0042 MV Cables

c) Engineering Standard SPE-EE-0012: Cable Supports

d) Data Sheet: DS-PS-0042

### PS 9.18.2 Scope

New MV cables shall be provided as shown on the Single Line Diagram (SLD), drawing number 106777-0504-DRG-EE-0550.

The main cable routes are shown on drawing no. 106777-0504-DRG-EE-0559 and 106777-0504-DRG-CC-0201. Detail cable routes shall be designed by the Contractor to suit the equipment offered and shall be approved by the Engineer before cable supports are installed and trenching starts.

### PS 9.18.3 Installation

The main incoming MV supply cables shall be installed in cable ducts in the ground from the 11 kV termination point at the new Eskom substation to the cable gallery underneath the 11 kV switchgear room of the pump station. In the cable gallery cable ladders shall be used to support the cables.

The pump station shall supply the new Tsomo WTW with power. A feeder cable shall be laid to the overhead line feeding the WTW. The termination point to the overhead line structure and the overhead line route must still be confirmed.

Cables through walls and floors shall be sealed watertight with expansion foam, screeded over and coated similar to the surrounding surfaces.

Inside the Pump Station, the MV cables shall be installed on cable ladder.

Cables to the MV motors shall be installed in 500mm deep cable trenches (in the Pump Room floor), which shall be filled with compacted sand and covered with a cement screed to provide a smooth finished floor. The cables shall exit the trench onto a cable ladder to the motor terminal box.

## PS 9.19 11 kV OVERHEAD LINE TO TSOMO WTW

An overhead line will be installed from the pump station to supply the Tsomo WTW. The route for this overhead line have not been determined yet. Preliminary quantities have been allowed in the bill for pricing.

## PS 9.20 MV SWITCHGEAR

### PS 9.20.1 General

The switchboards shall comply with:

- DWA Standard Specification for MV Switchgear
- Engineering Standard SPE-EE-0022: MV and LV Power Factor Correction with Static Capacitors.
- Data Sheet: DS-EP-0002.
- The single line diagrams: 106777-0504-DRG-EE-0550 to 0552.

### PS 9.20.2 11kV Switchgear

A 11-panel 11 kV switchboard, comprising the following panels, shall be provided in the 11 kV Room of the pump station:

a) two incomer circuit breakers (CBs) for receiving supply from the 2 x 10 MVA transformers.

b) two feeder CBs for providing supply to the local distribution transformers (100 kVA each).

c) one feeder for new supply to the WTW (currently in construction)

d) Bus section CB and riser.

e) four DOL circuit breaker type motor starter panels for the pump MV motors.

Under normal operation the board shall be operated with the bus section closed, to ensure the necessary fault level at 11kV busbar for starting of the motors.

### PS 9.20.3 Protection and Relays

Protection for the incomers and feeders shall be provided in the form of relay(s) with following functionality as per the SLD:

a) Overcurrent (directional overcurrent on incomers),

b) earth-fault,

c) arc protection and

d) cable differential protection (incomers only)

Protection for the motor starter circuit breakers shall be provided in the form of motor protection relays (MPR) that shall include, but not limited to the following functionality:

e) Overcurrent

f) Short circuit.

g) Earth Fault.

h) Number of starts allowed.

i) Loss of load/undercurrent.

j) Loss of phase.

k) Unbalance (asymmetrical).

l) Thermal over load.

m) Start/stalled.

n) Locked rotor (start-up).

o) Speed switch input.

p) Winding temperature (PT100) input.

q) E-stop

r) Arc protection shall be provided in accordance with Arc protection single line diagram.

The switchboard manufacturer shall test the protection before the switchboard is delivered to Site, and the Engineer shall witness these factory tests at the travel cost of the Contractor. Upon completion of the erection of the switchboard on Site, the protection shall be re-tested and commissioned by a specialist protection sub-contractor.

The Contractor shall employ a recognized specialist protection sub-contractor for the following, and who shall be approved by the Engineer:

a) Calculation of all protection relay settings, including liaison with the Employer to obtain upstream relay settings and co-ordination margins.

b) Setting of all protection relays.

c) Site testing of all protection relays and associated equipment.

The Contractor shall include protection relay settings and test certificates issued by the specialist protection sub-contractor in the Operating and Maintenance Manuals, and shall issue copies to the Employer as required via the Engineer.

Programming software and data cables for connecting the protection relays to a laptop PC shall be provided for each type / model of relay.

PS 9.20.4 **Power Meters**

The incomer circuit breakers shall be equipped with summation CTs to a power meter with time-of-use (ToU) capability to be used as a billing check meter. The power meter shall have the capability to record and timestamp the rapid voltage changes during motor startup, which shall be used as part of the Contractor’s motor starting compliance checks.

PS 9.20.5 **Power Factor Correction**

PFC shall comply with:

a) Engineering Standard SPE-EE-0022: Power Factor Correction.

b) Data Sheet: DS-EP-0002

Power Factor Correction (PFC) shall be provided in the form of individual compensation per motor, with a capacitor bank being connected directly to each motor starter as shown

on the single-line diagram. A separate free-standing capacitor bank shall be installed in the cable gallery, directly below the MV switchgear.

The PFC capacitors shall be rated to provide reactive compensation equal to 90% of the motor no-load reactive power draw i.e. based on 0,9 times the motor no-load current.

### PS 9.20.6 Busbars

The MV switchgear shall contain a single set of busbars, rated to continuously carry a minimum current of 630 A. The busbars and circuit connections shall be air-insulated, but shall be completely covered with solid insulation capable of withstanding the rated voltages.

### PS 9.20.7 Circuit Breaker Operation

Each circuit breaker shall be withdrawable and equipped with an electric motor-charged spring-operated mechanism (with back-up manual charging) for performing the opening and closing operation.

One extraction table/trolley shall be provided for the removal of the circuit breakers and the earthing truck from the switchboard.

### PS 9.20.8 Auxiliary Switches

Auxiliary switches for all the circuit breakers shall be provided as follows for wiring to the Pump Station Master PLC (incomers and feeders) and the respective Pump PLC (Motor Starters) which shall be provided under the Contract:

| **Auxiliary Switches** | |
|---|---|
| CB | Open |
| CB | Closed |
| CB | Racked in: service position |
| CB | Racked out: service position |
| CB | Racked in: earth position |

### PS 9.20.9 Instrumentation and Indication

All instrumentation and measurement transducers shall be provided in accordance with the single line diagrams.

Indication lamps of the multi-LED type shall be provided to indicate the following on each panel of the switchboard:

a) CB open.

b) CB closed.

c) CB spring charged.

d) Heater on.

Voltage presence indicators of the capacitive type shall be provided on all incomer panels to indicate if the incoming cables are live.

### PS 9.20.10 Cable Boxes

The panels shall be provided with air-termination cable boxes suitable for the termination of the respective cables.

### PS 9.20.11 Earthing Arrangement

Circuit breaker panels shall be equipped with an integral earthing switch whereby the circuit cable may be positively earthed. Robust mechanical interlocking shall be provided to prevent the closing of the earthing switch unless the circuit breaker is open. A key locking facility shall be provided to enable the earthing switch to be locked in either the open or closed position.

The incomer circuit breaker's earthing switches shall be electrically interlocked with the Eskom 11kV line isolator.

An earthing truck shall be provided for the earthing of the busbars at the incomer panels. The truck shall be used in the place of the circuit breaker and it shall be possible to lock it in the service position with a padlock.

### PS 9.20.12 Current and Voltage Transformers

Current and voltage transformers (CTs and VTs) shall be provided in accordance with the single-line diagrams.

### PS 9.20.13 Control and Instrumentation Panel

An unequipped MV panel shall be provided to serve as a marshalling panel for the switchgear hardwired signals to the PLCs. Multicore and multipair cables shall be used to relay the signals back to the PLCs.

It shall also house the substation RTU that will be connected via an ethernet bus-network to the IEDs and Master PLC for supervision only.

### PS 9.20.14 MV Control Panel

A control panel shall be provided inside the LV room for starting and stopping the motors from the LV room. The panel shall have start/stop push buttons and indicators for all 4 pumps which shall be wired to the respective PLCs in the control room.

The Contractor shall provide a special lockable key in order to prevent manual operation of the pumpsets without the due authorisation and access keys.

## PS 9.21 BATTERY TRIPPING UNIT (BTU)

### PS 9.21.1 General

The units shall comply with

a) Engineering Standard SPE-EP-0004: Battery Tripping Units

b) Data Sheet: DS-EP-0004

### PS 9.21.2 Scope

Battery tripping unit (BTU) comprising batteries and a charger shall be provided for each MV switchboard to provide a 110 V dc supply for the switchgear's dc standing loads and trip coils.

It shall be supplied and installed complete with wiring, outputs to PLC, charge indicators, voltage sealed batteries and all necessary items.

A wall mounted 110V DC distribution board shall be provided adjacent to the BTU to supply the switchgear DC loads.

### PS 9.21.3 Installation

The BTU shall be installed in the 11kV room, adjacent to the MV switchgear panels, in the position indicated on the layout drawing no. 106777-0504-EE-0559.

The BTU shall be connected to the Pump Station Master PLC and all alarm signals and status signals shall be brought out to a terminal block in the Master PLC panel for this connection.

## PS 9.22 DISTRIBUTION TRANSFORMERS

### PS 9.22.1 General

The transformers shall comply with

a) Engineering Standard SPE-EP-0023: Distribution Transformers

b) Data Sheet: DS-EP-0023

### PS 9.22.2 100 kVA Transformers

Two new 100 kVA 11000 / 420 V distribution transformers shall be provided in the transformer bays along the outside of the Pump Station, in the positions indicated in layout drawing no. 106777-0504-DRG-EE-0559.

The transformers shall supply the small power and lighting, and all LV and control equipment of the Pump Station.

The transformers are both individually rated to supply the entire Pump Station LV load, but only one shall be connected to the main distribution board at any given time (mechanical changeover in LV panel).

A concrete bunded area shall be constructed for each transformer for oil catchment.

Each transformer bay shall be under roof, but open to the front with structural steel gates.

## PS 9.23 MV ELECTRIC MOTORS

### PS 9.23.1 General

The MV motors shall comply with

a) Engineering Standard SPE-EP-0008: MV Motors

b) Data Sheet: DS-EP-0008

The motor rated power indicated on the single-line diagram is the Engineer's estimate and the actual rated power shall be selected by the Tenderer to suit the offered pump and provide the specified rating margins.

### PS 9.23.2 Specific Requirements

The pump motors shall be 11 kV cage induction motors with rated speed, cooling method and mounting arrangement as stated in Detail Sheet No. EP-0008.

The starting (locked rotor) current of the motors shall be limited to a maximum of 350% of the motor rated nominal current. This shall include the 20% tolerance allowed by SANS 60034-1. Notwithstanding the above the start-up current shall not exceed 210 A. The starting (locked rotor) power factor of the motors shall be limited to a minimum of 15%.

### PS 9.23.3 Bearings

Motors shall be provided with oil lubricated bearings. Grease lubrication is not acceptable.

Slide bearings are preferred. Oil lubricated rolling element bearings are acceptable if slide bearings cannot be provided.

All operational states, including run down following electrical supply failure, shall be designed for so that no damage is caused.

Each bearing shall be provided with seals to exclude water and solids.

### PS 9.23.4 Surge Suppressors

Surge suppressors of the Zorc type or equal approved shall be provided in the terminal box of each motor.

### PS 9.23.5 Testing

A witnessed factory acceptance test shall be performed which shall include a temperature rise test, routine tests and additional tests indicated on the data sheets.

In addition to general testing of the motors the Contractor shall also take motor starting measurements that shall include the following:

a) starting current of the motors

b) the rapid voltage changes caused by motor starting for the different starting scenarios (one motor starting, one motor running and one starting etc.) at the 11kV busbar and 66kV busbar.

c) This study findings shall be presented as part of the Testing and Commissioning Report.

## PS 9.24 LV ELECTRICAL INSTALLATION

### PS 9.24.1 General

The LV electrical installation shall comply with:

a) Engineering Standard SPE-EE-0011 LV Electrical Cables

b) Engineering Standard SPE-EE-0012: Cable Supports

c) Data Sheet: DS-EE-0011

### PS 9.24.2 LV Cable Installation

Heavy duty mild steel hot-dipped galvanised cable ladders shall be provided to support power cables.

Heavy duty mild steel hot-dipped galvanised wire mesh cable tray shall be provided to support control and instrumentation cables.

Control and instrumentation cables shall be installed at least 300 mm away from power cables.

Inside the Pump Room the LV cables shall be installed inside the trenches provided in the pump station floor and on cable ladder where the cables exit the trenches.

Inside the Pump Room control and instrumentation cables shall be installed inside the trenches provided in the pump station floor and on wire mesh cable tray where the cables exit the trenches.

Cables shall enter and exit the LV MCC board from the bottom of the panel.

All surface-mounted conduits used for the installation of LV cables shall be hot-dip galvanised.

Cables through walls and floors shall be sealed watertight with expansion foam, screeded over and coated similar to the surrounding surfaces.

## PS 9.25 LV ELECTRIC MOTORS

### PS 9.25.1 General

LV motors shall comply with:

a) Engineering Standard SPE-EE-0025: LV Electric Motors

The motor rated power indicated on the single-line diagram is the Engineer's estimate and the actual rated power shall be selected by the Tenderer to suit the offered equipment and provide the specified rating margins.

## PS 9.26 LV SWITCHGEAR AND CONTROLGEAR ASSEMBLIES

### PS 9.26.1 General

The LV motor control centre shall comply with

a) Engineering Standard SPE-EE-0010: LV Switchgear and Controlgear Assemblies

b) Data Sheet: DS-EE-0010.

The LV MCC and Local Control Table attached to the specification contain details of the starters, control and indication which shall be provided in the MCC.

Drawing 106777-0504-DRG-EE-0554 shows a single line diagram of the MCC.

### PS 9.26.2 Assemblies

The MCC shall consist of the following:

a) Two main incomer sections.

b) Manual changeover panel (with mechanical interlock) (for selection of transformer supply).

c) Power supply and control compartments for the required incomer, pump motor starters, and other equipment.

d) Building services distribution section (small power and lighting) (also see Electrical and Electronic Building Services Section)

e) Ventilation fan feeders.

f) Actuator feeders

g) Single phase supplies to the 11kV Switchgear, BTU

h) Single phase supplies to instrumentation and control (via isolator transformer)

i) Terminal strip for termination of all control wiring. All control inputs and outputs for each LV motor shall be wired to the relevant pump PLC. Only the power supply (main circuit breakers open/close, control voltage, etc) shall be wired to the Master PLC.

### PS 9.26.3 Local Control Stations

A pedestal mounted Emergency Stop Station shall be installed within arm's length on both sides of each MV motor.

### PS 9.26.4 Installation

The assembly shall be installed in the LV distribution room.

The MCC shall be earthed to the building earth bar.

All cables shall enter and exit the MCC from the bottom.

## PS 9.27 ELECTRICAL ACTUATORS

### PS 9.27.1 Generals

The electrical actuators shall comply with:

a) DWS 2510 02: Auxiliary drives

b) Detail Sheet DS-EE-0026

### PS 9.27.2 Installation

A 3-pole switch-disconnector shall be installed within arm's length of the actuator. The signal from the switch-disconnector shall be wired back to the respective pumpset PLC.

## PS 9.28 EARTHING AND BONDING

### PS 9.28.1 Generals

Earthing and bonding shall comply with:

a) Engineering Standard SPE-EE-0020: Earthing of Industrial MV and LV Electrical Installations as varied below.

b) Earthing shall be installed as per drawings 106777-0504-DRG-EE-0560 to 0561.

### PS 9.28.2 Earth Electrode

A building ring earth electrode (70mm² Bare Copper Earth Conductor) shall be installed around the pump station and reservoir, inside the concrete foundations.

For the pump station, the earth electrodes shall be brought out to a building earth bar, which shall be installed in the cable gallery of the 11kV Switchroom. The earth electrode of the reservoir shall also be connected to this earth bar.

A 1500mm earth rod (16mm Diameter, copper plated, with 2000mm tail) shall be installed at each corner of the pump stations and at an even spacing around reservoir foundations.

### PS 9.28.3 Earthing Conductors

Earthing conductors shall be PVC-insulated copper conductors or bare earth copper conductor as indicated and sized in accordance with the earthing schematic drawings.

### PS 9.28.4 Earth Continuity Conductors

Earth continuity conductors shall be provided with all MV and LV power cables to electrical equipment and as shown on the single-line diagrams.

Where no separate earth continuity conductor is shown on the single-line diagrams, the intention is that a spare core in the power cable shall serve this function.

### PS 9.28.5 Bonding

All accessible extraneous conductive parts of electrical equipment/electrically-driven equipment shall be bonded in accordance with SANS 10142-1.

## PS 9.29 LIGHTNING PROTECTION

### PS 9.29.1 General

Lightning Protection shall comply with:

a) Engineering Standard SPE-EE-0021: Lightning Protection for Structures.

Lightning protection shall be installed as for the pump station as per drawings 106777-0504-DRG-EE-0560 to 0561 and for the reservoir as per drawing 106777-0503-DRG-ST-0406.

### PS 9.29.2 Pump Station Lightning protection

500mm High aluminium vertical air termination rods (finials) shall be installed on each corner of the roof of the pump station.

A 50mm² aluminium down conductor shall be installed from each termination rod around the top edge of the roof structure (roof edge conductor) and down to the earth electrode (down conductor) at each corner of the pump station building.

Down conductors shall be installed in uPVC ducts which shall be installed inside the pump station walls.

The bottom edge of the telemetry mast shall be connected to the earth electrode with 50mm² aluminium conductor.

Bi-metallic connectors shall be used to interconnect copper earth electrode and aluminium down conductors. A test joint shall be installed for each of these connections.

### PS 9.29.3 Reservoir Lightning protection

500mm High vertical air termination rods (finials) shall be installed on top of the reservoirs, spaced at even intervals.

An associated 50mm² aluminium down conductor shall be installed from each termination rod around the top edge of the reservoir and down to the earth electrode (down conductor).

Down conductors shall be installed inside the reservoir walls, clamped to the reservoir rebar.

Bi-metallic connectors shall be used to interconnect copper earth electrode and aluminium down conductors. A test joint shall be installed for each of these connections.

## PS 9.30 GENERAL INSTRUMENTATION AND CONTROL INSTALLATION

### PS 9.30.1 General

The electronic installation shall comply with:

a) Engineering Standard SPE-II-0001: General Electronic Installation

b) Engineering Standard SPE-II-0003: Industrial Network Installation

c) Data Sheet: DS-II-0001

### PS 9.30.2 Appended Tables and Schedules

The following preliminary lists are appended to the Instrumentation and Control Particular Specification.

a) Instrumentation and control cable schedule.

b) I/O List.

The lists shall be further developed as part of the detail design by the Contractor.

### PS 9.30.3 Electricity Supply

A single-phase 230V 50Hz supply shall be provided from the LV MCC in the LV supply room to the PLCs panel via a UPS. Electrical supplies (230V ac and 24V dc) shall be provided to equipment contained in the PLC panels, to the control desks and to field instrumentation from the PLC panels as required.

Another single-phase 230V 50Hz supply shall be provided from the LV MCC in the LV supply room to the SCADA computer and screens via a second UPS.

### PS 9.30.4 Control Cables

Control cables shall be provided as required for control circuitry of all controlled equipment.

Control cables shall be 600 / 1000V multicore 1,5mm² copper conductor, PVC-insulated cables with galvanised steel wire armouring and PVC serving.

### PS 9.30.5 Instrumentation Cables

Instrumentation cables shall be provided as required for all instrumentation signals, where the instrumentation is not equipped with integral cables long enough to reach the control desks or PLC panels.

Instrumentation cables shall be twisted pair, copper conductor, individually and overall screened, PVC-insulated with galvanised steel wire armouring and PVC serving.

### PS 9.30.6 Data Cables

The following cables shall be provided to create the PLC/SCADA network and links to associated equipment:

a) Master PLC to Pump Set PLCs: CAT 5 cables.

b) PLC to HMIs: Cat 5 (or dedicated cable to suit HMI and PLC offered).

c) PLC to SCADA: CAT 5 Cable.

d) Master PLC to WTW PLC: 8 core single mode fibre optic.

e) PLCs to MV switchgear control panel/junction box: Multicore/Multipair.

f) PLCs to MV switchgear relays (via substation RTU): CAT 5 cable (for monitoring only)

g) Pump PLC to pump set instrument junction box: Multicore/Multipair.

### PS 9.30.7 Fibre optic installation

An 8 core blow in fibre optic cable shall be installed from the Pump Station to the future reservoir and also to the WTW control room.

The fibre shall be blown into microducts in a 32mm HDPE cable duct next to the pipeline route indicated on the layout drawing 106777-CC-0100. Another similar cable shall be installed to the WTW.

The 32 mm ducts shall be installed with polyester draw wire with breaking capacity of at least 800 kg if the microducts will be drawn in afterwards.

Telebox draw pits shall be installed along the route at intervals not more than 250 meters. The drawpits shall be buried, but a special ball marker for locating the box shall be installed on top of the lid.

### PS 9.30.8 Junction Boxes

A junction box shall be provided for each motor/pump set for connecting integral instrumentation cables of equipment / instrumentation to the relevant pump set PLC panels.

7 segment displays for the pumpset's thermal and vibration instruments shall be mounted on the junction box for monitoring of the pumpset parameters.

The instrumentation cables shall be connected to conventional cables via terminal strips in the junction boxes.

Junction boxes shall be installed adjacent to the electric motor in an easily accessible location on a purpose made stand or bracket which is not in the way of maintenance required to equipment in that area.

### PS 9.30.9 UPS

One UPS shall be installed inside the Master PLC panel (for PLCs and instruments) and one in the SCADA 19" rack.

UPSs shall comply with SANS 62040.

Adequate provision shall be made for ventilation of the UPSs inside the PLC panel and computer rack.

## PS 9.31 PROGRAMMABLE LOGIC CONTROLLER

### PS 9.31.1 General

The PLC installation shall comply with

a) Engineering Standard SPE-II-0002: Programmable Logic Controllers

b) Data Sheets: DS-II-0002

The Control Architecture is depicted on drawing no. 106777-0504-DRG-0563.

### PS 9.31.2 Scope

A system of networked programmable logic controllers (PLCs) shall be provided as illustrated on the Control Architecture drawing. The system shall comprise a master PLC (referred to as the "PS Master PLC") and four pumpset PLCs.

A dedicated pumpset PLC (referred to as “Pump No.x PLC”) shall be provided for each of the four pumpsets. The pumpset PLCs shall be networked with the PS Master PLC and the SCADA system in the Control Room.

The communication medium shall be Ethernet between the PLCs.

As part of the detail design, the Contractor shall produce a Control System Functional Design Specification (FDS) that describes how the PLC system will be programmed and configured.

The Contractor shall allow for at least two iterations of the document and one meeting with the Engineer and DWS for the client to review the FDS.

The Contractor shall involve the PLC OEM (original equipment manufacturer) with the design of the network architecture according to their preferences and with the commissioning of the control system.

All control signals shall be hardwired to the PLC.

All intelligent electronic devices, such as MV switchgear, power meters, intruder detection alarms, fire detection alarms, instrumentation and Telemetry shall be connected to the PLC for monitoring and control purposes.

### PS 9.31.3 PLC Software

The PLCs shall be programmed to provide automatic operation of the works according to the specified control system.

The PLCs shall be programmed using the IEC 61131 standard or compatible equivalent.

The PLCs shall be programmed to provide the required Pump Station monitoring and controls.

### PS 9.31.4 Input and Outputs

Digital input / output cards shall be 24 Vdc and analog input / output cards 4- 20mA current loops. Temperature probes (PT100) shall not be directly wired into the PLCs, but shall include transmitters that provide a 4-20mA signal.

The input / output modules shall be provided with their own power supply independent from the CPU power supplies.

An indicative I/O count is provided attached to this specification. This shall only serve as a guide to Tenderers, and the Contractor shall be responsible for determining and providing all the required I/O including spares to provide the specified control and monitoring functions.

### PS 9.31.5 Data Communication

The following communications shall be utilised:

a) PLC to PLCs: Industrial Ethernet protocol

b) PLC to HMIs: use Industrial Ethernet or a propriety protocol common to both the offered PLCs and HMIs

c) PLCs to SCADA: Industrial Ethernet protocol

d) Master PLC to WTW PLC: Industrial Ethernet protocol

e) PLCs to MV switchgear control panel: Analog (4-20mA)/Digital (for control and protection)

f) PLCs to MV switchgear relays (via substation RTU): Industrial Ethernet protocol or fieldbus (for monitoring only)

g) PLC to Instrument Junction Box: Analog (4-20mA)/Digital

### PS 9.31.6 PLC Panel

A PLC panel shall be installed in the Control Room and include the following hardware:

a) PS Master PLC

b) Master PLC HMI,

c) dc power supplies

d) UPS

e) Main network switch

f) Fibre optic patch panel

It shall also serve as a marshalling panel with the back half of the panel being used for this purpose.

The PLC panel shall be floor standing and olive green in colour.

The PLC panel doors shall be fitted to the front and rear of the panel and the front doors armour-plated glass windows for viewing the status of the PLC.

The PLC panel shall be properly ventilated with extractor fans and filter blocks. Special care shall be taken to the panel housing the UPS.

The PLC CPU shall be located in the top front section of the PLC panel. I/O blocks, relays controls (front) shall be wired to the terminal blocks in the marshalling panel (rear) from where cables to field instruments and other equipment shall be run.

The panel shall be large enough to allow for all required equipment plus 20% spare space.

Power distribution and instrument supply circuit breakers shall be located in the front of the PLC panel.

A 16A SSO shall be provided in the front bottom of the PLC panel for the programmer's laptop.

A panel light, connected to a door switch shall be provided.

An earth bar and UPS shall be supplied at the bottom of the PLC panel.

PS 9.31.7 **Control Desk**

A Control Desk shall be installed adjacent to the window of the Control Room, overlooking the pumps. Four HMIs shall be installed in the control desk for control and monitoring of the associated pump sets and auxiliary/common equipment and instrumentation. The desk shall be ergonomically designed the operator and can operate the pumps while standing and looking out at the pump sets.

The pump set PLCs shall also be installed in the Control Desk.

Power to the Control Desk shall be obtained from the UPS supply in the Master PLC panel.

The PLC panel shall be floor standing and olive green in colour.

The PLC panel doors shall be fitted to the front of the panel.

The PLC panel shall be properly ventilated with extractor fans and filter blocks.

The PLC CPU shall be located in the top front section of the PLC panel. I/O blocks, relays controls (front) shall be wired to the terminal blocks in the marshalling panel from where cables to field instruments and other equipment shall be run.

The panel shall be large enough to allow for all required equipment plus 20% spare space.

A panel light, connected to a door switch shall be provided.

A red mushroom type E-stop shall be mounted to the right corner of the Control Desk, which shall shut down all active pumps simultaneously.

PS 9.31.8 **Human Machine Interfaces (HMIs)**

One graphical human machine interface (HMI) shall be provided in the PLC panel (for the PS Master PLC) and four in the Control Desk (one for each pump). The HMIs shall be configured to provide the operator with pump station control and status information, alarm lists, graphical trends and limited data logging.

The HMI related to each pump shall only display the relevant controls, alarms and trends for that specific pump, while the HMI related to the PS Master PLC (housed in the PLC panel) shall display ancillary PS controls, including but not limited to MV switchgear, Fire Detection, UPS status, etc. The HMI for the PS Master PLC shall not be a direct Mimic copy of the SCADA. (Only the SCADA screen shall display the system as a whole).

The HMI which is housed in the PLC panel shall be installed at such a height that it can be easily operated by an operator. The HMI shall be installed above the PLC CPU and I/O in such a way that the PLC CPU and I/O are still visible through the glass door of the PLC panel when the door is closed.

The HMIs shall also allow control parameter changes to the PLCs, which shall be password protected and logged. Operator actions, selections or setting described in the control philosophy shall be possible via the HMI interface.

The HMIs shall be configured with a simple default graphic display (mimic) showing all pertinent equipment, its status (running, tripped or stopped) and instantaneous instrument readings.

Mode selection on related electrical equipment (e.g. motorized valves, motor starters,etc) shall be clearly indicated on the HMI.

A navigation screen on the HMI associated with the Master PLC shall be provided from where the operator can navigate from the overview to detailed screens for the auxiliary/common equipment and instrumentation not associated with a particular pumpset.

Status shall be indicated by different state colours (such as white for ready, green for running, amber for tripped and red for ‘E-stop’ or other fault states).

A trending page shall be provided showing all measured value readings over time. The trend page shall show live and historical data (which shall be logged to the HMI memory in a first in first out rolling log file). Trends shall be configured to show an hourly interval of readings.

An alarm page shall be provided showing all outgoing and incoming alarms. Alarms shall also be stored in a first in first out file stored in the HMI memory. It shall be possible to scroll backward and forward in the alarm list.

## PS 9.32 INSTRUMENTATION

### PS 9.32.1 General

The instrumentation installation shall comply with

a) Engineering Standard SPE-II-0007: Instrumentation

b) Data sheet SPE-II-0007.

### PS 9.32.2 Scope

Instrumentation are indicated in the Piping and Instrumentation Diagram drawing number 106777-0504-DRG-MM-0501 to 0502.

The Instrumentation and control cable schedule and instrument list indicates the instruments and instrumentation cable requirements.

### PS 9.32.3 Installation

Transmitters shall be mounted separate from the sensors and shall allow local indication where specified in the Instrumentation list.

Field instrumentation shall be connected to the PLCs (as indicated in the I/O list) to provide the required monitoring and control specified in the control specifications. Instruments for critical pump set protection such as winding temperatures shall be wired to the 11kV Switchgear (by means of Motor Protection Relay) to ensure tripping by hardwiring, even with the PLC not working.

All instruments which are not an integral part of mechanical equipment shall be installed by the Contractor together with all brackets, adaptors and connectors that may be necessary.

All instruments shall be on UPS power unless they are potential free contacts or loop-powered by the PLC.

### PS 9.32.4 Pump/Motor Protection

Pump and motor protection shall be provided as per the P&IDs. Two PT100's shall be provided per winding (one per phase, two sets of outputs: one to PLC and one to MPR).

Should the pump and/or motor manufacturer require additional protection this shall be included in the cost.

### PS 9.32.5 Instrumentation Junction Boxes

An instrumentation cable junction box shall be installed at each pump set.

Where instruments are supplied with separate transmitters it shall also be housed in this panel.

All instrument wiring and control wiring for the respective pump set (including plunger valve signals) shall be wired to these panels.

### PS 9.32.6 Flow Measurement

One dual channel clamp-on type ultrasonic flow meter shall be provided on the discharge manifold in the pump station as shown on the drawings. The Contractor shall ensure that upstream and downstream straight length of pipework is as per the manufacturer's installation requirements. A minimum straight length of pipe no less than 15 x DN value of the pipe shall be provided upstream and 6 x DN value of the pipe downstream of the flow meter.

One insertion flow sensor, electro-magnetic type, shall be provided on the delivery line of each pump. This signal shall be used for low flow and high flow protection.

### PS 9.32.7 Pressure Measurement

Suitably rated pressure gauges shall be provided on the suction and discharge legs of each pump and one shall be provided on the suction and discharge manifold.

Pressure transmitters shall be provided to measure the suction pressure and the discharge pressure in each pump leg as well as the pressure in the manifold.

### PS 9.32.8 Level Measurement

A hydrostatic type level meter shall be provided on the scour outlet of the reservoir.

Float type switches shall be used as level switches in the reservoirs and the pump room (flooding alarm).

## PS 9.33 SCADA

### PS 9.33.1 General

The SCADA system shall comply with

a) Engineering Standard SPE-EE-0005: SCADA

b) Data Sheet: DS-EE-0005

### PS 9.33.2 Scope

The control architecture is shown on drawing no. 106777-0504-DRG-EE-0563

As part of the detail design, the Contractor shall produce a Control System Functional Design Specification (FDS) that describes how the SCADA system will be programmed and configured.

The SCADA software OEM shall form part of the SCADA development team at concept development phase and during testing and commissioning.

The Contractor shall allow for at least two review meetings with the Employer and Engineer to discuss mimics, trending and reporting proposals before final development of the SCADA system.

PS 9.33.3 **Pump Station SCADA hardware**

The SCADA system shall allow full control and supervision of the Pump Station and Reservoir from the control station.

The SCADA workstation shall be located in the Control Room.

The SCADA hardware shall include the following:

a) Purpose made desk; 1 chair and a desk for one computer

b) One rack mounted industrial computer

c) Standard 19” server rack to house SCADA hardware and accessories

d) Network switches

e) Network Firewall

f) GSM Router for web access

g) Two 23” desktop displays

h) VOIP Phone for communication to the pump station

i) UPS

and all other necessary accessories.

PS 9.33.4 **WTW SCADA hardware**

A new client SCADA station shall be provided at the WTW (under construction). This will be the primary control station of the pump station and will be connected to the pump station SCADA via a fibre optic cable.

The SCADA system shall allow full control and supervision of the Pump Station and Reservoir from the control station.

The SCADA workstation shall be located in the Control Room.

The SCADA hardware at the WTW shall include the following:

a) Purpose made desk; 1 chair and a desk for one computer

b) One rack mounted industrial computer

c) Standard 19” server rack to house SCADA hardware and network accessories

d) Network switch

e) Fibre optic patch panel

f) Two 23” desktop displays

g) VOIP Phone for communication to the pump station

h) UPS

PS 9.33.5 **SCADA Software**

The SCADA software shall be the latest stable version of a reputable SCADA software vendor.

A remote client shall be established at the WTW and shall allow full monitoring and control of the pump station.

The Contractor shall derive all tags necessary for the SCADA system to display, monitor, log, trend and record all information from the PLCs.

All pump station trip conditions and faults shall be sent to the SCADA alarming system and all operator actions to start, stop, reset and change pump parameters shall be event-logged on the SCADA.

PS 9.33.6 **Remote access via Web Client**

The SCADA software shall include at least 3 web client licences.

The system shall support full functionality of the SCADA system functionality via an internet web browser such as Internet Explorer, Chrome or Firefox. It shall not be necessary to export, compile or recreate graphics specifically for the Web Clients. Both full control and view only web clients shall be available.

The web clients will operate in conjunction with firewalls and provide security to reduce the possibility of unauthorized access.

Assuming reasonable ISP performance, users accessing via the internet using a 56K modem access shall consistently obtain display refresh times on average of 1 to 5 seconds and page display times of on average less than 5 seconds.

Systems that require third party thin client software to be loaded onto the Web Clients (such as Microsoft Remote Desktop or Citrix) to achieve this functionality will not be accepted.

This interface will be used by the Employer and the Engineer to monitor the performance of the pump station during defects liability.

PS 9.33.7 **SCADA Mimics**

The SCADA mimics shall be based on the process flow and piping and instrumentation diagrams.

An overview mimic of the complete Pump Station shall be programmed as well as detailed mimics of each pumpset, the MV switchgear and the MV motor starters (based on the SLD). A mimic shall also be provided to indicate the status of all communications networks (based on control architecture), UPS, PLC and HMI's associated with the Pump Station.

The pumpset mimics shall be similar to the mimics shown on their respective HMI's, but not be a direct copy of the displays shown on the HMI for PS Master PLC.

PS 9.33.8 **Trending**

Historical and realtime trending shall be provided for the following:

a) Each pumpset's operation (trended with flow and reservoir level).

b) Each pumpset's temperatures and vibration levels.

c) Each pumpset's delivery and suction line pressures.

d) The Pump Station suction reservoir level.

e) The common delivery flow rate.

f) Each pumpset’s efficiency (input power vs hydraulic power)

g) Power usage

PS 9.33.9 **Reporting**

The SCADA software’s report suite shall be configured to allow at least the following type of reporting:

Query type reporting where parameters and timeframes can be chosen and the output is in the form of a csv type file and standard external reports (for different time intervals e.g daily, weekly, monthly and yearly)) that shall include the following:

a) Each pumpset's run hours and fault downtime.

b) Each pumpset's maximum, minimum and average temperatures, suction and delivery pressures and vibration levels.

c) The suction reservoir level

d) The maximum, minimum and average values of the delivery flow rate.

e) The maximum, minimum, average and current values cumulative flows.

f) Each pumpset's efficiency (input power vs hydraulic power)

The reports shall also be configured to be shown as a visual dashboard, to give an overview of the pump station performance.

PS 9.33.10 **Access**

SCADA user access security levels shall be as programmed for operator names provided by the Client.

## PS 9.34 ELECTRICAL AND ELECTRONIC BUILDING SERVICES

### PS 9.34.1 Scope

The electrical and electronic building services shall include the following:

a) One 400V Distribution Board (as part of the MCC).

b) Power outlets

c) Lighting installation (indoor and outdoor)

d) LV cables, conduits and wiring to power outlets and lights.

e) Earthing and bonding

f) Fire Detection

g) Security Alarm (intruder detection)

h) Certificates of Compliance

## PS 9.35 ELECTRICAL BUILDING SERVICES INSTALLATION

### PS 9.35.1 General

The LV electrical installation shall comply with:

a) Standard Specification SPE-EE-0013: Wiring and outlets

b) Standard Specification SPE-EE-0014: Lighting

c) Drawings no. 106777-0504-DRG-EE-0556 & 106777-0504-DRG-EE-0558

### PS 9.35.2 Distribution Board

One distribution section, LV-DB, shall be installed in the MCC located in the LV distribution room.

All small power and lighting for the pump station shall be fed from LV-DB.

The equipment for the distribution board shall be installed to match the single line diagram (drawings no. 106777-0504-DRG-EE-0554).

### PS 9.35.3 Installation

All wiring to light fittings (except for pump room lights), light switches, single power outlets in the pump station shall be supplied by house wire through PVC conduits installed inside walls, floors or the roof where possible, otherwise surface mounted inside hot dipped galvanised trunking/conduits.

The wiring and/or cabling to the pump room lights shall be done inside surface mounted hot dipped galvanised trunking. At each light fitting the cable shall be looped out to the light fitting as shown on typical drawing.

### PS 9.35.4 Power Outlets

All single phase switched socket outlets (except for pump room outlets) shall be installed flush mounted into walls.

Industrial 3-Phase switched socket outlets shall be 5-Pin IP55 and surface mounted.

### PS 9.35.5 Lighting

Exterior lighting shall be controlled by means of a contactor and photo cell. A bypass switch shall be installed in control room.

All light fittings shall be LEDs.

Light switches shall be flush mounted where possible.

## PS 9.36 FIRE DETECTION

### PS 9.36.1 General

The Fire Detection installation shall comply with

a) Standard Specification SPE-EL-0001 – Fire Detection

b) Drawing no. 106777-0504-DRG-EE-0558

### PS 9.36.2 Detail Requirements

In the event of a fire the fire detection system shall switch the pump room and electrical room fans off and follow the procedure stipulated in the fire rationale design.

### PS 9.36.3 Installation Requirements

The installation shall include the supply, installation and commissioning of the following:

a) New analogue addressable fire detection panel within the Control Room.

b) Smoke and heat detectors

c) Combination siren and strobe units.

d) Red break-glass units

e) Fire resistant wiring as required by regulations – FR120.

f) Input / Output units (min 3).

g) The system's alarm signals shall be displayed on the SCADA system.

## PS 9.37 SECURITY SYSTEM

### PS 9.37.1 General

The Intruder Detection installation shall be as per drawing no. 106777-0504-DRG-EE-0558.

### PS 9.37.2 Installation Requirements

The installation shall include the supply, installation and commissioning of the following:

a) An integrated Intruder Detection system complete with control panel and minimum two hour battery back-up shall be installed.

b) Double tap passive infra-red motion detecting, long range detectors to monitor movement. The detectors shall be mounted with suitable brackets at the corner of the ceiling and wall surfaces.

c) Magnetic type door monitors (with battery backup) to monitor open/close status of external doors.

d) Beam across the length of the Pump Room.

e) The control panel shall be installed at the single door entrance to the Pump Room (next to the Store Room door). This keypad shall be used to arm and disarm the building or certain zones.

f) All wiring shall be flush mounted where permitted, with surface mounted wiring and conduits allowed otherwise.

g) Conduit wire ways as required.

h) Labelling

i) Training and instruction manuals.

j) The system shall be linked to a reputable, armed response company (approved by the client) after the installation is complete.

## PS 10 ELECTRICAL AND CONTROL AND INSTRUMENTATION SCHEDULES: MECHANICAL AND ELECTRICAL WORKS - PUMP STATION

The preliminary electrical and control and instrumentation schedules are included hereunder as Appendix A of this Project Specification.

The final schedules depend on the Contractor's design and shall be updated by the Contractor wherever applicable.

APPENDIX A

ELECTRICAL AND CONTROL AND INSTRUMENTATION SCHEDULES

- Motor and Equipment Schedule
- Cable Schedule
- MCC and Field Control Schedule
- Instrumentation and Control Cable Schedule
- Instrumentation Schedule
- I/O List
- MV I/O List

# PS 11 SUB-CONTRACT: 66KV SUB-STATION

**PREAMBLE**

This clause specifies the sub-contract for the 66kV sub-station part of the Works.

The pump station 66/11kV Sub-station (S/S) connecting the pump station to the existing Eskom grid via the pump station 66kV line, will be created under the Eskom "**STANDARD FOR HV SELFBUILD CUSTOMERS PROJECTS IN DISTRIBUTION,** reference **240-43874056, Rev 2".**

The 66/11kV S/S as an asset is therefore created on behalf of Eskom, and handed over to Eskom as the asset owner, and operator.

The design development phase is executed by Aurecon, subject to the approvals by Eskom committees, as milestones in the execution process.

The procurement of material and equipment is subjected to the Eskom Distribution Technology Standards and Specifications for Sub-station components, and specifically the "**Eskom Eastern Cape Operating Unit Approved Material Database, reference ECSTAN 007, rev 8"**.

The procurement of S/S components, the construction, commissioning, and handing over to Eskom, of the pump station 66/11kV S/S, needs to be executed by a Selected Sub-contractor.

The Selected Sub-contractor is to be appointed in conjunction with the Engineer, Aurecon, and needs to comply with the following selection criteria:

The contractor must be registered with Eskom Eastern Cape Operating Unit as an approved High Voltage S/S construction contractor.

The contractor must have the appropriate CIDB rating for the value of the High Voltage S/S sub-contract.

A breakdown of prices for the work including full technical descriptions, shall be submitted to the Engineer for approval.

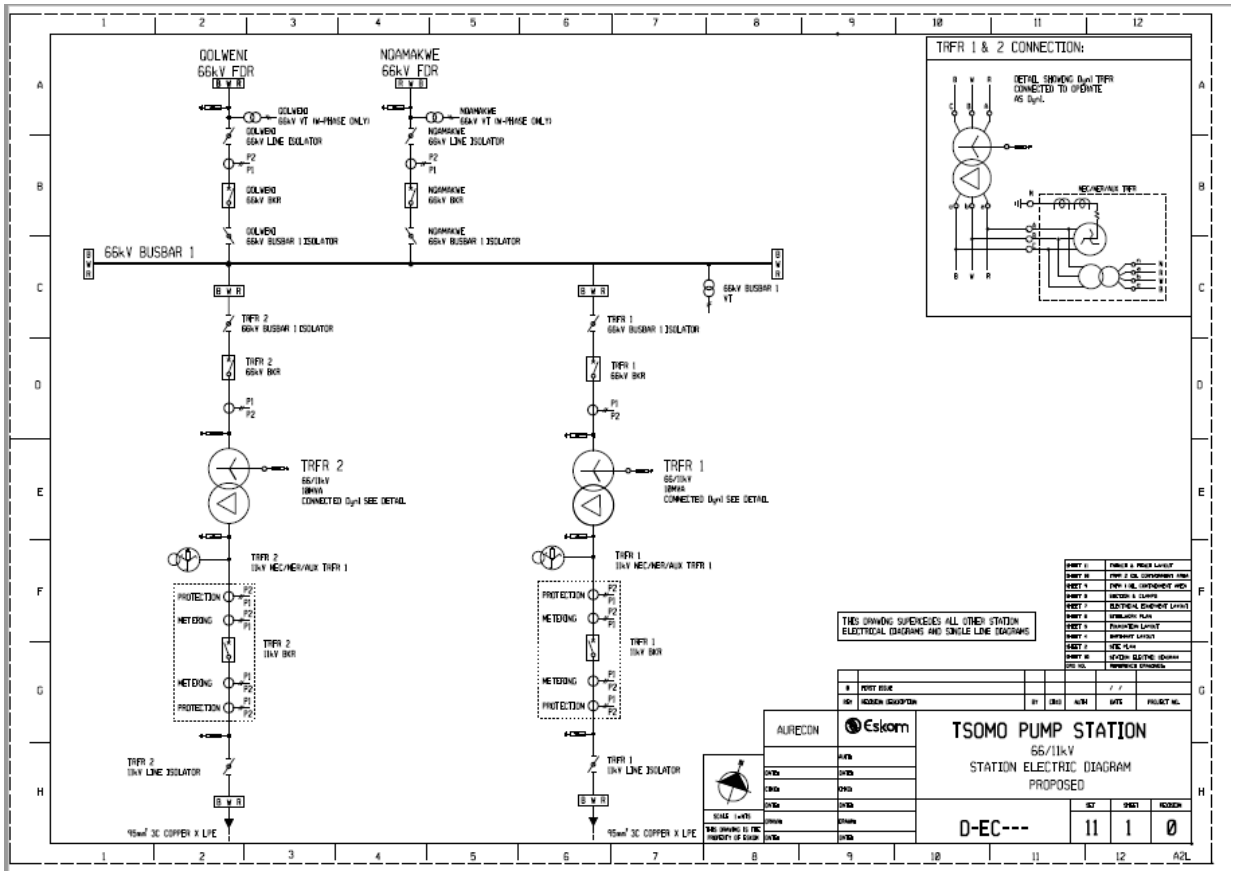
The Self-build process makes provision for milestones for approval by Eskom, ie at Preliminary Design, Final Design, Material inspection and approval at Site Establishment phase, commissioning phase and test results approval, and finally handover inspections and approval.

The S/S Control Plant commissioning will be done by a selected specialist Eskom approved sub-contractor, who works in conjunction with Eskom Control Plant staff, to do the final commissioning on the S/S Control Plant. The selection of the Control Plant commissioning contractor from the Eskom ECOU registration list, is done in conjunction with the Engineer, selected S/S contractor, and Eskom Control Plant specialists. The specialist Control Plant sub-contractor, will act as a sub-contractor to the selected S/S Sub-contractor.

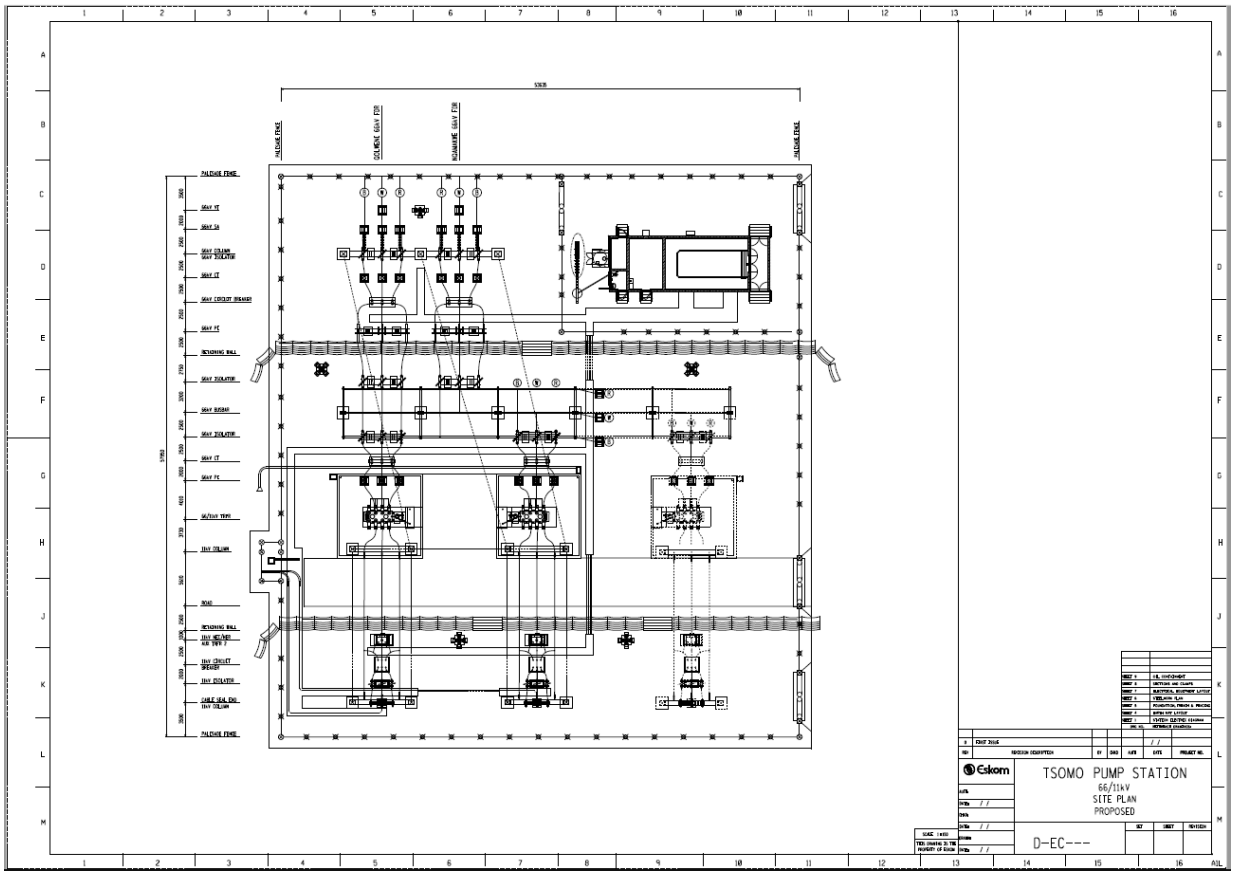
## PS 11.1 SCOPE

### PS 11.1.1 General

The proposed layout and configuration of the Works, are indicated on the Station Electric Diagram, and S/S Site Plan below:




**Pump station 66/11kV Substation Electric Diagram (SED)**




**Pump station 66/11kV Substation Site Plan**

The 66/11kV S/S is configured as follows:

- 2 X 66kV feeder bays
- 2 X 66/11kV 10MVA transformer bays
- 2 X 11kV customer isolating points, and cable sealing ends
- Control Building housing protection, metering, tele-control, and telecommunication equipment.

The battery limits for the Contract, are described as follows:

On the 66kV line side – The 66kV closing spans between the S/S gantry and the 66kV line terminal poles, are the responsibility of the 66kV line contractor. The 66kV jumpers from the closing spans, including the terminations there-of onto the closing span stringers, are included in this contract.

On the 11kV pump station side – This contract includes the installation of the "Trf 1 11kV Isolators", and "Trf 2 11kV Isolators". The installation of the two 11kV cables, and the terminations there-of onto the 11kV cable sealing ends, is the responsibility of the pump station M&E contractor. The installation of Control Plant cabling and the termination there-of, between the 66/11kV S/S and the pump station 11kV Switchgear, is the responsibility of the pump station M&E contractor. The installation of cable sleeves where the pump station cables exist the 66/11kV S/S, is the responsibility of this contract.

Access road – The gate ramp at the 66/11kV S/S entrance is included in this contract. The access road from that point onwards, is the responsibility of the main contractor.

### PS 11.1.2 Scope

The scope of works for the pump station 66/11kV S/S entails the following:

- Finishing to top of platform, drainage, and internal access road
- Earth grid, fencing, and gates.
- Cable trenches
- Plinths, steelwork, and primary S/S equipment
- 2 X 66/11 kV 10MVA transformers
- Gantry's, stringers, and jumpers
- Isolators, 66kV breakers, 11kV "Dog box" breaker units, Current transformers, Voltage transformers, and Surge Arrestors
- Control building, including Control Room, Battery room, toilet, and store room
- Control Plant panels housing AC and DC supplies, Protection, Metering, Scada, Tele-control, and Telecommunication equipment.

The supply of all material and equipment and equipment is included in this contract. All material supplies, and the installation there-of, will take place in accordance with the Distribution Technology and Eskom ECOU Standards and Specifications.

### PS 11.1.3 Configuration, Installation & Testing

The scope of works include the testing and commissioning of primary plant and control plant by the specialist selected sub-contractor, in accordance with Distribution Technology and Eskom Eastern Cape Operating Unit Standards and Specifications, for handing over to Eskom as the asset owner and operator.

### PS 11.1.4 Work Not Included in this Contract

All work beyond on the outside of the 66/11kV S/S outside perimeter fence, and not indicated on the S/S drawings.

# PS 12 SUB-CONTRACT: 66KV HIGH VOLTAGE LINE

**PREAMBLE**

This clause specifies the sub-contract for the 66kV high voltage line part of the Works.

The pump station 66kV supply line connecting the 66/11kV pump station sub-station to the existing Eskom grid, will be created under the Eskom "**STANDARD FOR HV SELFBUILD CUSTOMERS PROJECTS IN DISTRIBUTION,** reference **240-43874056, Rev 2".**

The 66kV line as an asset is therefore created on behalf of Eskom, and handed over to Eskom as the asset owner, and operator.

The design development phase is executed by Aurecon, subject to the approvals by Eskom committees, as milestones in the execution process.

The procurement of material and equipment is subjected to the Eskom Distribution Technology Standards and Specifications for High Voltage line components, and specifically the "**Eskom Eastern Cape Operating Unit Approved Material Database, reference ECSTAN 007, rev 8"**.

The procurement of line components, the construction, commissioning, and handing over to Eskom, of the pump station 66kV line, needs to be executed by a Selected Sub-contractor.

The Selected Sub-contractor is to be appointed in conjunction with the Engineer, Aurecon, and needs to comply with the following selection criteria:

The contractor must be registered with Eskom Eastern Cape Operating Unit as an approved High Voltage line contractor.

The contractor must have the appropriate CIDB rating for the value of the High Voltage line sub-contract.

A breakdown of prices for the work including full technical descriptions, shall be submitted to the Engineer for approval.

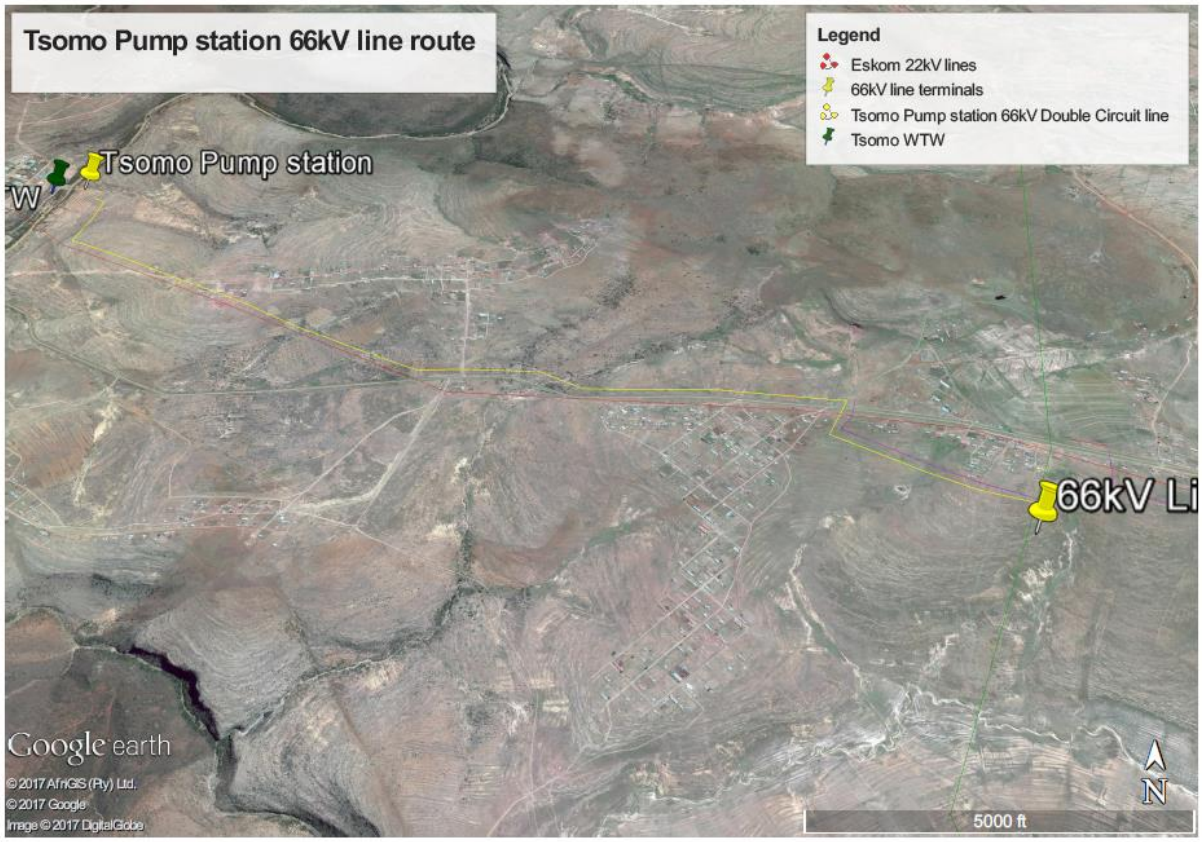
The Self-build process makes provision for milestones for approval by Eskom, ie at Preliminary Design, Final Design, Material inspection and approval at Site Establishment phase, commissioning and test results approval, and finally handover inspections and approval.

Should Eskom require the installation of an Optic Pilot Ground Wire (OPGW) on the Tsomo pump station 66kV line, the specialist supply and install contractor, will be selected in conjunction with Eskom from the Eskom National Contract (ENC).

## PS 12.1 Scope

### PS 12.1.1 General

The proposed line route are as follows:




The battery limits for the Contract, are described as follows:

- On the Pump station 66/11kV Substation side – The termination of the 66kV phase conductors onto the Substation gantry is included in this contract. The termination of the OPGW to the Substation gantry, as well as the extension of Optic Fibre to the Substation Control Room, and the termination of the Fibre onto the Control Room BME panel, is included in this contract.
- At the existing Eskom Qolweni-Nqamakwe 66kV line Tee-off position – The power outage required to interrupt the existing Eskom line, the planting of two D-DT-7645 angle strain structures under outage conditions, and the termination of the two existing Eskom circuits and earth wires, as well as the termination of the pump station circuits and OPGW wires, in order to complete the new circuits via pump station 66/11kV substation, forms part of this contract.

### PS 12.1.2 Scope of Works

The pump station 66kV Line will run from a Tee-off position on the existing Eskom Qolweni-Nqamakwe 66kV line, to the pump station located on the outskirts of Tsomo town. The total line route length is approximately 7km. The line will consist of 2 X 66kV circuits. Chickadee conductor will be used with 48 core OPGW shield wire. Steel D-DT-7649, or D-DT-7611 series self-supporting structures will be used as suspension, and D-DT-7645 guyed monople structures will be used as the angle supporting structures and inline strains. Trips D-DT-7618 structures will be used as terminal structure going into the Tsomo 66/11kV substation. Two D-DT-7645 guyed monople structures will be installed in-line on the existing Eskom Qolweni-Nqamakwe 66kV line under outage conditions, in order to create two 90 degree bend points, for the termination of the pump station 66kV line circuits, at the Tee-off position.

The scope of works entail the procurement and supply of all material components in accordance with the Eskom Distribution Technology and the Eskom Eastern Cape Operating Unit Standards and Specifications, and the construction and commissioning of the 66kV line and OPGW in accordance with the Eskom Distribution Technology and Eskom Eastern Cape Operating Unit Standards and Specifications.

### PS 12.1.3 Configuration, Installation & Testing

The scope of works include installation and testing of the 66kV line and OPGW in accordance with Distribution Technology and Eskom Eastern Cape Operating Unit Standards and Specifications, for handing over to Eskom as the asset owner and operator.

### PS 12.1.4 Work Not Included in this Contract

Obtaining of the line servitude, environmental, and other statutory approvals, and design of the 66kV line is not included in this contract.

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| 106777<br>*Butterworth Pump Station*<br>**MCC PS - Motor and Equipment Schedule** | | | | | | | | | Document Number<br>*106777_MCC PS_MES* | | | | | Rev<br>T0 | | Date<br>Dec-17 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item No** | **Tag No** | **Description** | **Location** | **Starter** | **Submersible (Y/N)** | **Volt** | **Ph** | **Rating** | **Unit** | **Supply Side Ratings** | | | | **Typical Equipment Rating** | | | **Util. Factor** | **Standby Power** |
| | | | | | | | | | | **S kVA** | **Amps** | **PF** | **Drive Eff.** | **Amps** | **PF** | **Eff.** | | |
| 1 | IN-LV-MCC-01 | Incomer MCC PS 01 | MCC Room | INCOMER | NO | 400 | 3 | 160 | A | 31 | 45 | 0.67 | - | - | - | - | - | - |
| 2 | IN-LV-MCC-02 | Incomer MCC PS 02 | MCC Room | INCOMER | NO | 400 | 3 | 160 | A | 31 | 59 | 0.67 | - | - | - | - | - | - |
| | | | | | | | | | | | | | | | | | | |
| 3 | HDP-01 | Hydraulic Pump 1 | Pump Station | DOL | NO | 400 | 3 | 1 | kW | 1.7 | 2.5 | 0.79 | 1 | 2.5 | 0.79 | 0.74 | 1 | NO |
| 4 | HDP-02 | Hydraulic Pump 2 | Pump Station | DOL | NO | 400 | 3 | 1 | kW | 1.7 | 2.5 | 0.79 | 1 | 2.5 | 0.79 | 0.74 | 1 | NO |
| 5 | HDP-03 | Hydraulic Pump 3 | Pump Station | DOL | NO | 400 | 3 | 1 | kW | 1.7 | 2.5 | 0.79 | 1 | 2.5 | 0.79 | 0.74 | 1 | NO |
| 6 | HDP-04 | Hydraulic Pump 4 | Pump Station | DOL | NO | 400 | 3 | 1 | kW | 1.7 | 2.5 | 0.79 | 1 | 2.5 | 0.79 | 0.74 | 0 | NO |
| 7 | FAN-01 | Pump Station Fan 1 | Control Room | DOL | NO | 400 | 3 | 7.5 | kW | 10.5 | 15.2 | 0.82 | 1 | 15.2 | 0.82 | 0.87 | 1 | NO |
| 8 | FAN-02 | Pump Station Fan 2 | Pump Station | DOL | NO | 400 | 3 | 7.5 | kW | 10.5 | 15.2 | 0.82 | 1 | 15.2 | 0.82 | 0.87 | 1 | NO |
| 9 | FAN-03 | MV Room Fan 1 | Control Room | DOL | NO | 400 | 3 | 1 | kW | 1.7 | 2.5 | 0.79 | 1 | 2.5 | 0.79 | 0.74 | 1 | NO |
| 10 | FAN-04 | MV Room Fan 2 | Control Room | DOL | NO | 400 | 3 | 1 | kW | 1.7 | 2.5 | 0.79 | 1 | 2.5 | 0.79 | 0.74 | 1 | NO |
| 11 | FAN-05 | Cable Gallery Fan 1 | Control Room | FDR | NO | 400 | 3 | 1 | kW | 1.7 | 2.5 | 0.79 | 1 | 2.5 | 0.79 | 0.74 | 1 | NO |
| 12 | CR-01 | Crane | Pump Station | FDR | NO | 400 | 3 | 7 | kW | 9.9 | 14.3 | 0.82 | 1 | 14.3 | 0.82 | 0.86 | 1 | NO |
| 13 | PLC-01 | Master PLC (Control) | Control Room | FDR | NO | 220 | 1 | 0.5 | kW | 0.6 | 2.8 | 0.72 | 1 | 2.8 | 0.72 | 0.66 | 1 | NO |
| 14 | SCD-01 | SCADA | Control Room | FDR | NO | 220 | 1 | 0.5 | kW | 0.6 | 2.8 | 0.72 | 1 | 2.8 | 0.72 | 0.66 | 1 | NO |
| 15 | DB-PS | DB Pump Station | LV Distribution room | FDR | NO | 400 | 3 | 15 | kW | 20.3 | 29.3 | 0.84 | 1 | 29.3 | 0.84 | 0.88 | 1 | NO |
| 16 | BFV-01 | Butterfly Valve (actuated) | Common Suction Pipework | FDR | NO | 400 | 3 | 0.1 | kW | 0.2 | 0.3 | 0.7 | 1 | 0.3 | 0.7 | 0.6 | 1 | NO |
| 17 | BFV-02 | Butterfly Valve (actuated) | RWP 1 Suction Pipework | FDR | NO | 400 | 3 | 0.1 | kW | 0.2 | 0.3 | 0.7 | 1 | 0.3 | 0.7 | 0.6 | 1 | NO |
| 18 | BFV-03 | Butterfly Valve (actuated) | RWP 2 Suction Pipework | FDR | NO | 400 | 3 | 0.1 | kW | 0.2 | 0.3 | 0.7 | 1 | 0.3 | 0.7 | 0.6 | 1 | NO |
| 19 | BFV-04 | Butterfly Valve (actuated) | RWP 3 Suction Pipework | FDR | NO | 400 | 3 | 0.1 | kW | 0.2 | 0.3 | 0.7 | 1 | 0.3 | 0.7 | 0.6 | 1 | NO |
| 20 | BFV-05 | Butterfly Valve (actuated) | RWP 4 Suction Pipework | FDR | NO | 400 | 3 | 0.1 | kW | 0.2 | 0.3 | 0.7 | 1 | 0.3 | 0.7 | 0.6 | 0 | NO |
| 21 | BFV-06 | Butterfly Valve (actuated) | Common Delivery Pipework | FDR | NO | 400 | 3 | 0.1 | kW | 0.2 | 0.3 | 0.7 | 1 | 0.3 | 0.7 | 0.6 | 1 | NO |
| 22 | GV-01 | Gate Valve (actuated) | RWP 1 Delivery Pipework | FDR | NO | 400 | 3 | 0.1 | kW | 0.2 | 0.3 | 0.7 | 1 | 0.3 | 0.7 | 0.6 | 1 | NO |
| 23 | GV-02 | Gate Valve (actuated) | RWP 2 Delivery Pipework | FDR | NO | 400 | 3 | 0.1 | kW | 0.2 | 0.3 | 0.7 | 1 | 0.3 | 0.7 | 0.6 | 1 | NO |
| 24 | GV-03 | Gate Valve (actuated) | RWP 3 Delivery Pipework | FDR | NO | 400 | 3 | 0.1 | kW | 0.2 | 0.3 | 0.7 | 1 | 0.3 | 0.7 | 0.6 | 1 | NO |
| 25 | GV-04 | Gate Valve (actuated) | RWP 4 Delivery Pipework | FDR | NO | 400 | 3 | 0.1 | kW | 0.2 | 0.3 | 0.7 | 1 | 0.3 | 0.7 | 0.6 | 0 | NO |

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**106777**
*Butterworth Pump Station*
**MCC PS - Cable Schedule**

| Document Number | Rev | Date |
|---|---|---|
| *106777_MCC PS_CAB* | T0 | Dec-17 |

| Parameters | | *Defaults* | Assumptions | |
|---|---|---|---|---|
| **Fault Level** | **5** | *kA* | | |
| Voltage | 400 | 400 | Maximum sustained conductor temperature | 70˚C |
| Ambient Temperature | 30 | 30 | Short Circuit max conductor temp is 160˚C for 1 sec | |
| Conductor Operating Temperature | 70 | 70 | Powerfactor | 1 |
| Ground Temperature | 25 | 25 | Balanced Phases | |
| Ground Thermal Resistivity | 1.2 | 1.2 | Multicore PVC Cu Insulated Cables | |
| Depth of laying to top of cable | 0.6 | 0.5 | Assumed Frequencies | 49-61HZ |
| Method of installation in ground | ground | ground/ pipes | Resistivity of conductor material at average temp during SC (Ω.mm | 0.023 |
| At coast or highveld | Highveld | Coastal/ Highveld | for further assumptions refer to SANS 10142-1 | |

| | Cable Route | | | | | | | | | | | | | | Circuit Breaker | | Earth | Field Control | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From | | To | | | | Cores | | | | | | | | | | | | |
| Item No | Equipment Tag No. | Description | Equipment Tag No | Description | Circuit Type | Estimate Length | Cores per cable | # of cores per phase | Armouring | Load Current (A) | Installation method | Allowable Volt Drop | Derating factor | Actual Volt Drop | Cable Type | Estimated Circuit breaker | Ii (A) | ECC BCEW (mm²) | # of Cores | Size (mm²) |
| | | | | | | | | | | | | | | | | | | | | |
| 1 | TRF-01 | 100kVA TRF | IN-LV-MCC-01 | Incomer MCC PS 01 | INCOMER | 70 | 4 | 2 | SWA | 45 | meth_4or6 | 1.5% | 0.90 | 1.14% | 2 x 4C x50mm² | 160 | 320 | 25 | | |
| 2 | TRF-02 | 100kVA TRF | IN-LV-MCC-02 | Incomer MCC PS 02 | INCOMER | 70 | 4 | 2 | SWA | 0 | meth_4or6 | 1.5% | 0.90 | 1.14% | 2 x 4C x50mm² | 160 | 320 | 25 | | |
| 3 | | | | | | | | | | | | | | | | | | | | |
| 4 | MCC_PS | MCC | HDP-01 | Hydraulic Pump 1 | DOL | 40 | 4 | 1 | SWA | 2.5 | meth_4or6 | 3.0% | 0.87 | 0.38% | 1 x 4C x2.5mm² | 3.2 | 38.4 | | 4C | 1.5 |
| 5 | MCC_PS | MCC | HDP-02 | Hydraulic Pump 2 | DOL | 23 | 4 | 1 | SWA | 2.5 | meth_4or6 | 3.0% | 0.87 | 0.22% | 1 x 4C x2.5mm² | 3.2 | 38.4 | | 4C | 1.5 |
| 6 | MCC_PS | MCC | HDP-03 | Hydraulic Pump 3 | DOL | 28 | 4 | 1 | SWA | 2.5 | meth_4or6 | 3.0% | 0.87 | 0.27% | 1 x 4C x2.5mm² | 3.2 | 38.4 | | 4C | 1.5 |
| 7 | MCC_PS | MCC | HDP-04 | Hydraulic Pump 4 | DOL | 25 | 4 | 1 | SWA | 2.5 | meth_4or6 | 3.0% | 0.87 | 0.24% | 1 x 4C x2.5mm² | 3.2 | 38.4 | | 4C | 1.5 |
| 8 | MCC_PS | MCC | FAN-01 | Pump Station Fan 1 | DOL | 35 | 4 | 1 | SWA | 15.2 | meth_4or6 | 3.0% | 0.87 | 2.04% | 1 x 4C x2.5mm² | 20 | 240 | | | |
| 9 | MCC_PS | MCC | FAN-02 | Pump Station Fan 2 | DOL | 35 | 4 | 1 | SWA | 15.2 | meth_4or6 | 3.0% | 0.87 | 2.04% | 1 x 4C x2.5mm² | 20 | 240 | | | |
| 10 | MCC_PS | MCC | FAN-03 | MV Room Fan 1 | DOL | 25 | 4 | 1 | SWA | 2.5 | meth_4or6 | 3.0% | 0.87 | 0.24% | 1 x 4C x2.5mm² | 3.2 | 38.4 | | | |
| 11 | MCC_PS | MCC | FAN-04 | MV Room Fan 2 | DOL | 25 | 4 | 1 | SWA | 2.5 | meth_4or6 | 3.0% | 0.87 | 0.24% | 1 x 4C x2.5mm² | 3.2 | 38.4 | | | |
| 12 | MCC_PS | MCC | FAN-05 | Cable Gallery Fan 1 | FDR | 10 | 4 | 1 | SWA | 2.5 | meth_4or6 | 3.0% | 0.87 | 0.09% | 1 x 4C x2.5mm² | 3.2 | 38.4 | 2.5 | | |
| 13 | MCC_PS | MCC | CR-01 | Crane | FDR | 35 | 4 | 1 | SWA | 14.3 | meth_4or6 | 3.0% | 0.87 | 1.93% | 1 x 4C x2.5mm² | 16 | 192 | 2.5 | | |
| 14 | MCC_PS | MCC | PLC-01 | Master PLC (Control) | FDR | 12 | 4 | 1 | SWA | 2.8 | meth_4or6 | 3.0% | 0.87 | 0.13% | 1 x 4C x2.5mm² | 3.2 | 38.4 | 2.5 | | |
| 15 | MCC_PS | MCC | SCD-01 | SCADA | FDR | 12 | 4 | 1 | SWA | 2.8 | meth_4or6 | 3.0% | 0.87 | 0.13% | 1 x 4C x2.5mm² | 3.2 | 38.4 | 2.5 | | |
| 16 | MCC_PS | MCC | DB-PS | DB Pump Station | FDR | 1 | 4 | 1 | SWA | 29.3 | meth_4or6 | 3.0% | 0.87 | 0.07% | 1 x 4C x4mm² | 40 | 480 | 4 | | |
| 17 | MCC_PS | MCC | BFV-01 | Butterfly Valve (actuated) | FDR | 50 | 4 | 1 | SWA | 0.3 | meth_4or6 | 3.0% | 0.87 | 0.07% | 1 x 4C x2.5mm² | 2 | 24 | 2.5 | 7C | 1.5 |
| 18 | MCC_PS | MCC | BFV-02 | Butterfly Valve (actuated) | FDR | 40 | 4 | 1 | SWA | 0.3 | meth_4or6 | 3.0% | 0.87 | 0.05% | 1 x 4C x2.5mm² | 2 | 24 | 2.5 | 7C | 1.5 |
| 19 | MCC_PS | MCC | BFV-03 | Butterfly Valve (actuated) | FDR | 23 | 4 | 1 | SWA | 0.3 | meth_4or6 | 3.0% | 0.87 | 0.03% | 1 x 4C x2.5mm² | 2 | 24 | 2.5 | 7C | 1.5 |
| 20 | MCC_PS | MCC | BFV-04 | Butterfly Valve (actuated) | FDR | 28 | 4 | 1 | SWA | 0.3 | meth_4or6 | 3.0% | 0.87 | 0.04% | 1 x 4C x2.5mm² | 2 | 24 | 2.5 | 7C | 1.5 |
| 21 | MCC_PS | MCC | BFV-05 | Butterfly Valve (actuated) | FDR | 25 | 4 | 1 | SWA | 0.3 | meth_4or6 | 3.0% | 0.87 | 0.03% | 1 x 4C x2.5mm² | 2 | 24 | 2.5 | 7C | 1.5 |
| 22 | MCC_PS | MCC | BFV-06 | Butterfly Valve (actuated) | FDR | 35 | 4 | 1 | SWA | 0.3 | meth_4or6 | 3.0% | 0.87 | 0.05% | 1 x 4C x2.5mm² | 2 | 24 | 2.5 | 7C | 1.5 |
| 23 | MCC_PS | MCC | GV-01 | Gate Valve (actuated) | FDR | 40 | 4 | 1 | SWA | 0.3 | meth_4or6 | 3.0% | 0.87 | 0.05% | 1 x 4C x2.5mm² | 2 | 24 | 2.5 | 7C | 1.5 |
| 24 | MCC_PS | MCC | GV-02 | Gate Valve (actuated) | FDR | 23 | 4 | 1 | SWA | 0.3 | meth_4or6 | 3.0% | 0.87 | 0.03% | 1 x 4C x2.5mm² | 2 | 24 | 2.5 | 7C | 1.5 |
| 25 | MCC_PS | MCC | GV-03 | Gate Valve (actuated) | FDR | 28 | 4 | 1 | SWA | 0.3 | meth_4or6 | 3.0% | 0.87 | 0.04% | 1 x 4C x2.5mm² | 2 | 24 | 2.5 | 7C | 1.5 |
| 26 | MCC_PS | MCC | GV-04 | Gate Valve (actuated) | FDR | 25 | 4 | 1 | SWA | 0.3 | meth_4or6 | 3.0% | 0.87 | 0.03% | 1 x 4C x2.5mm² | 2 | 24 | 2.5 | 7C | 1.5 |

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**106777**
*Butterworth Pump Station*
**MCC PS - MCC and Field Control Schedule**

| Document Number | Rev | Date |
|---|---|---|
| *106777_MCC PS_MCC* | T0 | Dec-17 |

| Item No | Tag No | Description | Length | Volt | Starter | Forced Ventilation | Selector Switches | Push Buttons | | | | | | | Indicators | | | | | | | | | | | | | Metering | | | | Protection | | | Field Control | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Manual/ Off/ Auto | Start | Stop | Open/Forward | Close/Reverse | Reset/Overload | Lamp Test | Other | Running | Stopped | Opened | Closed | Tripped/Fault | E-Stop | No Flow | Over Torque | Seal Failure | Overheat | Over vibration | Other | kWh | Amp | Volt | Run Hours | Overload | Earth Leakage | Surge Protection | Start/Stop/E-Stop | E-Stop | Open/Stop/Close | Local/Off/Remote | Forward / Reverse | Other | |
| 1 | IN-LV-MCC-01 | Incomer MCC PS 01 | 70 | 400 | INCOMER | | | | | | | | | | | | | | | | | | | | | 1 | Power meter | | | 1 | | 1 | | | | | | | | Alarms for reverse phase, over/under voltage, phase unbalanced |
| 2 | IN-LV-MCC-02 | Incomer MCC PS 02 | 70 | 400 | INCOMER | | | | | | | | | | | | | | | | | | | | | 1 | Power meter | | | 1 | | 1 | | | | | | | | Alarms for reverse phase, over/under voltage, phase unbalanced |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | HDP-01 | Hydraulic Pump 1 | 40 | 400 | DOL | | | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | | | | 1 | | 1 | 1 | | | 1 | | | | | | E-stop on Junction Box at pump/motor |
| 5 | HDP-02 | Hydraulic Pump 2 | 23 | 400 | DOL | | | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | | | | 1 | | 1 | 1 | | | 1 | | | | | | E-stop on Junction Box at pump/motor |
| 6 | HDP-03 | Hydraulic Pump 3 | 28 | 400 | DOL | | | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | | | | 1 | | 1 | 1 | | | 1 | | | | | | E-stop on Junction Box at pump/motor |
| 7 | HDP-04 | Hydraulic Pump 4 | 25 | 400 | DOL | | | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | | | | 1 | | 1 | 1 | | | 1 | | | | | | E-stop on Junction Box at pump/motor |
| 8 | FAN-01 | Pump Station Fan 1 | 35 | 400 | DOL | | | 1 | 1 | | | 1 | 1 | | 1 | 1 | | | 1 | 1 | | | | | | | | 1 | | 1 | 1 | | | 1 | | | | | | |
| 9 | FAN-02 | Pump Station Fan 2 | 35 | 400 | DOL | | | 1 | 1 | | | 1 | 1 | | 1 | 1 | | | 1 | 1 | | | | | | | | 1 | | 1 | 1 | | | 1 | | | | | | |
| 10 | FAN-03 | MV Room Fan 1 | 25 | 400 | DOL | | | 1 | 1 | | | 1 | 1 | | 1 | 1 | | | 1 | 1 | | | | | | | | 1 | | 1 | 1 | | | 1 | | | | | | |
| 11 | FAN-04 | MV Room Fan 2 | 25 | 400 | DOL | | | 1 | 1 | | | 1 | 1 | | 1 | 1 | | | 1 | 1 | | | | | | | | 1 | | 1 | 1 | | | 1 | | | | | | |
| 12 | FAN-05 | Cable Gallery Fan 1 | 10 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| 13 | CR-01 | Crane | 35 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| 14 | PLC-01 | Master PLC (Control) | 12 | 220 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| 15 | SCD-01 | SCADA | 12 | 220 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| 16 | DB-PS | DB Pump Station | 1 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| 17 | BFV-01 | Butterfly Valve (actuated) | 50 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | All actuator supplies shall be combined into one feeder cubicle |
| 18 | BFV-02 | Butterfly Valve (actuated) | 40 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | |
| 19 | BFV-03 | Butterfly Valve (actuated) | 23 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | |
| 20 | BFV-04 | Butterfly Valve (actuated) | 28 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | |
| 21 | BFV-05 | Butterfly Valve (actuated) | 25 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | |
| 22 | BFV-06 | Butterfly Valve (actuated) | 35 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | |
| 23 | GV-01 | Gate Valve (actuated) | 40 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | |
| 24 | GV-02 | Gate Valve (actuated) | 23 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | |
| 25 | GV-03 | Gate Valve (actuated) | 28 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | |
| 26 | GV-04 | Gate Valve (actuated) | 25 | 400 | FDR | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | |

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| 106777<br>*Butterworth Pump Station*<br>**PLC PS - Instrumentation and Control Cable Schedule** | | | | | | | | | | | | | | Document Number<br>*106777_MCC PS_I&CS* | Rev<br>T0 | Date<br>Dec-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item No** | **Tag No** | **Description** | **Location** | **P&ID** | **Estimate Length** | **Signal** | | **Power Cables** | | **Control Cables** | | **Instrumentation Cables** | | **Function** | | |
| | | | | | | **Analog** | **Digital** | **Cores** | **Size mm²** | **Type** | **Size mm²** | **Pairs** | **Size mm²** | | | |
| - | | | | | | | | | | | | | | | | |
| 1 | RWP-01 | Raw Water Pump 1 | Pump Station | 001 | 25 | | x | | | 4C | 1.5 | | | Start / E-Stop | | |
| 2 | RWP-02 | Raw Water Pump 2 | Pump Station | 001 | 15 | | x | | | 4C | 1.5 | | | Start / E-Stop | | |
| 3 | RWP-03 | Raw Water Pump 3 | Pump Station | 001 | 18 | | x | | | 4C | 1.5 | | | Start / E-Stop | | |
| 4 | RWP-04 | Raw Water Pump 4 | Pump Station | 001 | 28 | | x | | | 4C | 1.5 | | | Start / E-Stop | | |
| 5 | SV-01 | Solenoid Valve 1 | HDP 01 | 001 | 8 | | x | | | 4C | 1.5 | | | Open / Close | | |
| 6 | SV-02 | Solenoid Valve 2 | HDP 02 | 001 | 8 | | x | | | 4C | 1.5 | | | Open / Close | | |
| 7 | SV-03 | Solenoid Valve 3 | HDP 03 | 001 | 8 | | x | | | 4C | 1.5 | | | Open / Close | | |
| 8 | SV-04 | Solenoid Valve 4 | HDP 04 | 001 | 8 | | x | | | 4C | 1.5 | | | Open / Close | | |
| 9 | LT-01 | Level Meter | Suction reservoir | 001 | 100 | x | | 3C | 2.5 | | | 1-pair | 1.5 | Low level cut out, High level alarm | | |
| 11 | LS-01 | Level Switch | Suction Reservoir | 001 | 100 | | x | | | 3C | 1.5 | | | Low level cut out | | |
| 13 | TT-01 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 14 | TT-02 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 15 | TT-03 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 16 | TT-04 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 17 | TT-05 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding - Drive end | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 18 | TT-06 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding - Non-Drive End | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 19 | TT-07 | Temperature Transmitter (PT100) | Raw Water Pump 1 Bearing - Drive end | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 20 | TT-08 | Temperature Transmitter (PT100) | Raw Water Pump 1 Bearing - Non-Drive End | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 21 | TT-09 | Temperature Transmitter (PT100) | Raw Water Pump 1 - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 22 | TT-10 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 23 | TT-11 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 24 | TT-12 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 25 | TT-13 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 26 | TT-14 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding - Drive end | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 27 | TT-15 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding - Non-Drive End | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 28 | TT-16 | Temperature Transmitter (PT100) | Raw Water Pump 2 Bearing - Drive end | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 29 | TT-17 | Temperature Transmitter (PT100) | Raw Water Pump 2 Bearing - Non-Drive End | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 30 | TT-18 | Temperature Transmitter (PT100) | Raw Water Pump 2 - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 31 | TT-19 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 32 | TT-20 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 33 | TT-21 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 34 | TT-22 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 35 | TT-23 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding - Drive end | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 36 | TT-24 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding - Non-Drive End | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 37 | TT-25 | Temperature Transmitter (PT100) | Raw Water Pump 3 Bearing - Drive end | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |

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| 106777<br>*Butterworth Pump Station*<br>**PLC PS - Instrumentation and Control Cable Schedule** | | | | | | | | | | | | | | Document Number<br>*106777_MCC PS_I&CS* | Rev<br>T0 | Date<br>Dec-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item No** | **Tag No** | **Description** | **Location** | **P&ID** | **Estimate Length** | **Signal** | | **Power Cables** | | **Control Cables** | | **Instrumentation Cables** | | **Function** | | |
| | | | | | | **Analog** | **Digital** | **Cores** | **Size mm²** | **Type** | **Size mm²** | **Pairs** | **Size mm²** | | | |
| 38 | TT-26 | Temperature Transmitter (PT100) | Raw Water Pump 3 Bearing - Non-Drive End | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 39 | TT-27 | Temperature Transmitter (PT100) | Raw Water Pump 3 - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 40 | TT-28 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 41 | TT-29 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 42 | TT-30 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 43 | TT-31 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 44 | TT-32 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding - Drive end | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 45 | TT-33 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding - Non-Drive End | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 46 | TT-34 | Temperature Transmitter (PT100) | Raw Water Pump 4 Bearing - Drive end | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 47 | TT-35 | Temperature Transmitter (PT100) | Raw Water Pump 4 Bearing - Non-Drive End | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 48 | TT-36 | Temperature Transmitter (PT100) | Raw Water Pump 4 - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 49 | VT-01 | Vibration Sensor | Raw Water Pump 1 Bearing - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 50 | VT-02 | Vibration Sensor | Raw Water Pump 2 Bearing - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 51 | VT-03 | Vibration Sensor | Raw Water Pump 3 Bearing - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 52 | VT-04 | Vibration Sensor | Raw Water Pump 4 Bearing - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 53 | VT-05 | Vibration Sensor | Raw Water Pump 1 Bearing - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 54 | VT-06 | Vibration Sensor | Raw Water Pump 2 Bearing - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 55 | VT-07 | Vibration Sensor | Raw Water Pump 3 Bearing - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 56 | VT-08 | Vibration Sensor | Raw Water Pump 4 Bearing - Casting | 001 | 3 | x | | | | | | 1-pair | 1.5 | | | |
| 57 | ZS-01a | Proximity sensor | RWP 1 Delivery Actuated Pinch Valve | 001 | 3 | | x | | | | | 1-pair | 1.5 | BFV fully opened | | |
| 58 | ZS-01b | Proximity sensor | RWP 1 Delivery Actuated Pinch Valve | 001 | 3 | | x | | | | | 1-pair | 1.5 | BFV fully closed (no flow) | | |
| 59 | ZS-02a | Proximity sensor | RWP 2 Delivery Actuated Pinch Valve | 001 | 3 | | x | | | | | 1-pair | 1.5 | BFV fully opened | | |
| 60 | ZS-02b | Proximity sensor | RWP 2 Delivery Actuated Pinch Valve | 001 | 3 | | x | | | | | 1-pair | 1.5 | BFV fully closed (no flow) | | |
| 61 | ZS-03a | Proximity sensor | RWP 3 Delivery Actuated Pinch Valve | 001 | 5 | | x | | | | | 1-pair | 1.5 | BFV fully opened | | |
| 62 | ZS-03b | Proximity sensor | RWP 3 Delivery Actuated Pinch Valve | 001 | 5 | | x | | | | | 1-pair | 1.5 | BFV fully closed (no flow) | | |
| 63 | ZS-04a | Proximity sensor | RWP 4 Delivery Actuated Pinch Valve | 001 | 5 | | x | | | | | 1-pair | 1.5 | BFV fully opened | | |
| 64 | ZS-04b | Proximity sensor | RWP 4 Delivery Actuated Pinch Valve | 001 | 5 | | x | | | | | 1-pair | 1.5 | BFV fully closed (no flow) | | |
| 65 | PT-01 | Pressure Transmitter | Common Suction Pipework | 001 | 35 | x | | 3C | 2.5 | | | 1-pair | 1.5 | | | |
| 66 | PT-02 | Pressure Transmitter | RWP 1 Suction Pipework | 001 | 10 | x | | 3C | 2.5 | | | 1-pair | 1.5 | | | |

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| 106777<br>*Butterworth Pump Station*<br>**PLC PS - Instrumentation and Control Cable Schedule** | | | | | | | | | | | | | | Document Number<br>*106777_MCC PS_I&CS* | Rev<br>T0 | Date<br>Dec-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item No** | **Tag No** | **Description** | **Location** | **P&ID** | **Estimate Length** | **Signal** | | **Power Cables** | | **Control Cables** | | **Instrumentation Cables** | | **Function** | | |
| | | | | | | **Analog** | **Digital** | **Cores** | **Size mm²** | **Type** | **Size mm²** | **Pairs** | **Size mm²** | | | |
| 67 | PT-03 | Pressure Transmitter | RWP 2 Suction Pipework | 001 | 10 | x | | 3C | 2.5 | | | 1-pair | 1.5 | | | |
| 68 | PT-04 | Pressure Transmitter | RWP 3 Suction Pipework | 001 | 10 | x | | 3C | 2.5 | | | 1-pair | 1.5 | | | |
| 69 | PT-05 | Pressure Transmitter | RWP 4 Suction Pipework | 001 | 10 | x | | 3C | 2.5 | | | 1-pair | 1.5 | | | |
| 70 | PT-06 | Pressure Transmitter | RWP 1 Delivery Pipework | 001 | 5 | x | | 3C | 2.5 | | | 1-pair | 1.5 | | | |
| 71 | PT-07 | Pressure Transmitter | RWP 2 Delivery Pipework | 001 | 5 | x | | 3C | 2.5 | | | 1-pair | 1.5 | | | |
| 72 | PT-08 | Pressure Transmitter | RWP 3 Delivery Pipework | 001 | 5 | x | | 3C | 2.5 | | | 1-pair | 1.5 | | | |
| 73 | PT-09 | Pressure Transmitter | RWP 4 Delivery Pipework | 001 | 5 | x | | 3C | 2.5 | | | 1-pair | 1.5 | | | |
| 74 | PT-10 | Pressure Transmitter | Common Delivery Pipework | 001 | 20 | x | | 3C | 2.5 | | | 1-pair | 1.5 | | | |
| 75 | FT-01 | Flow Transmitter | RWP 1 Delivery Pipework | 001 | 5 | x | | 3C | 2.5 | | | 1-pair | 1.5 | High Flow / Low Flow | | |
| 76 | FT-02 | Flow Transmitter | RWP 2 Delivery Pipework | 001 | 5 | x | | 3C | 2.5 | | | 1-pair | 1.5 | High Flow / Low Flow | | |
| 77 | FT-03 | Flow Transmitter | RWP 3 Delivery Pipework | 001 | 5 | x | | 3C | 2.5 | | | 1-pair | 1.5 | High Flow / Low Flow | | |
| 78 | FT-04 | Flow Transmitter | RWP 4 Delivery Pipework | 001 | 5 | x | | 3C | 2.5 | | | 1-pair | 1.5 | High Flow / Low Flow | | |
| 79 | FS-01 | Flow Switch | RWP 1 | 001 | 5 | | x | | | | | 1-pair | 1.5 | | | |
| 80 | FS-02 | Flow Switch | RWP 2 | 001 | 5 | | x | | | | | 1-pair | 1.5 | | | |
| 81 | FS-03 | Flow Switch | RWP 3 | 001 | 5 | | x | | | | | 1-pair | 1.5 | | | |
| 82 | FS-04 | Flow Switch | RWP 4 | 001 | 5 | | x | | | | | 1-pair | 1.5 | | | |
| 83 | FS-05 | Flow Switch | RWP 1 | 001 | 5 | | x | | | | | 1-pair | 1.5 | | | |
| 84 | FS-06 | Flow Switch | RWP 2 | 001 | 5 | | x | | | | | 1-pair | 1.5 | | | |
| 85 | FS-07 | Flow Switch | RWP 3 | 001 | 5 | | x | | | | | 1-pair | 1.5 | | | |
| 86 | FS-08 | Flow Switch | RWP 4 | 001 | 5 | | x | | | | | 1-pair | 1.5 | | | |
| 87 | FIT-01 | Flow Transmitter | Common Delivery Pipework | 001 | 35 | x | | | | 3 | 1.5 | 2-pair | 1.5 | | | |
| Junction Boxes | | | | | | | | | | | | | | | | |
| 1 | PS-JB-01 | Junction Box | Raw Water Pump 1 | | 25 | x | | | | | | 19-pair | 1.5 | | | |
| 2 | PS-JB-01 | Junction Box | Raw Water Pump 1 | | 15 | x | | | | | | 19-pair | 1.5 | | | |
| 3 | PS-JB-01 | Junction Box | Raw Water Pump 1 | | 18 | x | | | | | | 19-pair | 1.5 | | | |
| 4 | PS-JB-01 | Junction Box | Raw Water Pump 1 | | 28 | x | | | | | | 19-pair | 1.5 | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

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| **106777**<br>Butterworth Pump<br>**PLC PS - Instrumentation Schedule** | | | | | Document Number<br>*106777_MCC PS_INST* | | | Rev<br>T0 | | Date<br>Dec-17 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item No** | **Tag No** | **Description** | **Location** | **P&ID** | **Specifications** | | | **Output** | | **Indication** | |
| | | | | | **Process Connection** | **Range** | **Unit** | **Analogue** | **Digital** | **Local** | **Remote** |
| | | | | | | | | | | | |
| 1 | SV-01 | Solenoid Valve 1 | HDP 01 | 001 | | | | | x | x | |
| 2 | SV-02 | Solenoid Valve 2 | HDP 02 | 001 | | | | | x | x | |
| 3 | SV-03 | Solenoid Valve 3 | HDP 03 | 001 | | | | | x | x | |
| 4 | SV-04 | Solenoid Valve 4 | HDP 04 | 001 | | | | | x | x | |
| 5 | LT-01 | Level Meter | Suction reservoir | 001 | | | Level | x | | x | x |
| 6 | LS-01 | Level Switch | Suction Reservoir | 001 | | | Level | | x | | x |
| 7 | TT-01 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding | 001 | | | Temperature | x | | | x |
| 8 | TT-02 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding | 001 | | | Temperature | x | | | x |
| 9 | TT-03 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding | 001 | | | Temperature | x | | | x |
| 10 | TT-04 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding | 001 | | | Temperature | x | | | x |
| 11 | TT-05 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding - Drive end | 001 | | | Temperature | x | | | x |
| 12 | TT-06 | Temperature Transmitter (PT100) | Raw Water Pump 1 Winding - Non-Drive End | 001 | | | Temperature | x | | | x |
| 13 | TT-07 | Temperature Transmitter (PT100) | Raw Water Pump 1 Bearing - Drive end | 001 | | | Temperature | x | | | x |
| 14 | TT-08 | Temperature Transmitter (PT100) | Raw Water Pump 1 Bearing - Non-Drive End | 001 | | | Temperature | x | | | x |
| 15 | TT-09 | Temperature Transmitter (PT100) | Raw Water Pump 1 - Casting | 001 | | | Temperature | x | | | x |
| 16 | TT-10 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding | 001 | | | Temperature | x | | | x |
| 17 | TT-11 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding | 001 | | | Temperature | x | | | x |
| 18 | TT-12 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding | 001 | | | Temperature | x | | | x |
| 19 | TT-13 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding | 001 | | | Temperature | x | | | x |
| 20 | TT-14 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding - Drive end | 001 | | | Temperature | x | | | x |
| 21 | TT-15 | Temperature Transmitter (PT100) | Raw Water Pump 2 Winding - Non-Drive End | 001 | | | Temperature | x | | | x |
| 22 | TT-16 | Temperature Transmitter (PT100) | Raw Water Pump 2 Bearing - Drive end | 001 | | | Temperature | x | | | x |
| 23 | TT-17 | Temperature Transmitter (PT100) | Raw Water Pump 2 Bearing - Non-Drive End | 001 | | | Temperature | x | | | x |
| 24 | TT-18 | Temperature Transmitter (PT100) | Raw Water Pump 2 - Casting | 001 | | | Temperature | x | | | x |
| 25 | TT-19 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding | 001 | | | Temperature | x | | | x |
| 26 | TT-20 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding | 001 | | | Temperature | x | | | x |
| 27 | TT-21 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding | 001 | | | Temperature | x | | | x |
| 28 | TT-22 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding | 001 | | | Temperature | x | | | x |
| 29 | TT-23 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding - Drive end | 001 | | | Temperature | x | | | x |
| 30 | TT-24 | Temperature Transmitter (PT100) | Raw Water Pump 3 Winding - Non-Drive End | 001 | | | Temperature | x | | | x |
| 31 | TT-25 | Temperature Transmitter (PT100) | Raw Water Pump 3 Bearing - Drive end | 001 | | | Temperature | x | | | x |
| 32 | TT-26 | Temperature Transmitter (PT100) | Raw Water Pump 3 Bearing - Non-Drive End | 001 | | | Temperature | x | | | x |
| 33 | TT-27 | Temperature Transmitter (PT100) | Raw Water Pump 3 - Casting | 001 | | | Temperature | x | | | x |
| 34 | TT-28 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding | 001 | | | Temperature | x | | | x |
| 35 | TT-29 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding | 001 | | | Temperature | x | | | x |
| 36 | TT-30 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding | 001 | | | Temperature | x | | | x |
| 37 | TT-31 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding | 001 | | | Temperature | x | | | x |
| 38 | TT-32 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding - Drive end | 001 | | | Temperature | x | | | x |
| 39 | TT-33 | Temperature Transmitter (PT100) | Raw Water Pump 4 Winding - Non-Drive End | 001 | | | Temperature | x | | | x |

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| 106777<br>Butterworth Pump<br>**PLC PS - Instrumentation Schedule** | | | | | Document Number<br>*106777_MCC PS_INST* | | | Rev<br>T0 | | Date<br>Dec-17 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item No** | **Tag No** | **Description** | **Location** | **P&ID** | **Specifications** | | | **Output** | | **Indication** | |
| | | | | | **Process Connection** | **Range** | **Unit** | **Analogue** | **Digital** | **Local** | **Remote** |
| | | | | | | | | | | | |
| 40 | TT-34 | Temperature Transmitter (PT100) | Raw Water Pump 4 Bearing - Drive end | 001 | | | Temperature | x | | | x |
| 41 | TT-35 | Temperature Transmitter (PT100) | Raw Water Pump 4 Bearing - Non-Drive End | 001 | | | Temperature | x | | | x |
| 42 | TT-36 | Temperature Transmitter (PT100) | Raw Water Pump 4 - Casting | 001 | | | Temperature | x | | | x |
| 43 | VT-01 | Vibration Sensor | Raw Water Pump 1 Bearing - Casting | 001 | | | Vibration | x | | | x |
| 44 | VT-02 | Vibration Sensor | Raw Water Pump 2 Bearing - Casting | 001 | | | Vibration | x | | | x |
| 45 | VT-03 | Vibration Sensor | Raw Water Pump 3 Bearing - Casting | 001 | | | Vibration | x | | | x |
| 46 | VT-04 | Vibration Sensor | Raw Water Pump 4 Bearing - Casting | 001 | | | Vibration | x | | | x |
| 47 | VT-05 | Vibration Sensor | Raw Water Pump 1 Bearing - Casting | 001 | | | Vibration | x | | | x |
| 48 | VT-06 | Vibration Sensor | Raw Water Pump 2 Bearing - Casting | 001 | | | Vibration | x | | | x |
| 49 | VT-07 | Vibration Sensor | Raw Water Pump 3 Bearing - Casting | 001 | | | Vibration | x | | | x |
| 50 | VT-08 | Vibration Sensor | Raw Water Pump 4 Bearing - Casting | 001 | | | Vibration | x | | | x |
| 51 | ZS-01a | Proximity sensor | RWP 1 Delivery Actuated Pinch Valve | 001 | | | Switch | | x | | x |
| 52 | ZS-01b | Proximity sensor | RWP 1 Delivery Actuated Pinch Valve | 001 | | | Switch | | x | | x |
| 53 | ZS-02a | Proximity sensor | RWP 2 Delivery Actuated Pinch Valve | 001 | | | Switch | | x | | x |
| 54 | ZS-02b | Proximity sensor | RWP 2 Delivery Actuated Pinch Valve | 001 | | | Switch | | x | | x |
| 55 | ZS-03a | Proximity sensor | RWP 3 Delivery Actuated Pinch Valve | 001 | | | Switch | | x | | x |
| 56 | ZS-03b | Proximity sensor | RWP 3 Delivery Actuated Pinch Valve | 001 | | | Switch | | x | | x |
| 57 | ZS-04a | Proximity sensor | RWP 4 Delivery Actuated Pinch Valve | 001 | | | Switch | | x | | x |
| 58 | ZS-04b | Proximity sensor | RWP 4 Delivery Actuated Pinch Valve | 001 | | | Switch | | x | | x |
| 59 | PT-01 | Pressure Transmitter | Common Suction Pipework | 001 | | | Pressure | x | | x | x |
| 60 | PT-02 | Pressure Transmitter | RWP 1 Suction Pipework | 001 | | | Pressure | x | | x | x |
| 61 | PT-03 | Pressure Transmitter | RWP 2 Suction Pipework | 001 | | | Pressure | x | | x | x |
| 62 | PT-04 | Pressure Transmitter | RWP 3 Suction Pipework | 001 | | | Pressure | x | | x | x |
| 63 | PT-05 | Pressure Transmitter | RWP 4 Suction Pipework | 001 | | | Pressure | x | | x | x |
| 64 | PT-06 | Pressure Transmitter | RWP 1 Delivery Pipework | 001 | | | Pressure | x | | x | x |
| 65 | PT-07 | Pressure Transmitter | RWP 2 Delivery Pipework | 001 | | | Pressure | x | | x | x |
| 66 | PT-08 | Pressure Transmitter | RWP 3 Delivery Pipework | 001 | | | Pressure | x | | x | x |
| 67 | PT-09 | Pressure Transmitter | RWP 4 Delivery Pipework | 001 | | | Pressure | x | | x | x |
| 68 | PT-10 | Pressure Transmitter | Common Delivery Pipework | 001 | | | Pressure | x | | x | x |
| 69 | FT-01 | Flow Transmitter | RWP 1 Delivery Pipework | 001 | | | Flow | x | | x | x |
| 70 | FT-02 | Flow Transmitter | RWP 2 Delivery Pipework | 001 | | | Flow | x | | x | x |
| 71 | FT-03 | Flow Transmitter | RWP 3 Delivery Pipework | 001 | | | Flow | x | | x | x |
| 72 | FT-04 | Flow Transmitter | RWP 4 Delivery Pipework | 001 | | | Flow | x | | x | x |
| 73 | FS-01 | Flow Switch | RWP 1 | 001 | | | Switch | | x | | x |
| 74 | FS-02 | Flow Switch | RWP 2 | 001 | | | Switch | | x | | x |
| 75 | FS-03 | Flow Switch | RWP 3 | 001 | | | Switch | | x | | x |
| 76 | FS-04 | Flow Switch | RWP 4 | 001 | | | Switch | | x | | x |
| 77 | FS-05 | Flow Switch | RWP 1 | 001 | | | Switch | | x | | x |
| 78 | FS-06 | Flow Switch | RWP 2 | 001 | | | Switch | | x | | x |
| 79 | FS-07 | Flow Switch | RWP 3 | 001 | | | Switch | | x | | x |
| 80 | FS-08 | Flow Switch | RWP 4 | 001 | | | Switch | | x | | x |
| 81 | FIT-01 | Flow Transmitter | Common Delivery Pipework | 001 | | | Flow | x | | x | x |

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| 106777<br>*Butterworth Pump Station*<br>**PLC PS - I/O List** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Digital Input | | | | | | | | | | | | Digital Output | | | Analog Input | | | | | Analog Ouput | | |
| **Item No** | **Tag No** | **Description** | **Tripped** | **Earth fault Tripped** | **E-Stop** | **Running/ Stopped** | **Opened** | **Closed** | **Auto/Man/Off** | **Test/Normal** | **Overheat** | **Seal Failure** | **Locked Rotor** | **Other** | **Start/Stop** | **Open/Close Forward/Reverse** | **Other** | **Measured Value** | **Amps** | **Volt** | **kW** | **Run hours** | **Set Point** | **Other** | **Remarks** |
| **MASTER PLC** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Equipment** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | IN-LV-MCC | Incomer LV MCC 01 | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | IN-LV-MCC | Incomer LV MCC 02 | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | FAN-01 | Pump Station Fan 1 | 1 | | | 1 | | | | | | | | | 1 | | | | | | | | | | | | |
| 4 | FAN-02 | Pump Station Fan 2 | 1 | | | 1 | | | | | | | | | 1 | | | | | | | | | | | | |
| 5 | FAN-03 | MV Room Fan 1 | 1 | | | 1 | | | | | | | | | 1 | | | | | | | | | | | | |
| 6 | FAN-04 | MV Room Fan 2 | 1 | | | 1 | | | | | | | | | 1 | | | | | | | | | | | | |
| 7 | FAN-05 | Cable Gallery Fan 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | CR-01 | Crane | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | PLC-01 | Master PLC (Control) | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | SCD-01 | SCADA | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | DB-PS | DB Pump Station | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | BFV-01 | Butterfly Valve (actuated) | 1 | | | | 1 | 1 | 1 | | | | | | | 1 | | | | | | | | | | | |
| 7 | BFV-06 | Butterfly Valve (actuated) | 1 | | | | 1 | 1 | 1 | | | | | | | 1 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Other** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | PLC-01 | Alarm annunication | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | Alarm on/off |
| 2 | IS-01 | Intruder | | | | | | | | | | | | 1 | | | | | | | | | | | | | Input from Intruder alarm panel |
| 3 | FD-01 | Fire Detection | | | | | | | | | | | | 1 | | | | | | | | | | | | | Input from Fire panel |
| 4 | UPS-01 | UPS - PLC | | | | | | | | | | | | 3 | | | | | | | | | | | | | On Standby, Charging, In Operation |
| 5 | UPS-02 | UPS - SCADA | | | | | | | | | | | | 3 | | | | | | | | | | | | | On Standby, Charging, In Operation |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Instrumentation** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | LT-01 | Level Meter | | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| 2 | LS-01 | Level Switch | | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| 3 | PT-01 | Pressure Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| 4 | PT-10 | Pressure Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| 5 | FIT-01 | Flow Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **MV Switchgear (see MV IO List)** | | | **143** | | | | | | | | | | | | **0** | | | **22** | | | | | **0** | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Active Total*: | | | 175 | | | | | | | | | | | | 8 | | | 26 | | | | | 0 | | | | |
| *30% spare to be allowed per type of IO card. | | | 53 | | | | | | | | | | | | 3 | | | 8 | | | | | 0 | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **PLC PUMP SET 1** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Equipment** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | RWP-01 | Raw Water Pump 1 | 1 | | 1 | 1 | | | | | | | 1 | 4 | 1 | | | | 1 | 1 | | | | | | | MPR (Loss of load/undercurrent; Loss of phase; Unbalance (asymmetrical); Thermal over load) |
| 2 | HDP-01 | Hydraulic Pump 1 | 1 | | 1 | 1 | | | 1 | 1 | | | | | 1 | | | | | | | | | | | | |
| 3 | SV-01 | Solenoid Valve 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |

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| 106777<br>*Butterworth Pump Station*<br>**PLC PS - I/O List** | | | | | | | | | | | | | | | | | | Document Number<br>*106777_MCC PS_IOList* | | | | | Rev<br>T0 | Date<br>Dec-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Digital Input | | | | | | | | | | | | Digital Output | | | Analog Input | | | | | Analog Ouput | | |
| **Item No** | **Tag No** | **Description** | **Tripped** | **Earth fault Tripped** | **E-Stop** | **Running/ Stopped** | **Opened** | **Closed** | **Auto/Man/Off** | **Test/Normal** | **Overheat** | **Seal Failure** | **Locked Rotor** | **Other** | **Start/Stop** | **Open/Close Forward/Reverse** | **Other** | **Measured Value** | **Amps** | **Volt** | **kW** | **Run hours** | **Set Point** | **Other** | **Remarks** |
| 4 | BFV-02 | Butterfly Valve (actuated) | 1 | | | | 1 | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| 5 | GV-01 | Gate Valve (actuated) | 1 | | | | 1 | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Instrumentation** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | TT-01 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 2 | TT-02 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 3 | TT-03 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 4 | TT-04 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 5 | TT-05 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 6 | TT-06 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 7 | TT-07 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 8 | TT-08 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 9 | TT-09 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 10 | VT-01 | Vibration Sensor | | | | | | | | | | | | 1 | | | | 1 | | | | | | | |
| 11 | VT-02 | Vibration Sensor | | | | | | | | | | | | 1 | | | | 1 | | | | | | | |
| 12 | ZS-01a | Proximity sensor | | | | | 1 | | | | | | | | | | | | | | | | | | |
| 13 | ZS-01b | Proximity sensor | | | | | | 1 | | | | | | | | | | | | | | | | | |
| 14 | PT-02 | Pressure Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | |
| 15 | PT-05 | Pressure Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | |
| 16 | FT-01 | Flow Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | Over & Under Flow |
| 17 | FS-01 | Flow Switch | | | | | | | | | | | | 1 | | | | | | | | | | | |
| 18 | FS-02 | Flow Switch | | | | | | | | | | | | 1 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| Active Total*: | | | 36 | | | | | | | | | | | | 5 | | | 7 | | | | | 0 | | |
| *30% spare to be allowed per type of IO card. | | | 11 | | | | | | | | | | | | 2 | | | 3 | | | | | 0 | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| **PLC PUMP SET 2** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Equipment** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | RWP-02 | Raw Water Pump 2 | 1 | | 1 | 1 | | | | | | | 1 | 4 | 1 | | | | 1 | 1 | | | | | MPR (Loss of load/undercurrent; Loss of phase; Unbalance (asymmetrical); Thermal over load) |
| 2 | HDP-02 | Hydraulic Pump 2 | 1 | | 1 | 1 | | | 1 | 1 | | | | | 1 | | | | | | | | | | |
| 3 | SV-02 | Solenoid Valve 2 | | | | | | | | | | | | | | 1 | | | | | | | | | |
| 4 | BFV-03 | Butterfly Valve (actuated) | 1 | | | | 1 | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| 5 | GV-02 | Gate Valve (actuated) | 1 | | | | 1 | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Instrumentation** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | TT-10 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 2 | TT-11 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 3 | TT-12 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 4 | TT-13 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 5 | TT-14 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 6 | TT-15 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 7 | TT-16 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |

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| 106777<br>*Butterworth Pump Station*<br>**PLC PS - I/O List** | | | | | | | | | | | | | | | | | | Document Number<br>*106777_MCC PS_IOList* | | | | | Rev<br>T0 | | Date<br>Dec-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Digital Input | | | | | | | | | | | | Digital Output | | | Analog Input | | | | | Analog Ouput | | |
| **Item No** | **Tag No** | **Description** | **Tripped** | **Earth fault Tripped** | **E-Stop** | **Running/ Stopped** | **Opened** | **Closed** | **Auto/Man/Off** | **Test/Normal** | **Overheat** | **Seal Failure** | **Locked Rotor** | **Other** | **Start/Stop** | **Open/Close Forward/Reverse** | **Other** | **Measured Value** | **Amps** | **Volt** | **kW** | **Run hours** | **Set Point** | **Other** | **Remarks** |
| 8 | TT-17 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 9 | TT-18 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 10 | VT-03 | Vibration Sensor | | | | | | | | | | | | 1 | | | | 1 | | | | | | | |
| 11 | VT-04 | Vibration Sensor | | | | | | | | | | | | 1 | | | | 1 | | | | | | | |
| 12 | ZS-02a | Proximity sensor | | | | | 1 | | | | | | | | | | | | | | | | | | |
| 13 | ZS-02b | Proximity sensor | | | | | | 1 | | | | | | | | | | | | | | | | | |
| 14 | PT-03 | Pressure Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | |
| 15 | PT-06 | Pressure Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | |
| 16 | FT-02 | Flow Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | Over & Under Flow |
| 17 | FS-03 | Flow Switch | | | | | | | | | | | | 1 | | | | | | | | | | | |
| 18 | FS-04 | Flow Switch | | | | | | | | | | | | 1 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| Active Total*: | | | 34 | | | | | | | | | | | | 5 | | | 7 | | | | | 0 | | |
| *30% spare to be allowed per type of IO card. | | | 11 | | | | | | | | | | | | 2 | | | 3 | | | | | 0 | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| **PLC PUMP SET 3** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Equipment** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | RWP-03 | Raw Water Pump 3 | 1 | | 1 | 1 | | | | | | | 1 | 4 | 1 | | | | 1 | 1 | | | | | MPR (Loss of load/undercurrent; Loss of phase; Unbalance (asymmetrical); Thermal over load) |
| 2 | HDP-03 | Hydraulic Pump 3 | 1 | | 1 | 1 | | | 1 | 1 | | | | | 1 | | | | | | | | | | |
| 3 | SV-03 | Solenoid Valve 3 | | | | | | | | | | | | | | 1 | | | | | | | | | |
| 4 | BFV-04 | Butterfly Valve (actuated) | 1 | | | | 1 | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| 5 | GV-03 | Gate Valve (actuated) | 1 | | | | 1 | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Instrumentation** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | TT-19 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 2 | TT-20 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 3 | TT-21 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 4 | TT-22 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 5 | TT-23 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 6 | TT-24 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 7 | TT-25 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 8 | TT-26 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 9 | TT-27 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 10 | VT-05 | Vibration Sensor | | | | | | | | | | | | 1 | | | | 1 | | | | | | | |
| 11 | VT-06 | Vibration Sensor | | | | | | | | | | | | 1 | | | | 1 | | | | | | | |
| 12 | ZS-03a | Proximity sensor | | | | | 1 | | | | | | | | | | | | | | | | | | |
| 13 | ZS-03b | Proximity sensor | | | | | | 1 | | | | | | | | | | | | | | | | | |
| 14 | PT-04 | Pressure Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | |
| 15 | PT-07 | Pressure Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | |
| 16 | FT-01 | Flow Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | Over & Under Flow |
| 17 | FS-05 | Flow Switch | | | | | | | | | | | | 1 | | | | | | | | | | | |
| 18 | FS-06 | Flow Switch | | | | | | | | | | | | 1 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |

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| 106777<br>*Butterworth Pump Station*<br>**PLC PS - I/O List** | | | | | | | | | | | | | | | | | | | | | | | | | | Document Number<br>*106777_MCC PS_IOList* | Rev<br>T0 | Date<br>Dec-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item No** | **Tag No** | **Description** | | **Digital Input** | | | | | | | | | | | | **Digital Output** | | | **Analog Input** | | | | | **Analog Ouput** | | **Remarks** |
| | | | **Tripped** | **Earth fault Tripped** | **E-Stop** | **Running/ Stopped** | **Opened** | **Closed** | **Auto/Man/Off** | **Test/Normal** | **Overheat** | **Seal Failure** | **Locked Rotor** | **Other** | **Start/Stop** | **Open/Close Forward/Reverse** | **Other** | **Measured Value** | **Amps** | **Volt** | **kW** | **Run hours** | **Set Point** | **Other** | |
| Active Total*: | | | 34 | | | | | | | | | | | | 5 | | | 7 | | | | | 0 | | |
| *30% spare to be allowed per type of IO card. | | | 11 | | | | | | | | | | | | 2 | | | 3 | | | | | 0 | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| **PLC PUMP SET 4** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Equipment** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | RWP-04 | Raw Water Pump 4 | 1 | | 1 | 1 | | | | | | | 1 | 4 | 1 | | | | 1 | 1 | | | | | MPR (Loss of load/undercurrent; Loss of phase; Unbalance (asymmetrical); Thermal over load) |
| 2 | HDP-04 | Hydraulic Pump 4 | 1 | | 1 | 1 | | | 1 | 1 | | | | | 1 | | | | | | | | | | |
| 3 | SV-04 | Solenoid Valve 4 | | | | | | | | | | | | | | 1 | | | | | | | | | |
| 4 | BFV-05 | Butterfly Valve (actuated) | 1 | | | | 1 | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| 5 | GV-04 | Gate Valve (actuated) | 1 | | | | 1 | 1 | 1 | | | | | | | 1 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Instrumentation** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | TT-28 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 2 | TT-29 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 3 | TT-30 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 4 | TT-31 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 5 | TT-32 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 6 | TT-33 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 7 | TT-34 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 8 | TT-35 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 9 | TT-36 | Temperature Transmitter (PT100) | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 10 | VT-07 | Vibration Sensor | | | | | | | | | | | | 1 | | | | 1 | | | | | | | |
| 11 | VT-08 | Vibration Sensor | | | | | | | | | | | | 1 | | | | 1 | | | | | | | |
| 12 | ZS-04a | Proximity sensor | | | | | 1 | | | | | | | | | | | | | | | | | | |
| 13 | ZS-04b | Proximity sensor | | | | | | 1 | | | | | | | | | | | | | | | | | |
| 14 | PT-05 | Pressure Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | |
| 15 | PT-08 | Pressure Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | |
| 16 | FT-04 | Flow Transmitter | | | | | | | | | | | | | | | | 1 | | | | | | | Over & Under Flow |
| 17 | FS-07 | Flow Switch | | | | | | | | | | | | 1 | | | | | | | | | | | |
| 18 | FS-08 | Flow Switch | | | | | | | | | | | | 1 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| Active Total*: | | | 34 | | | | | | | | | | | | 5 | | | 7 | | | | | 0 | | |
| *30% spare to be allowed per type of IO card. | | | 11 | | | | | | | | | | | | 2 | | | 3 | | | | | 0 | | |

| **106777**<br>*Butterworth Pump Station*<br>**PLC PS - MV I/O List** | | | | | | | | | | | | | | | | | | | | | | | | | | | | Document Number<br>*106777_MCC PS_MV IOList* | Rev<br>T0 | Date<br>Dec-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item No** | **Tag No** | **Description** | **Digital Input** | | | | | | | | | | | | | **Digital Output** | | | **Analog Input** | | | | | **Analog Ouput** | | **Remarks** | | | |
| | | | **CB Open** | **CB Closed** | **CB racked in position** | **CB racked out of position** | **CB racked in Earth position** | **Spring Charged** | **Heater On** | **Power outage/phase loss** | **ARC & OC & EF Protection Healthy** | **ARC Protection Operated** | **OC &EF Protection Operated** | **Trip Circuit Failure** | **Other** | **Open** | **Close** | **Other** | **Measured Value** | **Amps** | **Volt** | **kW/kWh** | **Run hours** | **Set Point** | **Other** | | | | |
| **MASTER PLC** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **MV Switchgear** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | | 11kV Switchgear - Incomer 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | 1 | 1 | | | Monitoring signals to be communicated over field/ethernet network via RTU | | | |
| 2 | | 11kV Switchgear - Incomer 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | 1 | 1 | | | | | | |
| 3 | | 11kV Switchgear - Motor Starter 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | | | | 1 | | | | | | | | | |
| 4 | | 11kV Switchgear - Motor Starter 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | | | | 1 | | | | | | | | | |
| 5 | | 11kV Switchgear - Motor Starter 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | | | | 1 | | | | | | | | | |
| 6 | | 11kV Switchgear - Motor Starter 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | | | | 1 | | | | | | | | | |
| 7 | | 11kV Switchgear - 100kVA TRF FDR 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | | | | 1 | | | | | | | | | |
| 8 | | 11kV Switchgear - 100kVA TRF FDR 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | | | | 1 | | | | | | | | | |
| 9 | | 11kV Switchgear - WTW FDR 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | | | | 1 | | | | | | | | | |
| 10 | | 11kV Switchgear - Bus-Section | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | |
| 11 | | 11kV Switchgear - BTU | | | | | | | | | | | | | 4 | | | | | | | | | | | On, Standby, Charging, Fault | | | |
| 12 | | 11kV Switchgear - PFC 1 | | | | | | | | | | | | | 3 | | | | | | | | | | | Charged, Alarms | | | |
| 13 | | 11kV Switchgear - PFC 2 | | | | | | | | | | | | | 3 | | | | | | | | | | | Charged, Alarms | | | |
| 14 | | 11kV Switchgear - PFC 3 | | | | | | | | | | | | | 3 | | | | | | | | | | | Charged, Alarms | | | |
| 15 | | 11kV Switchgear - PFC 4 | | | | | | | | | | | | | 3 | | | | | | | | | | | Charged, Alarms | | | |
| 16 | | 11/0.4 kV Transformer 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | | 11/0.4 kV Transformer 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Sub total for Master PLC | 124 | | | | | | | | | | | | | 0 | | | 13 | | | | | 0 | | | | | |

# PART C3.2: AMENDMENTS TO THE PARTICULAR SPECIFICATIONS

# C3.2: AMENDMENTS TO THE PARTICULAR SPECIFICATIONS

In certain clauses the standard and particular specifications allow a choice to be specified in the project specifications between alternative materials and / or methods of construction and / or for additional requirements to be specified to suit a particular contract. Details of such alternative or additional requirements applicable to this contract are contained in this part of the specifications or in Part C3.1 Project Specification.

Where the Amendments to the Particular Specifications are included in this section, they are included as stand-alone sections, each with index pages that reference the relevant Particular Specification being amended. The paragraph and sub-paragraph numbers of each amendment are unique to the relevant Particular Specification. Each paragraph and sub-paragraph is immediately followed by the heading and the number of the clause or sub-clause in the Particular Specification being referenced.

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

The following Amendments to the Particular Specifications shall apply to this contract. Note that amendments to the Particular Specifications in terms of the Mechanical and Electrical Works are referenced only within Part C3.1 Project Specification

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Page

**AMENDMENTS**

The following amendments to this Specification apply to this Contract. The paragraph letters and numbers indicate the relevant clause number to which the amendments apply. Alternatively, the relevant clause number will be shown in brackets as part of the heading. New clauses add to this Specification are assigned with new numbers.

**1. Scope (Clause 1)**

This Specification covers the design and manufacture of the pipe specials and fittings required for the reservoir and rising main portion of this Contract, which shall include, but not be limited, to the following:

a) DN 700 inlet pipes and bends to the suction reservoir;

b) DN 600 outlet pipes and bends between the suction reservoir and pump station;

c) Overflow and scour outlet pipes at the reservoir of various diameters;

d) DN 700 bends on the rising main;

e) DN 700 x DN 700 tee pieces at air valve chambers;

f) DN 700 x DN 200 tees at scour valve chambers; and

g) Pipe specials inside air valve, scour valve and non-return valve chambers of various diameters.

The general arrangement of the specials and fittings, as well as the required pressure classes, are shown on the drawings and are described in the Bill of Quantities.

The pipe specials and fittings required within the pump station are dealt with under C3.1 Project Specifications.

**1. Interpretations (Clause 2)**

*Replace the first sentence in the first paragraph of sub-clause 2.2 with:*

"This specification contains clauses that are generally applicable to the design, manufacture and supply of steel pipes, specials and fittings for duties up to 6.3 MPa."

**2. Pipe and Specials (Clause 3.1)**

*Delete entire clause and replace with:*

"Unless otherwise shown on the drawings or described in the Bill of Quantities, pipe specials shall be manufactured from the following grades of steel:

a) All pipe specials equal to or less than 150 mm diameter shall be manufactured from heavy class steel in accordance with SANS 62;

b) All pipe specials larger than 150 mm diameter shall be manufactured from API 5L steel Grade X52 or Grade S 355 JR (i.e. Grade 350 WA) steel;

c) Steel pipe supports in valve chambers shall be manufactured from the same material as the pipework to be supported or from API 5L steel Grade S 275 JR or Grade X42 steel; and

d) All pipe specials at the inlet, outlet, overflow and scour of the reservoir shall be manufactured from Grade 316 stainless steel."

**3. Fasteners and Jointing Materials (Clause 3.3)**

*Replace the last paragraph with the following:*

"Asbestos gaskets in accordance with BS 1832 Grade B, and having a minimum thickness of 1,5 mm, shall be supplied for working pressures not exceeding PN 16.

Where working pressures exceed PN 16, and for DN 400 and over, rubber "O" rings dimensioned in accordance with BS EN 1092 Section 3.1, Fig. 4 for Types G and H flanges, shall be supplied to suit appropriately machined flanges.

Where flanges have not been machined in accordance with the above, spiral wound gaskets, style CG to BS 3381 shall be used. The external ring shall be made of carbon steel and electro plated. The metal windings shall consist of Grade 316 L stainless steel with asbestos filler.

Where flanges with flat faces are jointed, the gaskets shall be of the type manufactured by HPE and as specified below:

The gasket shall consist of a seal ring made from ultra high molecular weight polyethylene (UHMWPE) (section 10 mm x 5 mm minimum) which fits snugly inside a 3 mm thick x 30 mm wide (minimum) flat steel outer ring. The reuse of UHMWPE seal rings is inadmissible.

The outer ring shall consist either of:

a) A mild steel ring, hot-dip galvanized in accordance with SANS 121 to a minimum mean coating thickness of 65 µm. The finish shall be of even thickness to ensure that the ring bears evenly throughout between the two flanges.

   or

b) A 3CR12 steel ring"

**4. Fabrication (Clause 5.3)**

*Add the following subclause:*

"5.3.4 Shop Drawings

The Contractor shall, before issuing of shop drawings for manufacture, provide detailed pipework layout drawings for approval in principle by the Engineer. Such drawings shall contain general arrangements and assemblies for the pipes, pipe auxiliaries, pipe specials and valves and include materials schedules, standard parts, etc. Drawings shall provide all the information necessary to demonstrate full compliance with the drawings and specifications and to facilitate subsequent submission of shop drawings free of fit-up error. The Contractor shall be fully responsible for determining the actual dimensions of the specials.

Pipe layout drawings shall incorporate all relevant prime and subsidiary dimensions (primarily, but not necessarily limited to, face-to-face dimensions).

Drawings shall be prepared to acceptable industry standards, an example of which shall be submitted for approval before draughting commences. Due account is to be taken in preparing drawings of the necessity, inter alia, to facilitate straight-forward subsequent fit-up on site, without undue site trimming and site

preparation for butt welding, so minimizing also the necessity for extensive site repairs to, or extensions of, internal and external corrosion protection.

Only after approval of final pipework layout drawings by the Engineer shall shop drawings for manufacture of pipes and specials commence. For subsequent approval by the Engineer these shall be in such detail as is appropriate for manufacture. No manufacturing of pipework shall be permitted without approval of the shop drawings by the Engineer.

Approval by the Engineer of any drawing shall not relieve the Contractor of responsibility for correct manufacture and subsequent fit-up on site."

**5. Welding (Clause 5.3.1)**

*Delete entire clause in its entirety and replace with:*

"Only qualified welders, certified as having passed the qualification tests as specified in Clauses 6.1 to 6.7 inclusive of API Standard 1104 or alternatively, SANS 10044: Part IV, shall be used to do all welding required. Copies of the certificates shall be made available to the Engineer.

Welding and inspection of welds shall be in accordance with Clauses 7 to 11.4 inclusive of API Standard 1104 or alternatively, SANS 10044: Part III. Where radiographic inspection is specified in the Amendments, the procedure followed shall be in accordance with Clause 11.1 of API Standard 1104. Only qualified radiographers as specified in API Standard 1104 shall be employed to do the radiography.

Internal reinforcement in the form of backing rings at weld seams shall not be permitted.

The internal weld bead/upset metal and flash on the inner surface shall not exceed 1 mm. For pipes and specials to be joined by butt welding, the internal weld bead shall not protrude more than 1 mm into the bore of the pipe or special. For electric resistance welded pipes, the height of upset metal and flash on the inner surface shall not exceed 1 mm. For pipes and specials to be joined by butt welding, the internal weld bead shall be ground flush with the pipe body for a length of 200 mm from the ends to be jointed. For pipes and specials to be coupled by flexible couplings, external weld reinforcement or upset metal and flash shall be ground flush with the pipe body for a length of 250 mm from the end to be coupled and shall be free from indentations projections or roll marks

Where automatic submerged-arc welding is employed, at least one pass shall be made on the inside and at least one pass on the outside. This shall apply for double jointing of pipes in the factory as well. The number of longitudinal weld seams shall not exceed:

(a) 1 for pipes up to 1 000 mm nominal diameter;

(b) 2 for pipes larger than 1 000 mm and up to 2 220 mm nominal diameter.

For pipes to be joined by flexible couplings the pipe manufacturer is required to weld steel plates not less than 50 mm x 50 mm x 16 mm thick to each end of all pipes during the pipe manufacturing process, (i.e. before priming, lining and coating). Steel plates shall be located far enough from each pipe end so as not to interfere with the installation of the flexible coupling."

**6. Pipes (Clause 5.3.2)**

*Delete entire clause in its entirety and replace with:*

"Specials which require joints to be butt welded on site shall be supplied with ends bevelled in accordance with the requirements of SANS 719, Clause 5.1.5."

**7. General (Clause 5.3.3.1)**

*In the third line of the first paragraph delete wording "*sections 3 and 4 of".

**8. Bends (Clause 5.3.3.2)**

*Replace the last sentence of the first paragraph with:*

Bend radii shall be three pipe diameters unless otherwise indicated on the drawings or specified in the Bill or Schedule of Quantities."

**9. Branches and nozzles for bypasses, drains, air valves, pressure gauges, etc (Clause 5.3.3.3)**

*Delete the entire paragraph that starts with* "Scour valve tees are to…" *in its entirety and replace with:*

"For scour valve tees the branch, consisting of a 90 degree bend, shall be located centrally on the pipe invert and point vertically downwards with the horizontal section at right angles to the barrel of the pipeline. The branch flange shall be set so that the scour valve spindle points vertically upwards, as shown on the drawings."

**10. Flexible couplings (Clause 5.3.3.5)**

*Delete entire clause in its entirety and replace with:*

"Ends for use with mechanical couplings shall be square cut or bevelled plain ends, cut square to the pipe axis, with all edge burrs, weld splatter and scratches removed. The outside of the pipe shall be free of indentations, projections or roll marks for a distance of 250 mm from each end to permit proper make-up of the coupling. Longitudinal or spiral welds on the outside of the plain end shall be ground to plate or sheet surface for a minimum distance of 250 mm.

Flexible couplings for plain-ended steel pipe and adaptor couplings shall be either of the slip-on type complying with Clause 15 of BS 534 or of the slip-on type without centre register conforming to the drawings, as scheduled. Slip-on flange adaptors for steel pipes shall conform to the relevant drawings.

A coupling shall be able to withstand without failure a hydrostatic test pressure of twice the working pressure specified for the pipe for which the coupling is required, and coupling flanges shall be capable of withstanding without damage all stresses caused by proper tightening of the bolts. Rubber rings shall comply with the relevant requirements of SANS 974: Part I and shall have a hardness of 66 to 75 IRHD.

All grinding off of welds shall conform accurately with the profile of the rolled section and so that no flats occur on surfaces that are supposed to be curved. The centre register (where present) shall be ground off on either side of the weld in such a manner that all sharp edges which would result in weakening of the protective coating are removed. Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings."

**11. Flanges (Clause 5.3.3.7)**

*Replace the first sentence with:*

"Except where specified to the contrary in the Project Specification or on the drawings, all flanges shall be steel-plate for welding and shall conform to BS EN 1092. Flanges not covered by the BS EN 1092 standard shall be in accordance with ASME B16 47 for the relevant pressure class."

*Replace the seventh sentence with:*

All flanges shall be machined overall with gramophone finish in accordance with SANS 1123.

**12. Marking of Pipes and Specials (Clause 6)**

*Delete entire clause in its entirety and replace with:*

"Upon fabrication, each special shall be hard stamped with a unique reference number to ensure traceability. The stamp is to be 100mm from the pipe end and next to a weld. On completion of the contract or at reasonable intervals during the contract, the following pipe information shall be supplied to the Engineer in Microsoft Excel ® format:

a) Pipe reference number
b) Contract number
c) Date of manufacture
d) Outside diameter
e) Wall thickness/pressure rating
f) Grade of steel
g) Coating type and nominal thickness
h) Lining type and nominal thickness
i) Mass of uncoated and unlined special in kg/m
j) Applicable drilling tables stamped on the periphery of all flanges
k) Bends shall have their "centre plane" marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends during laying."

**13. Storage, Handling and Transport (Clause 7)**

*Delete entire clause in its entirety and replace with:*

"Specials shall be protected against damage at all stages from manufacture to delivery. Particular care shall be taken to protect the ends of all specials against denting and to prevent deformation of the pipe body in excess of 2 % of the diameter or any other such limitations to prevent damage to pipe linings and coatings.

In the transportation, loading and unloading of specials, an adequate fleet of vehicles shall be operated and maintained at all times to ensure that specials and their protective linings and coatings are not damaged.

Specials shall be so transported, stored and handled that they are not overstressed at any time and fittings are not damaged in any way. Access for delivery on site might be restricted by poor weather conditions and the Contractor shall make due allowance for such disruption. Unless otherwise specified the pipes shall be off-loaded adjacent to the laying position. All thin-walled and soft-coated specials shall be handled with particular care and shall be so stored that they are not subjected to concentrated pressure from stones or other objects. Specials damaged or cracked in any way shall be removed from the Site at no cost to the Employer.

If cradles are used to transport the specials they must be rubber lined to avoid damage to the coating. During transportation specials shall be safely secured.

The Contractor shall be responsible for dispatching and transporting of the pipes to site and off-loading.

Temporary end covers shall be provided for the protection of the ends of all pipes and specials to protect pipe linings from damage during transport and during storage and handling on site. Suitable access along the pipeline route must be provided by the Contractor."

**14. General (Clause 8.1)**

All welds shall be radiographically tested (X-rayed) over 100% of the weld length. Where radiographical testing cannot be performed, 100% dry liquid penetrant testing shall be done.

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

**15. Visual Inspection (Clause 8.2.1)**

*Delete the last sentence of the paragraph*

**16. Ultrasonic Inspection to API 5L (Clause 8.2.2)**

*Delete entire clause in its entirety*

**17. Hydrostatic Testing (Clause 8.2.4)**

*Delete the last sentence of the paragraph*

**18. Repair of Injurious Defects (Clause 8.5.4)**

*Add the following to the end of the clause:*

"If a special fails to pass any of the tests specified, it will be rejected but the Engineer may permit repairs or alterations to be made to enable the special to pass the test.

Repairs of welded joints will be permitted during the process of manufacture. Where repairs are required the defective weld metal shall be cut out, and the parent metal prepared by grinding, and re-welded, to the satisfaction of the Engineer.

Each repair weld shall be marked with the welder's identifying stamp.

When the repair has been made, it shall be radiographically tested (X-rayed) over the full length of the repair.

On discovery of defective welds the Engineer may, at his discretion, call for additional radiographic examination until it is shown that the necessary standard is being maintained.

Should a weld repair be required on a special subsequent to hydraulic testing, the repaired special shall be retested."

**19. Destructive Testing (Clause 8.4)**

*Delete entire clause in its entirety*

**20. Corrosion Protection (Clause 9)**

*Replace* "Section C1" *in the first sentence with* "Section C7"*:*

**21. Measurement and Payment (Clause 12.3)**

*Delete entire clause in its entirety and replace with:*

"Unless specific provision is made in the Bill of Quantities, no separate payment will be made for corrosion protection. The rates tendered will be held to cover the cost of any protection system specified.

Measurement and payment shall be per linear metre of straight pipe fabricated, supplied and delivered to site. Measurement and payment of specials and fittings shall be per the number of each special and fitting fabricated, supplied and delivered to site.

The unit rates shall cover the cost of the provision of each special, complete with couplings and/or other jointing materials as appropriate, and for the design of all specials including all drawings and shop drawings.

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for the supply and delivery to Site of any additional couplings and jointing materials which may be required for the connection of the specials."

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**AMENDMENTS**

The following amendments to this Specification apply to this Contract. The paragraph letters and numbers indicate the relevant clause number to which the amendments apply. Alternatively, the relevant clause number will be shown in brackets as part of the heading. New clauses add to this Specification are assigned with new numbers.

**1. Scope (Clause 1)**

This Specification covers the construction of the steel rising main and reservoir steel pipework with its associated structures outside of the pump station. The construction of steel pipelines and associated structures inside the pump station for this Contract is dealt with under C3.1 Project Specifications.

The construction of uPVC and HDPE pipelines are covered by SANS 1200L and its amendments.

**2. Standards (Clause 2)**

*Delete the entire first paragraph and replace with*

"The following Standard Specifications, Codes of Practice, Regulations and associated amendments shall apply as specified hereinafter".

*Delete the reference* "Act 85/1993 Occupational Health and Safety act and regulations" and replace with "The Project Health and Safety Specification".

*Replace reference to* "DWS 9900 C1" and replace with "DWS 9900 C7"

*All references to made to* "DWS 9900 C1" within the entire DWS 1110 document shall be replaced with reference to "DWS 9900 C7"

**3. Flanges (Clause 3.1.6)**

*Delete entire clause and replace with:*

"DWS 1130 Clause 5.3.3.7 and its amendments shall apply"

**4. Fasteners (Clause 3.1.7 )**

*Delete entire clause in its entirety and replace with:*

"DWS 1130 Clause 3.3 and its amendments shall apply"

**5. Gaskets and rubber joint rings (Clause 3.1.8)**

*Delete entire clause in its entirety and replace with:*

"DWS 1130 Clause 3.3 and its amendments shall apply"

**6. Concrete pipe jacking sleeves (Clause 3.5)**

*Delete entire clause in its entirety and replace with:*

"SANS 1200 LG and its amendments shall apply"

**7. Manhole covers and frames and ventilators (Clause 3.7)**

*Delete entire clause in its entirety and replace with:*

"Shall be manufactured as shown in the Drawings"

**8. Concrete Work (Clause 3.9 up to Clause 3.14)**

*Delete all six clauses in its entirety and replace with:*

"DWS 0750 and its amendments shall apply"

**9. Backfill material (Clause 3.16)**

*Delete entire clause in its entirety and replace with:*

"SANS 1200 LB Clause 3 and its amendments shall apply for pipe bedding.

SANS 1200 DB Clause 3.5 and its amendments shall apply for pipe backfill."

**10. Repairs (Clause 3.19.4)**

*For Clause 3.19.4, replace the last sentence of the Subclause starting with* "The ends of pipes intended for field welding…" *with the following:*

"The ends of pipes intended for field welding shall be re-chamfered as described in Clause 5.1.5 of SANS 719. The minimum gap between pipe end root faces before welding shall be 1,5 mm and the maximum gap shall be 3,0 mm."

**11. Maintenance of cleanliness (Clause 3.20)**

*Delete entire clause in its entirety and replace with:*

"Every reasonable precaution shall be taken to prevent the entry of foreign matter and water into the pipe(s). At the close of each day's work, or at any time when work is suspended for a significant period, the last laid section of the pipeline shall be plugged, capped or otherwise tightly closed until laying is recommenced.

The interior of pipes shall be perfectly clean before being laid and the Engineer may instruct that the pipe interior be cleaned or washed before the pipes are lowered into the trench. All brushes, trowels, welding rod stumps, pieces of mortar, dust and all foreign matter shall be removed from pipes immediately before laying. Once a section of pipeline has been cleaned, it shall be sealed off and not be entered again unless permitted by the Engineer.

During laying and jointing of pipes and until the pipeline has passed the required acceptance tests and the trench has been backfilled, the trench shall be kept in a state which, in the opinion of the Engineer, is reasonably dry.

The Contractor shall at his own expense make good any damage to valves and fittings or clogging of off-takes or malfunctioning of fittings which result from his failure to keep the pipeline in a thoroughly clean condition."

**12. General (Clause 4.1.1)**

The detailed design is the responsibility of the Engineer.

**13. Setting out (Clause 4.2)**

*Delete entire clause in its entirety and replace with:*

"SANS 1200 A and its amendments shall apply"

**14. Entry and work upon land (Clause 5)**

*Delete entire clause in its entirety and replace with:*

"SANS 1200 A, 1200 C, 1200 D, 1200 DB and its amendments shall apply"

**15. Site preparation (Clause 6)**

*Delete entire clause in its entirety and replace with:*

"SANS 1200 C, 1200 DB and its amendments shall apply"

**16. Earthworks (Clause 7)**

*Delete entire clause in its entirety and replace with:*

"SANS 1200 D, 1200 DB, 1200 LB and its amendments shall apply"

**17. Flanges (Clause 8.2.2.3)**

*Delete entire clause in its entirety and replace with:*

"DWS 1110 Clause 8.5.4 and its amendments shall apply"

**18. Installation of valves and meters (Clause 8.3)**

*For Subclause 8.3.1, add the following after the second sentence:*

"Where fabricated steel stools are approved or specified they shall comply with the requirements of SANS 10044-3 and shall be fabricated to the Engineer's approval."

*Delete Subclause 8.3.3 and replace with the following*

"8.3.3 Unless otherwise specified or directed, gate valves shall be set upright and butterfly valves shall be set with the main shafts horizontal. All valves and meters shall be correctly set, supported, and placed in position as the work proceeds, and shall be properly jointed to their respective pipes. All valves and fittings shall be left in working order and shall be housed in chambers as shown on the Drawings."

*Add the following Subclauses to Clause 8.3:*

"8.3.4 Valves, meter bodies and fittings shall be supplied, painted externally and internally. The Contractor shall thoroughly clean damaged exterior painted surfaces of all valves, meter bodies and fittings of all dirt, rust, grease and other foreign matter by methods approved by the Engineer and shall make good all damaged surfaces in accordance with the requirements of DWS 9900 C7.

All valves and meters supplied under separate contracts, which are defective due to circumstances outside the Contractor's control shall be repaired, replaced or modified by the valve suppliers who will also be responsible for commissioning the valves.

Hydrostatic testing of individual sections of the pipeline shall only be carried out when all scour valves, air valves and control valves have been installed, except where otherwise instructed by the Engineer in writing.

Should line control valves or other equipment not be delivered timeously to enable the Contractor to lay continuously and to test the pipeline, the Engineer may order the Contractor to substitute specially made temporary flanged closure pieces. Such temporary closure pieces shall be supplied and installed by the Contractor to enable laying and testing to proceed. Subsequently after installation of the control valves, etc., they shall be removed and shall become the Contractor's property. These temporary closure pipes shall have the same face to face dimensions as the line control valves and shall be fitted with a suitably reinforced control diaphragm plate for sealing of the section of pipeline where it is fitted.

Wall thickness and diameter of the closure pipes shall be the same as the pipeline. A 100 mm nominal bore valve-controlled by-pass shall be fitted externally around the diaphragm plate."

**19. Field Welding (Clause 8.4)**

*Delete entire clause in its entirety and replace with:*

"8.4.1 General

At the discretion of the Engineer, roll welding will be permitted, provided an alignment is maintained by use of skids or of structural framework to accommodate two or more lengths of pipe with an adequate number of roller dollies to prevent sag in the pipe. The entire root bead, however, shall be made with the pipe in a stationary position.

All pipes welded in the trench shall be properly laid and aligned before welding commences. Joint holes shall be excavated at all field welds. The Contractor shall not lift the pipe to provide adequate access for the welders to enable them to weld the joint.

The alignment of abutting ends shall be such that the offset will not exceed 1.5 mm. Line up clamps shall be used for joint "fit-ups". The use of "bridges and wedges" or any method that may induce unnecessary stresses will not be permitted.

Both ends of coated and lined pipes shall be wrapped for a distance of at least 800 mm on either side of the weld by means of an asbestos mat or other approved material to ensure that weld spatter or other damage is not caused to the coating and lining during the welding process. The pipe trench shall be kept free of all dirt and water in the vicinity of the weld until after all corrosion protection measures have been completed and approved.

Destructive testing as specified in API 1104 Clause 6.5 shall be carried out and approved prior to any field welding being done. The Contractor shall submit to the Engineer for approval a full procedure specification as detailed in API 1104 Clause 5.3 prior to any field welding being allowed.

8.4.2 Welding procedure and qualification of welders

Welding shall only be done by qualified welders who satisfy the requirements of API Std. 1104, Clause 6 and who have been tested at the Contractor's expense by an Independent Inspectorate.

Before any welding of pipeline materials commences, the qualification of welders shall have been approved, all detailed welding procedure specifications with weld diagrams required for their completion shall have been submitted for approval in a neat form and the welding procedure qualification tests shall have been successfully concluded all in accordance with the relevant standard specifications. Each welder shall mark the pipe adjacent to the weld with the figure assigned to him.

Sufficient records shall be kept by the Contractor to ensure that all field welds can be subsequently identified with the welder concerned.

As far as practicable all out of trench welding shall preferably be done by an automatic submerged process and the Contractor shall provide all necessary plant to carry out this process. Manual submerged electric arc process (MSEAP) welding may be used where in-trench welding is done.

Pre- and post-heat treatment for welding shall be in accordance with API Std. 1104 if required by same and the Contractor shall provide an approved shield to protect the pipe joint from wind and weather during heat treatment and welding.

8.4.3 Line up

Pipes shall be lined up in such a manner as to prevent damage thereto. If the pipe to be used has a longitudinal seam, these seams shall be staggered by not less than twenty degrees and welded sections, or single lengths, shall be assembled in such a manner that this seam shall remain in the top quadrant of the pipe during coating operations and after lowering into the trench.

8.4.4 Cleaning of pipe ends

Before welding, all foreign matter shall be removed from the bevelled ends. If any of the ends of the pipe joints are damaged to the extent that satisfactory welding contact cannot be obtained, the damaged pipe ends shall be cut and bevelled with an approved bevelling machine. These field bevels of pipe ends shall be made to the satisfaction of the Engineer. Should laminations, split ends, or other defects in the pipe be discovered, the joints of pipes containing such defects shall be cropped, repaired, or removed from the line as designated by the Engineer.

8.4.5 Weather conditions

No welding shall be carried out during rain or high wind unless the welder and joint are adequately protected and sheltered, to ensure that the welding is not impaired.

8.4.6 Protection of paintwork

Before welding commences, a suitable apron at least 800 mm wide shall be wrapped around both sides of the area to be welded to ensure that weld spatter or fallout from arc weld does not damage the paintwork.

During the welding of joints, the Contractor shall ensure that either rubber mats or other suitable material is laid in the pipe invert of epoxy lined steel pipes to protect the lining against damage by traffic or fall-out from

arc welding at the joint. The mats shall be placed the full distance from the point of access up to the point of weld or weld inspection and shall be of sufficient width.

Workmen shall wear soft rubber soled shoes before entering lined pipes. Care shall be taken not to stroke arcs on the epoxy lined areas adjacent to the weld joint. Immediately before welding of joints, the protective tape between the ends of concrete or epoxy linings and coatings and pipe ends shall be removed."

**20. Butt Welding (Clause 8.5.2)**

*Delete entire clause in its entirety and replace with:*

"8.5.2.1 General

Pipes and specials to be joined by field welding shall be supplied with ends bevelled for welding. All welding of joints shall comply with API Std. 1104 and only approved type welding rods shall be used.

If backing rings are used, they shall be placed in position and wedged up or adjusted so that the pipe ends are completely circular and properly mated. The space between abutting pipe ends, when aligned for welding, shall be such as to ensure complete penetration without burn-through. For pipes having the same dimensions, the spacing shall be approximately 1,5 mm.

The alignment of the abutting pipe ends shall be such as to minimize the offset between pipe surfaces. For pipes of the same nominal wall thickness, the offset shall not exceed 1,5 mm. Internal line-up clamps shall be used wherever practicable and may be removed after the root bead is 50 % completed, provided that the completed part of the root bead is in segments of approximately equal lengths, spaced about the circumference of the pipe. If conditions make it difficult to prevent movement of the pipe, or if the weld will be unduly stressed, the root bead shall be completed before releasing clamp tension.

External line-up clamps shall be used where it is impracticable to use internal line-up clamps. Partial root beads made when using external clamps shall be uniformly spaced about the circumference of the pipe, and shall have an accumulative length of not less than 50% of the pipe circumference before the clamps are removed.

Tack-welding shall be carried out to maintain the root gap and position of the pipe ends during the welding proper. The number of tack-welds shall be kept to a minimum but shall not be less than four around the circumference of the pipe.

After proper preparation and tack-welding, the root bead shall be carried out followed by successive filler passes, and capper finish pass in accordance with the approved welding procedure.

The filler and finish beads shall be deposited by an acceptable method and each filler bead shall be approximately 3 mm in thickness. Completed welds shall have a reinforcing of not less than 0,8 mm and not more than 1,5 mm above the pipe surface around the entire perimeter of the weld, and the width of the finish or cover shall be not more than 3 mm greater than the original groove.

The number of beads required shall be governed by the wall thickness of the pipe, so that the completed weld will have the reinforcement previously specified; provided, however, that each weld shall consist of at least three beads. No two beads shall be started at the same point. No mitre welds will be permitted, and all welds are to be at ninety degrees (± 5 degrees) to the axis of the pipe. All slag and scale shall be removed from each bead for visual inspection immediately after each bead is run.

In all field butt-welds where it is possible to work inside the pipe, the inside weld shall be done first. The chemical composition of weld metal and parent metal shall be similar and the inner weld metal or reinforcement shall not extend more than 1 mm above the inside metal surface of a pipe or special, and any excess shall be removed by grinding.

Defects caused by stray welding arc flashes shall be removed by grinding, provided that the pipe wall thickness is not reduced to less than the specified minimum thickness, otherwise the portion shall be cut out and repaired.

8.5.2.2 Welding alongside the trench

Snaking into the trench of butt-welded sections of steel pipeline which has been factory lined and/or coated will not be permitted without the written approval of the Engineer.

The Contractor may butt-weld factory coated and/or lined steel pipes together alongside the edge of the trench to form continuous welded pipeline sections up to a maximum length of 45 m and to lower each section into the trench, provided the pipe, coating and/or lining are in no way damaged during these operations and provided furthermore that the deflection of the pipe barrel at any point during any stage of the operation does not exceed 2% of pipe outside diameter.

The linings and coatings of factory coated and/or lined pipes jointed together outside the trench shall be made good at these joints outside the trench.

8.5.2.3 Repair of welds

Rectification of defective welds shall be in accordance with API Std. 1104 and to the satisfaction of the Engineer. All costs related to the repair of defective welds shall be borne by the Contractor. Defective welds shall be repaired immediately once they are found to be defective. The Engineer has the right to stop the Contractor proceeding with further pipe laying in the event of the Contractor delaying the rectification of defective welds. Furthermore, no consideration will be given to any claims arising from delays in construction resulting from such action."

**21. Flanged joints (Clause 8.5.4)**

*Delete entire clause in its entirety and replace with:*

"All flanges shall be installed with bolt holes off-centre and symmetrically off-set from the vertical centre lines of the flanges. Flanges shall be installed truly square to the axis of the pipe.

In the jointing of steel pipes with flanges, special care shall be taken to align, grade and level the pipes, specials and valves to avoid straining of the flanges. All bitumen and paint shall be removed from the mating face of each flange immediately before jointing. Epoxy paints shall not be removed from flange faces. Insertion pieces that have accurately cut holes for bolts shall be placed to form a continuous one-piece ring between the flanges. Bolts shall be tightened up to ensure uniform bearing on the insertion. Care shall be taken to avoid damage to the internal surface of the pipes during assembly of the pipeline.

Wherever loose flanges are welded onto pipelines, the Contractor shall ensure that the inner lining is restored to the thickness specified for such lining and that the new repaired lining is soundly jointed to the existing lining.

In making the joint the Contractor shall ensure that the flanges are truly parallel with all bolts evenly firm before being finally drawn up with torque wrenches to watertightness. Taper gauges shall be used to check that there is a uniform gap before and after final tightening up of bolts. Bolts shall be tightened in an approved sequence with bolts equally spaced and tightened equally at opposite ends first. The Contractor shall ensure that the correct jointing materials, i.e. gaskets and bolts and nuts are available when required. In the case of insulated joints the insulated materials shall be arranged as set out in Code of Practice No. SAECC/1.

Flanged fittings shall be so installed that there are no stresses induced into the pipework specials or fittings by forcing ill-fitting units into position or by bolting up flanges with faces not uniformly in contact with their gaskets over their whole faces.“

**22. Linings and coating of butt welded pipes (Clause 9.1.3)**

*Delete entire clause in its entirety and replace with:*

“As soon as practicable, but not more than 24 h after the welding of joints in the field has been approved and accepted by the Engineer, the internal lining of pipes and specials shall be made evenly continuous over the joints. At no time shall lining and coating repairs/remedial work lag more than 60 metres behind the last pipe laid.

Materials for this work shall have the same properties as those used respectively for the adjacent lining or coating and shall be so applied that the finished work over the joint shall have the same quality as specified respectively for the adjacent”

**23. Leakage rates (Clause 12.3)**

*Delete entire clause in its entirety and replace with:*

“The test pressure shall be maintained for a period of 1 hour after the completion of the test period during which time the volume of water required to be pumped into the pipeline for maintenance of the pressure shall be measured.

The permissible leakage for welded and flanged steel pipelines is zero (0) litres.”

**24. Initial pipe filling (Clause 12.5.4)**

*Add the following after the first sentence of the Subclause:*

“Unless otherwise specified or approved in writing by the Engineer, filling of the pipeline for hydraulic testing shall be carried out at a velocity in the main pipeline not exceeding 0.5 m/s.”

*Replace the term* “1 hour” *in the last sentence which reference to unlined steel pipelines and linings other than concrete to* “24 hours”

**25. Drainage of pipeline (Clause 14)**

*Delete the last sentence of the paragraph starting with* “This will generally apply….*”*

**26. General (Clause 15.2.1)**

*Delete entire clause in its entirety and replace with:*

“DWS 0750 and its amendments shall apply. Unless otherwise specified or indicated on the Drawings, anchor/thrust blocks, pedestals and concrete encase of pipelines shall be constructed of 20 MPa/19 mm concrete or such other class as is scheduled.”

**27. Radiographic examination (Clause 19.2.1)**

*Delete entire clause in its entirety and replace with:*

"Radiographic tests and adjudication of test records shall be carried out by an Independent Inspectorate, appointed by the Engineer to act on his behalf. The Inspectorate shall be afforded every facility during the course of pipeline construction and testing to enable the inspection to be carried out effectively. 100% of the total length of all manual field butt welds and 100% of the total length of field welds done by an approved automatic process shall be examined radiographically with particular reference to weld intersections, using equipment supplied and staffed by the Inspectorate. All welds on critical sections such as river, rail and road crossings shall be 100% radiographically tested.

The Inspectorate shall process and adjudicate radiographs on site. The standard of acceptability shall be in accordance with API 1104. All welds which are found to be unsatisfactory shall be repaired and 100% re-radiographed at the Contractor's expense.

Field welds may be examined by radiographic inspection as stated in API 1104. Should two or more welders participate in making the weld, the welding foreman and the Engineer's Representative shall decide which welder is responsible for the defective work. The Engineer shall be privileged in the judgement of his inspector to cut out welds for further tests. The test welds that meet the Engineer's requirements and specifications when properly tested shall be replaced with a satisfactory tie-in at the Employer's expense. Should any test weld cut from the line prove unsatisfactory to the Engineer when properly tested, it shall be replaced at the Contractor's expense. Test welds shall be cut from the line as soon as practicable after completion to avoid unnecessary delay and expense, and shall consist of an annular ring not less than 230 mm long with the weld in the middle.

When welding the line together at places where the test welds have been cut out, one weld will be used if it is practicable to pull the line back into position; otherwise, two welds will be made by setting in a short length of pipe with a minimum length of 750 mm.

The Contractor shall furnish approved types of machines for testing. A record of the results of each test weld shall be made by the Engineer's inspector and jointly signed by the Engineer's Representative and Contractor's Representative. The Contractor will be reimbursed for extra welds at the rates tendered if scheduled in the Contract as a separate item. Extra welds shall be construed to mean those welds cut out at the Engineer's request which, after specified tests, are found to meet the Engineer's specifications, except those free initial test welds referred to herein.

Claims arising from delays in construction caused by justifiable additional radiography which may be ordered by the Engineer or re-radiography of repairs, will not be considered."

**28. Payment clauses (Clause 20.2 up to Clause 20.13)**

*Delete all twelve clauses in its entirety:*

**29. Laying and jointing of piping and specials (Clause 20.14.2)**

*Add to the end of the clause:*

"The rates shall also cover the supply and installation of steel pipe couplings as scheduled on the drawings."

**30. Installation of in-line valves, scour valves, air valves, non-return valves, flow meters and fittings (Clause 20.15.2)**

*Add to the end of the clause:*

"The rates shall also cover the supply and installation of steel pipe or concrete pipe supports (not necessarily shown on the drawings)."

**31. Chambers, culverts and pipeline structures (Clause 20.17)**

*Delete the reference* "Clause 8 of SANS 1200 Section G" *in the first sentence and replace with* "DWS 0750 and its amendments."

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**AMENDMENTS**

The following amendments to this Specification apply to this Contract. The paragraph letters and numbers indicate the relevant clause number to which the amendments apply. New clauses add to this Specification are assigned with new numbers.

## 1. Scope

This Specification covers the design and manufacture of air valves required inside valve chambers located on the reservoir and rising main pipework for this Contract.

The nominal diameter, pressure rating and general arrangement of the valves are shown on the drawings

The applicable technical detail sheets found in Part T2.2: Returnable Schedules must be completed for all the valves.

The air valves required inside the pump station for this Contract, and which form part of the contractor's design, are dealt with under C3.1 Project Specifications.

## 2. General (Clause 1)

The valves shall be designed for potable water. Air release valves for water pipework shall be of the non-slam type, Vent-O-Mat RBX, or ARI or equivalent.

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.

Witnessing of factory testing would not be required. However, a test report shall be submitted to the Engineer.

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.

## 3. Construction and Operational Requirements (Clause 2)

*Add the following to the clause:*

"Valves shall be flanged. The flange shall comply with the flange specification for the pipeline.

It shall be possible to remove the valve's working parts without unbolting the bottom flange from the pipeline. Floats and seats shall not, however, require maintenance under normal conditions.

A stainless steel screen shall prevent foreign matter from entering and blocking the air ports.

Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation.

The air valves shall be fitted with a ½ inch BST connection and plug to allow the insertion of pressure gauges for pipeline performance testing."

**4. Valve Material Specification (Clause 3)**

*Add the following to the clause:*

General

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.

Material specification

Ductile iron shall be protected with a water resistant, non-toxic and non-tainting, fusion bonded epoxy pipe coating to a dry film thickness of at least 250 microns. Specialist applied Rilsan coatings will also be acceptable.

Seals shall be nitrile rubber or otherwise approved by the Engineer.

Electrolytically applied plating of ferrous materials is not acceptable.

*Add the following new subclauses*:

**5. "Installation (Clause 4)**

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) Corrosion protection requirements shall be carefully attended to and the requirements of DWS 9900 C7 must be noted. All mating faces must be coated before and sealed after assembly.

e) 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.

f) Crevices 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."

**6. Measurement and Payment (Clause 5)**

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.

The installation of the valves is covered under Clause 20.15 of DWS 1110."

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**AMENDMENTS**

The following amendments to this Specification apply to this Contract. The paragraph letters and numbers indicate the relevant clause number to which the amendments apply. New clauses add to this Specification are assigned with new numbers.

## 1. Scope

This Specification covers the design and manufacture of double flanged metal seated wedge gate valves required inside valve chambers located on the reservoir and rising main pipework for this Contract which shall include, but not be limited, to flanged metal seated wedge gate valves used as isolating valves on the scour outlets and air valve installations.

The nominal diameter, pressure rating and general arrangement of the valves are shown on the drawings.

The applicable technical detail sheets found in Part T2.2: Returnable Schedules must be completed for all the valves.

The specification of metal seated wedge gate valves required inside the pump station for this Contract is dealt with under C3.1 Project Specifications.

## 2. General (Clause 1)

The valves shall be of the metal seated wedge gate type.

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.

Witnessing of factory testing would not be required. However, a test report shall be submitted to the Engineer.

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.

## 3. Specification (Clause 1.2)

*Add the following to the clause:*

Corrosion protection shall comply with DWS 9900 C7.

Installation work shall comply with DWS 1110 and amendments.

## 4. Gearboxes (Clause 1.4)

*Add the following to the clause:*

Gearboxes shall have ingress protection to IP 55. Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel. A breather designed to prevent moisture from entering shall be fitted.

## 5. Operation (Clause 1.5)

The following requirements are applicable operation and control of the valves:

- The valves will be used to isolate the scour outlets on the pipeline and air valve. The scour outlets will be closed and the air valve installations will be open under normal operating conditions.
- The valves shall be manually operated. Actuation is not required.
- The direction of closing shall be clockwise.
- 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-torqueing.
- The valves shall be suitable to withstand velocities of up to 7 m/s.

## 6. Position indicators (Clause 1.6)

*Add the following to the clause:*

Clear indication of current valve position shall be provided.

## 7. Construction and Operational Requirements (Clause 2)

*Delete reference to* "DWS 9900 C3" *and replace with* "DWS 9900 C7"

*Add the following to the clause:*

The body shall incorporate a drain with a stainless steel plug

A slipping clutch shall be provided to prevent damage. Shear pins and other torque limiting devices which have to be replaced after activation are not acceptable but mechanisms equivalent to a slipping clutch will be acceptable.

Fixing lugs for end of travel limit switches shall be provided.

The body shall incorporate storage feet.

Manually operated valves shall be provided with handwheels of a size and construction which permit easy opening of the wedge gate when subjected to a differential pressure equal to the rated pressure difference across the wedge gate. 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). Suitable gearboxes shall be fitted to achieve this.

## 8. Wedge Gate Valve (Clause 3.3)

*Add the following to the clause:*

<u>General</u>

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.

Material specification

Internal and external surfaces of the valve body shall be protected with a water resistant, non-toxic and non-tainting, fusion bonded epoxy pipe coating to a dry film thickness of at least 250 microns. Specialist applied Rilsan coatings will also be acceptable.

Handwheels shall be of cast metal or shall be of stainless steel.

Guides and wedge shoes shall be of a copper based alloy or of engineering plastic or of stainless steel.

All other external metal components and fasteners integral to the valve shall be of EN Grade 1.4401 (316).

Electrolytically applied plating of ferrous materials is not acceptable.

*Add the following new subclauses*:

**9. "Installation (Clause 4)**

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) Corrosion protection requirements shall be carefully attended to and the requirements of DWS 9900 C7 must be noted. All mating faces must be coated before and sealed after assembly.

e) 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.

f) Crevices 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."

**10. Measurement and Payment (Clause 5)**

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.

The installation of the valves is covered under Clause 20.15 of DWS 1110."

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**AMENDMENTS**

The following amendments to this Specification apply to this Contract. The paragraph letters and numbers indicate the relevant clause number to which the amendments apply. New clauses add to this Specification are assigned with new numbers.

## 1. Scope

This Specification covers the design and manufacture of double flanged eccentric axis butterfly valves required on the reservoir and rising main pipework for this Contract, which shall include, but not be limited, to double flanged butterfly valves used as isolating valves for potable water on pipelines with diameters of up to DN 700.

The diameter, pressure rating and general arrangement of the valves are shown on the drawings.

Where detailed on the drawings, a small diameter bypass with an isolating metal seated wedge gate valve shall be provided.

The applicable technical detail sheets found in Part T2.2: Returnable Schedules must be completed for all the valves.

The specification of eccentric axis butterfly valves required inside the pump station for this Contract is dealt with under C3.1 Project Specifications.

## 2. General (Clause 1)

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

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.

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 it 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 it 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.

### 3. Specification (Clause 1.2)

*Add the following to the clause:*

Corrosion protection shall comply with DWS 9900 C7.

Installation work shall comply with DWS 1110 and amendments.

### 4. Operation (Clause 1.4)

The following requirements are applicable operation and control of the valves:

- These valves will be open under normal operating conditions.
- The valves shall be manually operated. Actuation is not required.
- The direction of closing shall be clockwise.
- 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-torqueing.
- The valves shall be used to isolate certain sections of the pipeline.

### 5. Construction and Operational Requirements (Clause 2)

*Add the following to the clause:*

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.

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).

<u>Valves DN 250 and larger</u>

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.

### 6. Position indicators (Clause 2.8)

*Add the following to the clause:*

The valve shall incorporate provision for attaching limit switches for signalling valve fully open and valve fully closed.

**7. Gearboxes (Clause 2.9)**

*Add the following to the clause:*

A breather designed to prevent moisture from entering shall be fitted. Manually operated gearboxes shall be provided with a stainless steel grease nipple.

**8. Valve Material Specifications (Clause 3)**

*Delete sub-clauses 3.3 to 3.5:*

The following is applicable to the project:

General

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.

Material specification

The valve body and disc shall be coated to a dry film thickness no less than 250 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.

Handwheels shall be of cast or forged metal (cast iron or aluminium) or shall be of stainless steel.

Seal retaining rings shall be of EN Grade 1.4401 (316).

All other external metal components and fasteners integral to the valve shall be of EN Grade 1.4401 (316).

Electrolytically applied plating of ferrous materials is not acceptable.

*Add the following new subclauses*:

**9. "Installation (Clause 4)**

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) Corrosion protection requirements shall be carefully attended to and the requirements of DWS 9900 C7 must be noted. All mating faces must be coated before and sealed after assembly.

e) 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.

f) Crevices 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."

**10. Measurement and Payment (Clause 5)**

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.

The installation of the valves is covered under Clause 20.15 of DWS 1110."

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**AMENDMENTS**

The following amendments to this Specification apply to this Contract. The paragraph letters and numbers indicate the relevant clause number to which the amendments apply. New clauses add to this Specification are assigned with new numbers.

**1. Scope (Clause 1)**

This Specification covers the design and manufacture of nozzle check valves with spring closing required along the rising main for this Contract.

The nominal diameter, pressure rating and general arrangement of the valves are shown on the drawings.

The applicable technical detail sheets found in Part T2.2: Returnable Schedules must be completed for all the valves.

The specification of nozzle check valves required inside the pump station for this Contract is dealt with under C3.1 Project Specifications.

**2. Normative references (Clause 2)**

*Delete the references "*Aur 0001" *&* "Aur 0003" *from the list*

*Add reference "*DWS 9900 C7" *to the list*

**3. Performance requirements (Clause 5)**

The following requirements are applicable to the performance requirements of the check valve:

- The check valve shall open when the velocity in the pipeline exceeds 0.3 m/s.

**4. Design and construction (Clause 6)**

The following requirements are applicable to the design and construction of the check valve:

- The valve shall be PN 40 rated.
- Flanges shall be drilled to BS EN 1092 and where flange 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.

*Delete the last sentence.*

**5. Fasteners (Clause 9)**

Fasteners shall comply with DWS 1130 Clause 3.3 and its amendments."

**6. Installation (Clause 11)**

*Replace the clause contents with the following:*

"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) Corrosion protection requirements shall be carefully attended to and the requirements of AUR 0003 must be noted. All mating faces must be coated before and sealed after assembly.

e) 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.

f) Crevices 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."

*Add the following new clauses:*

**7. "Measurement and payment (Clause 15)**

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.

The installation of the valves is covered under Clause 20.15 of DWS 1110."

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**AMENDMENTS**

The following amendments to this Specification apply to this Contract. The paragraph letters and numbers indicate the relevant clause number to which the amendments apply. New clauses add to this Specification are assigned with new numbers.

**1. Scope (Clause 2)**

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, are dealt with under C3.1 Project Specifications.

**2. Normative references (Clause 3)**

*Delete the references "*Aur 0001" *&* "Aur 0003" *from the list*

*Add reference "*DWS 9900 C7" *to the list*

**3. Fabrication (Clause 7)**

*Replace the last sentence of the clause with the following:*

Fabrication shall comply with DWS 1130 and its amendments."

**4. Fasteners (Clause 8)**

*Replace the last sentence of the clause with the following:*

"Fasteners shall comply with DWS 1130 Clause 3.3 and its amendments."

**5. Castings (Clause 9)**

*Replace the last sentence of the clause with the following:*

Fabrication shall comply with DWS 1130 and its amendments."

**6. Corrosion Protection (Clause 10)**

*Replace the entire clause with the following:*

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

Corrosion protection shall comply with DWS 9900 C7."

**7. Installation (Clause 9)**

*Replace the clause contents with the following:*

"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) Corrosion protection requirements shall be carefully attended to and the requirements of AUR 0003 must be noted. All mating faces must be coated before and sealed after assembly.

e) 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.

f) Crevices 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."

*Add the following new subclause*:

**8. "Measurement and Payment (Clause 14)**

The rates for the installation of pipes, valves and meters (see Clause 20.14.2 of DWS 1110), shall cover the cost of the pipe couplings required complete with anchoring bolts, grouting and gaskets."

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**AMENDMENTS**

The following amendments to this Specification apply to this Contract. The paragraph letters and numbers indicate the relevant clause number to which the amendments apply. New clauses add to this Specification are assigned with new numbers.

**1. Scope (Clause 2)**

This Specification covers the design and manufacture of pipework supports required inside valve chambers located on 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, are dealt with under C3.1 Project Specifications.

**2. Normative references (Clause 3)**

*Delete the references "*Aur 0001" *&* "Aur 0003" *from the list*

*Add reference "*DWS 9900 C7" *to the list*

**3. General (Clause 5.1)**

*Add to the end of the clause:*

"Steel pipe supports in valve chambers shall be manufactured from the same material as the pipework to be supported or from Grade S 275 JR or Grade X42 steel."

**4. Fabrication (Clause 6)**

*Replace the clause contents with the following:*

**"6.1 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 "6.3 Welding" detailed below.

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.

### 6.2 Carbon steels

Structural steelwork shall be of grade S 275 JR 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 proper 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.

### 6.3 Welding

#### 6.3.1 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.

#### 6.3.2 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.

Crevices, including those arising from welding on one side only, shall be eliminated. This requirement applies to the welding of all metals and welding procedure shall be designed to prevent unacceptable deformation.

Welds which are only accessible from one side shall be prepared so that the root run provides an acceptable profile and prevents the formation of crevices. Pipework shall be designed so that such welds can be inspected and, where applicable, pickled and passivated.

In special cases only, non-continuous welding might be approved in writing by the Engineer. The resulting crevices shall be sealed with a two part solvent free epoxy which can be applied at thicknesses of up to 600 µm and above such as Sigmaline 523 or Corrocoat Zip E or Sigmacover 1000 or equivalent.

#### 6.3.3 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.

#### 6.3.4 Site welding

Site welding shall be kept to a minimum and shall only be undertaken with the approval of the Engineer.

#### 6.3.5 Inspections

The Contractor shall arrange for all fabrications to be inspected by the Engineer prior to transport from the fabrication workshop."

### 5. Fasteners (Clause 7)

*Replace the last sentence of the clause with the following:*

"Fasteners shall comply with DWS 1130 Clause 3.3 and its amendments."

### 6. Corrosion Protection (Clause 8)

*Replace the entire clause with the following:*

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

Corrosion protection shall comply with DWS 9900 C7."

### 7. Installation (Clause 9)

*Replace the clause contents with the following:*

"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) Corrosion protection requirements shall be carefully attended to and the requirements of AUR 0003 must be noted. All mating faces must be coated before and sealed after assembly.

e) 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.

f) Crevices 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."

*Add the following new subclause*:

### 8. "Measurement and Payment (Clause 11)

The rates for the installation of pipes, valves and meters (see Clause 20.15 of DWS 1110), shall cover the cost of the pipe supports required complete with anchoring bolts, grouting and gaskets."

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**AMENDMENTS**

The following amendments to this Specification apply to this Contract. The paragraph letters and numbers indicate the relevant clause number to which the amendments apply. Alternatively, the relevant clause number will be shown in brackets as part of the heading. New clauses add to this Specification are assigned with new numbers.

## 1. Scope (Clause 1)

This Specification covers the corrosion protection systems required for the steel rising main and reservoir steel pipework with its associated structures outside of the pump station. The corrosion protection of pipes, specials and all other mechanical equipment inside pump station for this Contract is dealt with under C3.1 Project Specifications

## 2. Recommended Corrosion Protection Systems

| Item | Environment Condition | Surface Preparation and Material | Surface Condition | System | DFT |
|---|---|---|---|---|---|
| Specified Coating for Main Pipeline:<br>DN 700 pipes, including all inline specials | Severely Corrosive.<br>Cathodic Protected. | Mild Steel | Sa 3 | **Coating:** Rigid Polyurethane | 1800 µm |
| Alternative Coating for Main Pipeline as described in Bill of Quantities (C1):<br>DN 700 pipes, including all inline specials | Severely Corrosive.<br>Cathodic Protected. | Mild Steel | Sa 3 | **Coating:** Fusion Bonded Medium Density Polyethylene<br>OR<br>**Coating:** Three Layer LPE | 2000 – 3000 µm<br>Total 3500 µm |
| Main Pipeline:<br>DN 700 pipes, including all inline specials | Severely Corrosive.<br>Cathodic Protected. | Mild Steel | Sa 3 | **Lining:** Solvent Free Epoxy | 600 µm |
| Specified Coating<br>Pipeline Joint: External | Severely Corrosive.<br>Cathodic Protected. | Mild Steel | Sa 3 | **Coating:** Rigid Polyurethane | 1800 µm |

| Item | Environment Condition | Surface Preparation and Material | Surface Condition | System | DFT |
|---|---|---|---|---|---|
| Alternative Coating<br>Pipeline Joint: External | Severely Corrosive. Cathodic Protected. | Mild Steel | Sa 3 | **Coating:** Tape Wrapping<br>Denso Densopol 80 or equal approved by Engineer | |
| Pipeline Joint: Internal | Severely Corrosive. Cathodic Protected. | Mild Steel | Sa 3 | **Lining:** System PL2: Solvent Free Epoxy | 600 µm |
| Pipe specials <= DN 200 in Valve Chambers and removable/ Not buried in Soil | Medium Corrosive | Mild Steel | Sa 3 | Hot Dip Galvanized (Heavy Duty) | Refer to Clause 10 of this Specification |
| Pipe specials > DN 200 in Valve Chambers and removable/ Not buried in Soil | Medium Corrosive | Mild Steel | Sa 3 | **Coating:** Rigid Polyurethane | 1500 µm |
| Pipe specials <= DN 200 buried in soil/ Outside Valve Chambers | Severely Corrosive | Mild Steel | Sa 3 | Hot Dip Galvanized (Heavy Duty) AND<br>Tape Wrapping (Denso Ultraflex or equal approved by Engineer) | Refer to Clause 10 of this Specification |
| Pipe specials > DN 200 buried in soil/ Outside Valve Chambers | Severely Corrosive | Mild Steel | Sa 3 | **Coating**: Rigid Polyurethane | 1500 µm |
| Pipe specials partially encased in Concrete at Valve Chambers or Structures and in Sleeves | Severely Corrosive | Same as for Pipe specials shown above | Sa 3 | Same as for Pipe specials shown above<br>AND<br>System 9: Tape Wrapping<br>Denso Ultraflex or equal approved by Engineer | Same as for Pipe specials shown above |

| Item | Environment Condition | Surface Preparation and Material | Surface Condition | System | DFT |
|---|---|---|---|---|---|
| Wedge Gate, RSV, Butterfly, Non-return and Air Valves | Severely Corrosive | Cast Iron and Cast Alloys | Sa 2½ | Fusion Bonded Epoxy<br>AND<br>Aliphatic Polyurethane | 250 µm<br><br>25 µm |
| Couplings buried in Soil/ Outside Valve Chambers | Severely Corrosive | Mild Steel | Sa 3 | Fusion Bonded Epoxy<br>AND<br>Petrolatum Tape Wrapping | 300 µm |
| Couplings in Valve Chambers/ Not buried in Soil. | Medium Corrosive | Mild Steel | Sa 3 | System 6: Fusion Bonded Epoxy | 300 µm |
| Pipes DN 700 at river crossings concrete encased | Severely Corrosive.<br>Cathodic Protection Installed. | Mild Steel | Sa 3 | Same System as for Main Pipeline<br>AND<br>System 9: Tape Wrapping<br>Denso Ultraflex or equal approved by Engineer | Same as Main Pipeline |
| Pipe Supports, handrails, ladders, etc. | Medium Corrosive | Mild Steel | Sa 3 | Hot Dip Galvanized (Heavy Duty) | Refer to Clause 10 of this Specification |

*Add the following clause:*

**3. "Rigid Polyurethane Coating System (Clause 17)**

This section of the Specification applies to two component solvent free rigid polyurethane.

**3.1 Standards**

Reference is made to the latest issues of the following Standards:

Manufacturer's data sheets/recommendation:

| | | |
|---|---|---|
| SANS | 1217 | The production of painted and powder coated steel pipes. |
| SANS Method | 767 | Cleanliness of blast-cleaned steel surfaces for painting (pictorial standards) |
| SANS Method | 769 | Cleanliness of blast-cleaned steel surfaces for painting (dust and debris). |
| SANS Method | 772 | Profile of blast-cleaned steel surfaces for painting. |
| SANS Method | 776 | Adhesion of coatings (direct pull-off method). |
| SANS ISO | 2808 | Determination of film thickness. |
| SANS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| SANS ISO | 9001 | Quality management system - Requirements. |
| BS EN | 10290 | Steel tubes and fittings for onshore and offshore pipelines – External liquid applied polyurethane and polyurethane modified coatings. |

**3.2 Material**

3.2.1 The required coating shall be a two-component liquid applied rigid polyurethane. the two components shall have different colours allowing the verification of the correct mixing, and checking of the uniformity of the colour of the mixed product. the coating is considered cured when it has attained the hardness recommended by the product manufacturer.

3.2.2 The coating material shall be handled, stored, applied and cured in accordance with the recommendations of the material manufacturer.

The cured coating shall comply with the following requirements for pre-qualification:

- Tensile strength at 3 mm thickness - ASTM D 638 - not less than 15 MPa.
- Adhesion to primed steel - SANS Method 776 - not less than 15 MPa.
- Adhesion to factory coating –BS EN 10290 Annex C – rating 1
- Adhesion to primed steel after 28 day hot water soak at 70°C - SANS Method 776 - not less than 7 MPa.
- Adhesion to factory coating after 28 day hot water soak at 70°C – BS EN 10290 Annex C – rating 2
- Impact resistance (direct) - ASTM G 14 - not less than 3 Joules/mm.
- Dielectric Strength - not less than 15 kV/mm.
- Specific Electrical Insulation Resistance – BS EN 10290 Annex K – 106 ohm.m2
- Elongation at break - not less than 25 %.
- Compressibility - not less than 25 MPa.
- Surface hardness of 5 mm thick sample - not less than 60 nor greater than 80 Shore 'D'.
- Water Vapour Permeability - not greater than 0,5 g/24 h/m²/mm².
- Cathodic disbondment - ASTM G8 Method B – Class A (18mm ECD).

**3.2.3 Pre-heating**

If necessary, the pipe shall be heated immediately prior to application of the polyurethane to achieve a surface temperature greater than the minimum required by the coating manufacturer

3.2.3.1 Application

- Abrasive blast clean in accordance with section 11. to grade Sa 3
- Apply the solvent free polyurethane by means of plural component hot airless spray fitted with metering pumps. The Contractor shall demonstrate that the machine is delivering components in the correct mixing ratio.

3.2.3.2 Tolerances

The applied coating thickness shall be minimum 1.5mm at all points

### 3.2.4 Testing of production pipes

3.2.4.1 Visual inspection (every pipe)

The coating shall be smooth, glossy, free from pin holes, excessive orange peel effect, bubbling or excessive runs or sags.

3.2.4.2 **D**ry film thickness (every pipe)

DFT shall be inspected in accordance with SANS ISO 2808.

3.2.4.3 Electrical insulation defects (holiday) inspection (every pipe)

The coating shall be free from electrical insulation defects when tested with a high voltage holiday detector set at 15 kV.

3.2.4.4 Hardness shore ‘d’ (every pipe)

The Shore ‘D’ hardness shall be greater than 75 when tested in accordance with ASTM D2240.

3.2.4.5 Adhesion (1 test per day’s production)

The pull-off adhesion at 23$^{o}$C shall be greater than 15 MPa

3.2.4.6 Cathodic disbondment (1 test per 350 pipes and commencement of new batch or new production run)

The disbondment shall be less than 7mm radius when tested at 3.5V @ 65 deg C for 24 hrs)

3.2.4.7 Composition (1 test per batch or new production run)

The TGA scan shall be checked against the manufacturer’s qualification scan.

3.2.4.8 Factory repair methods

Since polyurethane systems are chemically cured, very thorough abrasion of damaged or defective coating is required to ensure an adequate physical bond.

3.2.4.9 Repairs before full cure [within sixteen (16) hours at 23°c of application of last coat]

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The abraded surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris.

Brush grade polyurethane shall be applied in as many coats as are required to achieve the specified thickness free of electrical insulation defects.

3.2.4.10 Repairs after full cure [after sixteen (16) hours at 23°c of application of last coat]

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The abraded surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris.

The coating manufacturer's adhesive primer or activating solvent shall be applied only to the abraded surface.

After the designated curing time, brush grade polyurethane shall be applied in as many coats as are required to achieve the specified thickness free of electrical insulation defects."

# PART C3.3: PARTICULAR SPECIFICATIONS

# CIVIL AND MECHANICAL

# C3.3: PARTICULAR SPECIFICATIONS

In addition to the Standard Specifications, the following Particular Specifications shall apply to this contract.

Ngqamakwe Regional Water Supply: Butterworth Emergency Supply Scheme Particular Spec for Occupational Health and Safety

Ngqamakwe Regional Water Supply: Butterworth Emergency Supply Scheme Particular Specification for Environmental Management of Construction

**Civil and Mechanical:**

| | |
|---|---|
| SPEC PD | Building Work |
| SPEC PF | Fencing |
| SPEC PS | Security Door |
| AUR 0001 | General Mechanical Requirements |
| AUR 0002 | Operating and Maintenance Manual |
| AUR 0004 | Operation and Control |
| AUR 1001 | Permanent Ladders |
| AUR 1003 | Lifting Equipment |
| AUR 7012 | Nozzle Check Valve |
| AUR 7023 | Pipe Couplings |
| AUR 7024 | Pipework Supports |
| AUR 7030 | Plunger Valves |
| AUR 10 010 | Pump Station (Multi-Stage, Ring-Section, Centrifugal) |
| AUR 10 014 | Ventilation for Plant Rooms |
| DWS 0750 | Water Retaining Concrete |
| DWS 1810 | Specialist Services |
| DWS 1110 | Construction of Pipelines |
| DWS 1130 | Design and Manufacture of Steel Pipes, Specials and Fittings |
| DWS 2510.02 | Auxiliary Drives |
| DWS 2510.03 | Gate Valves |
| DWS 2510.03 | Air Release and Vacuum Control Valves |
| DWS 2510.04 | Butterfly Valves |
| DWS 9900 C7 | Corrosion Protection |

safe working practice
OCCUPATIONAL HEALTH AND SAFETY GROUP

# Project Health and Safety Specification

In terms of Construction Regulations 2014

## Client

## Description of Project Works

**Ngqamakhwe Phase 5 Water Supply Project**

## Project Location

**Chris Hani and Amathole District Municipalities, Eastern Cape**

## Date

**27 September 2017**


**Project Health and Safety Specification developed by:**

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Institute of Safety Management (IOSM) - South Africa
South African Institute of Safety and Health (SAIOSH) - South Africa
Association of Construction Health and Safety Management- South Africa
South African Construction Project Management and Construction Management Professions

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## 1.0 SPECIFIC PROJECT INFORMATION

### *1. 1 INTRODUCTION AND DEFINITIONS*

This Health and Safety Specification contains clauses that are generally applicable to construction activities, as well as imposing pro-active controls associated with activities that impact on Health and Safety as it relates to plant and machinery. Compliance to the requirements of the Occupational Health and Safety Act 1993 is in addition to the requirements of this Health and Safety Specification and is part of the Contractor's responsibility. The Client will monitor that the Contractors comply with the requirements of such legislation.

**PLEASE NOTE THAT IN THIS HEALTH AND SAFETY SPECIFICATION, THE TERM "PRINCIPAL CONTRACTOR" HAS THE SAME MEANING AS THE WORD "CONTRACTOR" IN THE GENERAL CONDITIONS OF CONTRACT 2010.**

**ALL REFERENCES TO CLIENT IN THIS HEALTH AND SAFETY SPECIFICATION ALSO REFER TO CLIENT AGENT, WHERE SO APPOINTED.**

***Definitions (as per the Construction Regulations 2014) applicable to this Health and Safety Specification:***

"agent" means a competent person who acts as a representative for a client;

"angle of repose" means the steepest angle of a surface at which a mass of loose or fragmented material will remain stationary in a pile on the surface, rather than sliding or crumbling away;

"bulk mixing plant" means machinery, appliances or other similar devices that are assembled in such a manner so as to be able to mix materials in bulk for the purposes of using the mixed product for construction work;

"client" means any person for whom construction work is being performed;

"competent person" means a person who has, in respect of the work or task to be performed, the required knowledge, training and experience and, where applicable, qualifications, specific to that work or task: Provided that where appropriate qualifications and training are registered in terms of the provisions of the National Qualification Framework Act, 2000 (Act No.67 of 2000), those qualifications and that training must be regarded as the required qualifications and training; and is familiar with the Act and with the applicable regulations made under the Act;

"construction manager" means a competent person responsible for the management of the physical construction processes and the coordination, administration and management of resources on a construction site;

"construction site" means a work place where construction work is being performed;

"construction supervisor" means a competent person responsible for supervising construction activities on a construction site;

"construction vehicle" means a vehicle used as a means of conveyance for transporting persons or material, or persons and material, on and off the construction site for the purposes of performing construction work;

"construction work" means any work in connection with-

- the construction, erection, alteration, renovation, repair, demolition or dismantling of or addition to a building or any similar structure; or

- the construction, erection, maintenance, demolition or dismantling of any bridge, dam, canal, road, railway, runway, sewer or water reticulation system; or the moving of earth, clearing of land, the making of excavation, piling, or any similar civil engineering structure or type of work;

"construction work permit" means a document issued in terms of regulation 3;

"contractor" means an employer who performs construction work;

"demolition work" means a method to dismantle, wreck, break, pull down or knock down of a structure or part thereof by way of manual labour, machinery, or the use of explosives;

"design" in relation to any structure, includes drawings, calculations, design details and specifications;

"designer" means a competent person who-

- prepares a design;
- checks and approves a design;
- arranges for a person at work under his or her control to prepare a design, including an employee of that person where he or she is the employer; or
- designs temporary work, including its components;
- an architect or engineer contributing to, or having overall responsibility for a design;
- a building services engineer designing details for fixed plant;
- a surveyor specifying articles or drawing up specifications;
- a contractor carrying out design work as part of a design and building project; or
- an interior designer, shop-fitter or landscape architect;

"excavation work" means the making of any man-made cavity, trench, pit or depression formed by cutting, digging or scooping;

"explosive actuated fastening device" means a tool that is activated by an explosive charge and that is used for driving bolts, nails and similar objects for the purpose of providing fixing;

"fall arrest equipment" means equipment used to arrest a person in a fall, including personal equipment, a body harness, lanyards, deceleration devices, lifelines or similar equipment;

"fall prevention equipment" means equipment used to prevent persons from falling from a fall risk position, including personal equipment, a body harness, lanyards, lifelines or physical equipment such as guard-rails, screens, barricades, anchorages or similar equipment;

"fall protection plan" means a documented plan, which includes and provides for -

- all risks relating to working from a fall risk position, considering the nature of work undertaken;
- the procedures and methods to be applied in order to eliminate the risk of falling; and
- a rescue plan and procedures;

"fall risk" means any potential exposure to falling either from, off or into;

"health and safety file " means a file, or other record containing the information in writing required by these Regulations;

"health and safety plan" means a site, activity or project specific documented plan in accordance with the client's health and safety specification;

"health and safety specification" means a site, activity or project specific document prepared by the client pertaining to all health and safety requirements related to construction work;

"material hoist" means a hoist used to lower or raise material and equipment, excluding passengers;

"medical certificate of fitness" means a certificate contemplated in regulation 7(8);

"mobile plant" means any machinery, appliance or other similar device that is able to move independently, and is used for the purpose of performing construction work on a construction site;

"National Building Regulations" means the National Building Regulations made under the National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977), and promulgated by Government Notice No. R. 2378 of 30 July 1990, as amended by Government Notices No's R. 432 of 8 March 1991, R. 919 of 30 July 1999 and R. 547 of 30 May 2008;

"person day" means one normal working shift of carrying out construction work by a person on a construction site;

"principal contractor" means an employer appointed by the client to perform construction work;

"Professional Engineer or Professional Certificated Engineer" means a person holding registration as either a Professional Engineer or Professional Certificated Engineer in terms of the Engineering Profession Act, 2000 (Act No. 46 of 2000);

"Professional Technologist" means a person holding registration as a Professional Engineering Technologist in terms of the Engineering Profession Act, 2000;

"provincial director" means the provincial director as defined in regulation 1 of the General Administrative Regulations, 2003;

"scaffold" means a temporary elevated platform and supporting structure used for providing access to and supporting workmen or materials or both;

"shoring" means a system used to support the sides of an excavation and which is intended to prevent the cave-in or the collapse of the sides of an excavation;

"structure" means-

- any building, steel or reinforced concrete structure (not being a building), railway line or siding, bridge, waterworks, reservoir, pipe or pipeline, cable, sewer, sewage works, fixed vessels, road, drainage works, earthworks, dam, wall, mast, tower, tower crane, bulk mixing plant, pylon, surface and underground tanks, earth retaining structure or any structure designed to preserve or alter any natural feature, and any other similar structure;
- any falsework, scaffold or other structure designed or used to provide support or means of access during construction work; or
- any fixed plant in respect of construction work which includes installation, commissioning, decommissioning or dismantling and where any construction work involves a risk of a person falling;

"suspended platform" means a working platform suspended from supports by means of one or more separate ropes from each support;

"temporary works" means any falsework, formwork, support work, scaffold, shoring or other temporary structure designed to provide support or means of access during construction work;

"the Act" means the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993);

"tunneling" means the construction of any tunnel beneath the natural surface of the earth for a purpose other than the searching for or winning of a mineral.

**Reference should be made to the following documentation in conjunction with this Safety Specification (including existing surveys, drawings and reports):**

1. Trial Pit Logs:
- Alternative Pump Station 1
- Alternative Reservoir Site
- Alternative Route
- Pipe Line
- Pump Station 1
- Pump Station 2
- Reservoir

2. Geological Desktop Investigation Report
3. Results:
- Foundation Indicator Report for Alternative Pump Station 1
- Foundation Indicator Report for Alternative Reservoir Site
- Material Test Report for Alternative Route
- Material Test Report for Pipe Line
- Material Test Report for Pump Station 1
- Material Test Report for Pump Station 2
- Material Test Report for Reservoir
- Determination of Soil Resistivity (1)
- Determination of Soil Resistivity (2)

4. Photographic Logs:
- Alternate Route
- Alternative Pump Station 1
- Alternative Reservoir Site
- Pipeline
- Pump Station 1
- Pump Station 2
- Reservoir

5. Geomorphology report on Butterworth drought relief water transfer Reviewed
6. Botanical Assessment Report
7. Aquatic Habitat & Biota Study
8. Archaeological & Cultural Heritage Impact Assessment

**IMPORTANT NOTE:**

This Health and Safety Specification has been prepared to comply with the requirements of the Construction Regulations 2014.

## *1.2 BACKGROUND TO THE HEALTH AND SAFETY SPECIFICATION*

Historically, the Construction Industry has had a poor health and safety record. Due to the complex and potentially dangerous operations being undertaken, there is a high risk of incidents, accidents and injuries. In many instances, poor adherence to the Act and Regulations has resulted in severe consequences for Health and Safety performance. The Client is determined that the highest Health and Safety standards will prevail throughout the Contract and that there will be full commitment from all parties involved.

To achieve this goal the Client has prepared this Health and Safety Specification. The Health and Safety Specification sets out guidelines and minimum levels of awareness and guidance for Health and Safety requirements for the project. Contractual responsibility for adhering to these requirements rests with the Contractors. All employees are encouraged to be pro-active in compliance.

The Client is committed to ensuring the highest Health and Safety standards for all work undertaken within the Contract.

**Contractors as employers are fully responsible and accountable for compliance with all Health and Safety requirements.**

**IMPORTANT NOTE:**

**Compliance with the Occupational Health and Safety Act and Regulations shall not be limited to this Health and Safety Specification and definitions contained in this document.**

**Contractors shall be conversant with the requirements and effects of Health and Safety legislation upon their activities, in particular the Construction Regulations, 2014, and the Occupational Health and Safety Act, 1993, and to have made adequate resource in their tender submission to comply with all legislative requirements.**

The Contractor's personnel will be responsible for the auditing of the implementation of the Health and Safety Specification and maintaining the document control and record systems associated with the Health and Safety Specification. The Client will conduct Health and Safety audits of the works too.

## *1.3 PURPOSE OF THE HEALTH AND SAFETY SPECIFICATION*

The purpose of this site-specific Health and Safety Specification is to comply with legal requirements and to provide health and safety information about specific project risks known by the Client, Designer and Client Agent to be applicable to this project. This document also provides minimum health and safety requirements, standards and expectations that the principal contractor and contractors must adhere to.

The Contractor must take into account all information in this specification and ensure that their tenders include adequate resource and competence to deal with the matters detailed herein so that all relevant contents are dealt with in a way which is in compliance with legislation and the ethical concerns for the safeguarding of employees, contractors and other persons affected by the construction activities.

The Health and Safety Specification will be implemented during construction of the works and any construction activity that the Client has control over.

This will also assist in ensuring that all the costs related to the compliance with Occupational Health Act 85 of 1993 and the Construction Regulations 2014, as well as this Health and Safety Specification, are taken into consideration at Tender stage.

No advice, approval of any document required by the Health and Safety Specification such as hazard identification and risk assessment action plans or any other form shall be construed as an acceptance by the Client of any obligation that absolves the Contractor from achieving the required level of performance and compliance with legal requirements.

Further, there is no acceptance of liability by the Client which may result from the Contractor failing to comply with the Health and Safety Specification unless the Client has issued an instruction to any requirement, i.e. the Contractor remains responsible for achieving the required performance levels.

## *1.4 IMPLEMENTATION OF THE HEALTH AND SAFETY SPECIFICATION*

This Health and Safety Specification forms an integral part of the Contract, and Contractors shall make it an integral part of their Contracts with Sub Contractors and Suppliers. Contractors employed by the Client are to ensure that the provisions of the Health and Safety Specification are applied both on the site and in respect of all off-site activities relating to the project, in particular in transport activities and project dedicated off site fabrication works.

The Contractor shall enforce the provisions of the Health and Safety Specification amongst all sub contractors and suppliers for the project.

The Contractor shall sign the acknowledgment on the last page of this safety specification that he/she has familiarized him/herself with the content of the Health and Safety Specification and shall comply with all obligations in respect thereof.

The successful Contractor will be required to compile a Health and Safety Plan based on the requirements of the Occupational Health Act 85 of 1993 and these Specifications, which will need to be approved by Client prior to commencement with construction work.

### 1.4.1 Client Duties

In terms of the Construction Regulations 2014 the Client (or their Agent, where appointed) has legal duties. Where an Agent (refer to "definitions" section of this document) is appointed in terms of this project, these Health and Safety duties assigned will also apply.

**All references to "Client" will apply to their appointed "Client Agent", where so appointed, in this Health and Safety Specification.**

The Client must:

- Prepare a baseline risk assessment for the construction work
- Prepare a suitable, sufficiently documented and coherent site-specific Health and Safety specification for the intended construction work, based on the baseline risk assessment
- Include the health and safety specification in the tender documents
- Ensure that potential principal contractors submitting tenders have made adequate provision for the cost of health and safety measures
- Ensure that the principal contractor to be appointed has the necessary competencies and resources to carry out the construction work safely
- Take reasonable steps to ensure co-operation between all contractors appointed by the client to enable each of those contractors to comply with the regulations
- Ensure, before work commences, that every principal contractor is registered and in good standing with the compensation fund, or with a licensed compensation insurer as contemplated in the Compensation for Occupational injuries and Diseases Act, 1993 (Act no 130 of 1993)
- Appoint each principal contractor in writing for the project, or part thereof
- Discuss and negotiate with the principal contractor the contents of the principal contractor's safety plan and thereafter finally approve that plan for implementation
- Ensure that a copy of the principal contractor's health and safety plan is implemented and maintained
- Ensure that periodic health and safety audits and document verification are conducted at intervals mutually agreed upon between the principal contractor and any contractor, but at least once every 30 days
- Ensure that a copy of the health and safety audit report is provided to the principal contractor within 7 days after the audit
- Stop any contractor from executing a construction activity which poses a threat to the health and safety of persons which is not in accordance with the principal contractor's health and safety plan for site
- Where changes are brought about to the design or construction work, make sufficient health and safety information and appropriate resources available to the principal contractor to execute the work safely
- Ensure that the health and safety file is kept and maintained by the principal contractor.
- Where the client requires additional work to be performed as a result of a design change or error in construction due to the actions of the client, the client must ensure that sufficient safety information and appropriate additional resources are available to execute the required work safely.
- Where more than one principal contractor is appointed, the client must take reasonable steps to ensure co-operation between all principal contractors and contractors to ensure compliance with the Regulations
- Where the Client has appointed a Client Agent for the project, their details for this project are contained in the Project Directory section of this health and safety specification.

### 1.4.2 Designer Duties

It must be noted that the Designer also has Health and Safety duties assigned in terms of the Construction Regulations. Where the contractor fulfils a design function in terms of this project (refer to "definitions" section of this document), these duties will also apply. Please refer to Regulation 6 of the Construction Regulations 2014.

**Please note that the designer of temporary works must ensure that:**

- all temporary works are adequately designed so that it will be capable of supporting all anticipated vertical and lateral loads that may be applied;
- the designs of temporary works are done with close reference to the structural design drawings issued by the contractor, and in the event of any uncertainty consult the contractor;
- all drawings and calculations pertaining to the design of temporary works is kept at the office of the temporary works designer and are made available on request by an inspector; and
- the loads caused by the temporary works and any imposed loads are clearly indicated in the design.

| ***1.5 PROJECT DIRECTORY*** | | |
|---|---|---|
| **Project Client**<br><br><br><br><br>**Contact Person** | **AMATHOLE DISTRICT MUNICIPALITY**<br>Waverley Office Park<br>3 – 33 Philip Frame<br>Chiselhurst<br>5201<br><br>Municipal Manager | **Tel:** 043 701 4000<br><br>**Fax:** 043 742 0337<br><br>**E-mail:** info@amathole.gov.za |
| **Client Agent**<br><br><br><br>**Contact Person** | **Safe Working Practice**<br>12 Putney Avenue,<br>Nahoon Valley,<br>East London,<br>5241<br><br>Jay Bhana | **Tel:** 043 735 1774<br><br>**Fax:** 086 720 1149<br><br>**Cell:** 084 479 2294<br><br>**E-mail:** buffalo@safepractice.co.za |
| **Implementing Agent**<br><br><br><br>**Contact Person** | **Aurecon**<br>1 Pearce Street,<br>Berea,<br>East London,<br>5241<br><br>Leigh Bahlmann | **Tel:** 043 721 0900<br><br><br>**Fax:** 043 721 0902<br><br><br>**Cell:** 083 458 9797 |

| ***OTHER PARTIES DIRECTORY*** | |
|---|---|
| **Department of Labour for Submission of Permit Application**<br><br>East London<br>Private Bag X9084<br>East London<br>1200<br><br>**Contact Name:** Mr K Nkanjeni | **Tel:** 043 702 7533<br><br>**Fax:** 086 622 7119 |
| **Telecommunications**<br><br>**Company:** Telkom<br><br>**Address:** East London | <br><br>**Tel: 10215** |
| **Water**<br><br>**Company:** Mnquma Local Municipality<br>**Address:** Cnr King & Mthatha Streets, Butterworth | **Tel:** 047 401 2400<br><br>**Fax:** 047 491 0195<br><br>**Web:** www.mnquma.gov.za |
| **Electricity**<br><br>**Company:** Mnquma Local Municipality<br>**Address:** Cnr King & Mthatha Streets, Butterworth | **Tel:** 047 401 2400<br><br>**Fax:** 047 491 0195<br><br>**Web:** www.mnquma.gov.za |

| ***1.6 PROJECT DETAILS*** |
|---|
| **Description of Works**<br><br>CONSTRUCTION OF A NEW 7ML RESERVOIR AND A PIPELINE FROM THE TSOMO RIVER TO RELEASE WATER INTO UPPER TRIBUTARIES OF THE XILINKA RIVER FLOWING INTO THE XILINKA DAM |
| **Anticipated Construction Duration**<br>Fifteen (15) Months |
| **Provisional Start Date**<br>January 2018 |
| **Provisional Completion Date**<br>June 2019 |

## *1.7 EXISTING ENVIRONMENT*

**Hazards particular to this project by virtue of location:**

1. Rivers and Wetlands
2. Cattle
3. Overhead Powerlines
4. Provoking of wildlife (Monkeys, snakes, insects, scorpions, cattle, sheep, goats etc)

**Overhead, Above Ground and Underground Services crossing the site:**

| | |
|---|---|
| **Overhead:** | Yes |
| **Underground:** | Yes |
| **Ground level:** | Yes |
| **Service Drawings available:** | Yes |
| **Wayleaves required:** | Yes |
| **Permits required:** | Yes |
| **Isolations required:** | No |

**Existing structures and surrounding land use (with a significant impact on Health & Safety):**

1. Overhead Powerlines
2. Vegetation and Flora
3. Rivers and Wetlands
4. National Route

Tsomo normally receives about 536mm of rain per year, with most rainfall occurring mainly during summer. It receives the lowest rainfall (5mm) in July and the highest (85mm) in March. The monthly distribution of average daily maximum temperatures ranges from 18.1°C in June to 26°C in February. The region is the coldest during July when the temperature drops to 3.7°C on average during the night.

Wienerts climatic N number for the area is between 2 and 5, which should indicate that the rocks would decompose implying that chemical weathering would dominate over mechanical weathering.

**Existing ground conditions and ground survey report:**

1. Botanical Assessment Report
2. Aquatic Habitat & Biota Study
3. Archaeological & Cultural Heritage Impact Assessment
4. Determination of Soil Resistivity (1)
5. Determination of Soil Resistivity (2)
6. Foundation Indicator Report for Alternative Pump Station 1
7. Foundation Indicator Report for Alternative Reservoir Site
8. Material Test Report for Alternative Route
9. Material Test Report for Pipe Line
10. Material Test Report for Pump Station 1
11. Material Test Report for Pump Station 2
12. Material Test Report for Reservoir

**Existing Traffic Systems**

**Condition:** Wetlands, Urban Developments, Landscapes, Untransformed habitat / land, transformed habitat / land, degraded habitat / land, Cultivated Urban and Natural Grasslands. Rural Homesteads.

**Restrictions to access:** Yes

**Speed restrictions:** 20 – 40 km/h

### *1.8 AVAILABLE DRAWINGS*

Refer to tender documentation.

### *1.9 PROJECT HEALTH AND SAFETY REQUIREMENTS*

**Significant health and safety hazards identified by Designer and Client Agent:**

1. Wetlands
2. Vegetation & Flora
3. Provoking of wildlife (Monkeys, snakes, insects, scorpions, cattle, sheep, goats etc)
4. Overhead Powerlines
5. Working in close proximity to the National Road Route

**Normal construction hazards expected are as follows:**

Asphalting
Bricklaying
Brushcutting
Chainsaw Use
Compacting and Filling
Compactor Operations
Concrete Pumping
Confined Spaces
Contaminated Land
Cutting Kerbs
Cutting Off Disc
Diesel
Electric Tools and Electrical Installations
Excavations
Explosive use
Explosive Actuated Fastening Devices
Fire
Flammable Liquids / Gas
Hand tools
Hazardous Substances
Hot Works
Kerb Laying
Lifting Operations
Manhole Rings and Pipes Storage
Manual Handling of General Items
Members of Public
Mobile Crane Erection and Dismantling and Use
Noise and Dust

Overhead Services (Working near)
Painting
Paving (Laying)
Piling
Plant/Vehicle and Equipment Operation
Plastering
Plumbing
Precast Slab / Unit Laying and Fixing
Rope Access Work
Site Establishment
Scaffold Erection / Dismantling
Shuttering Walls, Beams, Columns
Site Strip
Snakes
Steel Erection
Steel Fixing
Temporary Work (include False Work, Scaffold and Shoring)
Tower Crane Erection and Dismantling
Transportation of Workers
Tunnelling
Underground Services
Underpinning
Work over or next to Water
Working at Height (excl scaffold)

**NOTE: Please refer to end of this Health and Safety Specification for the baseline risk assessment for these risks.**

***ACTIVITIES REQUIRING APPROVED METHOD STATEMENTS (FOR HEALTH AND SAFETY)***

1. Management and Communication (Project Delegation)
2. Excavations
3. Security Plan
4. Site Establishment
5. Permanent Work
6. Task Specific Operations
7. QMS and Close Out

***ACTIVITIES REQUIRING PERMITS (FOR HEALTH AND SAFETY PURPOSES)***

| | |
|---|---|
| **Permit to Dig / Permit to Enter Excavations:** | Yes |
| **Permit to Work with Electricity:** | Yes |
| **Confined Space Permit:** | Yes |
| **Hot Works Permit:** | Yes |
| **Permit to Work under Power Lines:** | Yes |
| **Blasting:** | Yes |
| **Temporary Works:** | Yes |

***CONTRACTOR SAFETY OFFICER PROVISION***

Records of safety audits undertaken by the Contractor's Safety Officer must be kept on site in the safety file and non-conformances reported by the Safety Officer to the Contractor's management team. All non-conformances identified by the Safety Officer must be investigated and corrective action taken by the Contractor to prevent re-occurrence.

Please note that as from 7th August 2015 the safety officer must have formally applied to be professionally registered with the SACPCMP. If their registration is not yet complete, the safety officer must be in possession of a "Registration Verification Letter" which will be issued by the SACPCMP.

**PROVISION MUST BE MADE AVAILABLE FOR A FULL TIME SAFETY OFFICER.**

***MEDICAL CERTIFICATE OF FITNESS***

The contractor must ensure that their employees on site have a valid medical certificate of fitness, specific to the construction work being performed, issued by an occupational health practitioner in the form of an Annexure 3 template.

***MANAGEMENT AND SUPERVISION OF CONSTRUCTION WORK***

A principal contractor must, in writing, appoint one full-time competent person as the construction manager with the duty of managing all the construction work on a single site, including the duty of ensuring occupational health and safety compliance, and in the absence of the construction manager an alternate must be appointed by the principal contractor.

***TRAFFIC MANAGEMENT AND TRAFFIC SAFETY OFFICER PROVISION***

Traffic Management Procedures is required for all Plant Machinery and Construction Vehicles entering and exiting the site.

Traffic Safety Officer Provision is not applicable.

***ENVIRONMENTAL CONDITIONS***

Contractor must take into account adverse weather conditions on site activities and implement control measures to mitigate risk. This includes risk of exposure to excessive heat, cold, rain and wind.
The open nature of the site works will not preclude any of the above.

***ARRANGEMENTS FOR ACCESS, PARKING, DELIVERIES, ETC***

**Access to site by Construction Vehicles:**
Implementation and procedures must be in place.

**Access to site by Construction Workers and Visitors:**
Implementation and procedures must be in place.

***ARRANGEMENTS FOR SITE CAMP, ABLUTIONS AND YARD***

**Site camp location and set up**

- **Restrictions / requirements:** }
- **Storage areas:** } Contractor to advise in consultation with Engineer
- **Security:** }

**Ablutions and Welfare Arrangements**
Contractor to supply ablutions and facilities in line with the Construction Regulations 2014, refer to section 2.31 of this health and safety specification regarding the below. Please note that toilets should be provided with built in facilities for hand washing:

- **Toilets:** }
- **Washing facilities:** }
- **Drinking Water:** } Contractor to provide as per Regulations
- **Shelter:** }
- **Showers:** }

***PROTECTION OF SITE AGAINST UNAUTHORISED ACCESS BY PUBLIC***

**Excavation Fencing:** Note that excavations accessible to public, or adjacent to public roads / thoroughfares, must have:
(1) barrier / fence of at least 1m in height, and
(2) warning illuminates at night or when visibility is poor, or have other suitable precautionary measures if of both these are not practicable.

**General Fencing of Site:** Note that construction sites in built up areas adjacent to public way must be fenced off and have controlled access points.

**Warning Notices**: Yes

**Look Outs**: Yes

***PERSONAL PROTECTIVE EQUIPMENT (PPE)***

**The Client requires the Contractor to ensure that employees (and others under his/her control) wear the following minimum PPE:**

**Overalls:** Yes

**Safety Harnesses:** Yes

**Hard Hats:** Yes

**Reflective Vests:** Yes

**Goggles / gloves / ear defenders / respiratory protection:** Yes

| | |
|---|---|
| **Safety Footwear:** | Yes |
| **Specialist Equipment (eg: for confined Spaces, tunneling):** | Yes |

***HAZARDOUS SUBSTANCES***

**The following materials and substances have, or may have, to be used in the works and are identified as potentially posing special health and / or safety hazards during the project. Appropriate measures will need to be specified for their control:**

1. Diesel and Petrol
2. Cement
3. Oil
4. Paint

## *1.10 INTERFACE AND RESTRICTIONS BY CLIENT*

**Contractor must note that the following Client activities will continue during construction:**

There will be no active activities continuing during the construction period.

**The following Client safety rules and/or requirements are to be observed:**

All workers are to receive induction prior to commencement of work on site.
Other safety rules and requirements to be advised at induction.
Please also refer to tender document.

**Restrictions on times, access or other restrictions by Client**

Normal working hours apply, if weekend work is required, permission must be granted by the Client.

## *1.11 SAFETY FILE RETURN TO CLIENT*

The Safety File for the Project is to be handed over by the Principal Contractor to the Client upon Project Completion in either a hard copy format or on CD.

## 2.0 FURTHER REQUIREMENTS

### 2.1 Duties of Principal Contractor / Contractor in terms of Construction Regulations 2014

A Principal Contractor must:

- provide and demonstrate to the client a suitable, sufficiently documented and coherent site specific health and safety plan, based on the client's documented health and safety specifications, which plan must be applied from the date of commencement of and for the duration of the construction work and which must be reviewed and updated by the principal contractor as work progresses;

- open and keep on site a health and safety file, which must include all documentation required in terms of the Act and these Regulations, which must be made available on request to an inspector, the client, the client's agent or a contractor; and

- on appointing any other contractor, in order to ensure compliance with the provisions of the Act –

    - provide contractors who are tendering to perform construction work for the principal contractor, with the relevant sections of the health and safety specifications pertaining to the construction work which has to be performed;

    - ensure that potential contractors submitting tenders have made sufficient provision for health and safety measures during the construction process;

    - ensure that no contractor is appointed to perform construction work unless the principal contractor is reasonably satisfied that the contractor that he or she intends to appoint, has the necessary competencies and resources to perform the construction work safely;

    - ensure prior to work commencing on the site that every contractor is registered and in good standing with the compensation fund or with a licensed compensation insurer as contemplated in the Compensation for Occupational Injuries and Diseases Act, 1993;

    - appoint each contractor in writing for the part of the project on the construction site

    - take reasonable steps to ensure that each contractor's health and safety plan is implemented and maintained on the construction site;

    - ensure that the periodic site audits and document verification are conducted at intervals mutually agreed upon between the principal contractor and any contractor, but at least once every 30 days;

    - stop any contractor from executing construction work which is not in accordance with the client's health and safety specifications and the principal contractor's health and safety plan for the site or which poses a threat to the health and safety of persons;

- where changes are brought about to the design and construction, make available sufficient health and safety information and appropriate resources to the contractor to execute the work safely;

- discuss and negotiate with the contractor the contents of their health and safety plan and finally approve that plan for implementation;

- ensure that a copy of both the principal contractor and contractor's health and safety plan is available on request to an employee, an inspector, a contractor, the client or the client's agent;

- hand over a consolidated health and safety file to the client upon completion of the construction work, to include a record of all drawings, designs, materials used and other similar information concerning the completed structure;

- in addition to the documentation required in the health and safety file include and make available a comprehensive and updated list of all the contractors on site accountable to the principal contractor, the agreements between the parties and the type of work being done;

- ensure that all his or her employees have a valid medical certificate of fitness specific to the construction work to be performed and issued by an occupational health practitioner in the form of Annexure 3.

A contractor must prior to performing any construction work-

- provide and demonstrate to the principal contractor a suitable and sufficiently documented health and safety plan, based on the relevant sections of the client's health and safety specification and provided by the principal contractor, which plan must be applied from the date of commencement of and for the duration of the construction work and which must be reviewed and updated by the contractor as work progresses;

- open and keep on site a health and safety file, which must include all documentation required in terms of the Act and these Regulations, and which must be made available on request to an inspector, the client, the client's agent or the principal contractor;

- before appointing another contractor to perform construction work be reasonably satisfied that the contractor that he or she intends to appoint has the necessary competencies and resources to perform the construction work safely;

- co-operate with the principal contractor as far as is necessary to enable each of them to comply with the provisions of the Act;

- as far as is reasonably practicable, promptly provide the principal contractor with any information which might affect the health and safety of any person at work carrying out construction work on the site, any person who might be affected by the work of such a person at work, or which might justify a review of the health and safety plan.

Where a contractor appoints another contractor to perform construction work, the duties that apply to the principal contractor will apply to the contractor as if he or she were the principal contractor.

A principal contractor must take reasonable steps to ensure co-operation between all contractors appointed by the principal contractor to enable each of those contractors to comply with these Regulations.

No contractor may allow or permit any employee or person to enter any site, unless that employee or person has undergone health and safety induction training pertaining to the hazards prevalent on the site at the time of entry.

A contractor must ensure that all visitors to a construction site undergo health and safety induction pertaining to the hazards prevalent on the site and must ensure that such visitors have the necessary personal protective equipment.

A contractor must at all times keep on his or her construction site records of the health and safety induction training and such records must be made available on request to an inspector, the client, the client's agent or the principal contractor.

A contractor must ensure that all his or her employees have a valid medical certificate of fitness specific to the construction work to be performed and issued by an occupational health practitioner in the form of Annexure 3 (a template of which can be found in the Construction Regulations, 2014).

### *2.2 Management and Supervision of Construction Work*

A principal contractor must, in writing, appoint one full-time competent person as the construction manager with the duty of managing all the construction work on a single site, including the duty of ensuring occupational health and safety compliance, and in the absence of the construction manager an alternate must be appointed by the principal contractor.

A principal contractor must upon having considered the size of the project, in writing appoint one or more assistant construction managers for different sections thereof: Provided that the designation of any such person does not relieve the construction manager of any personal accountability for failing in his or her management duties in terms of this regulation.

Where the construction manager has not appointed assistant construction managers, or, in the opinion of an inspector, a sufficient number of such assistant construction managers have not been appointed, that inspector must direct the construction manager in writing to appoint the number of assistant construction managers indicated by the inspector, and those assistant construction managers must be regarded as having been appointed.

No construction manager appointed in terms of the Regulations may manage any construction work on or in any construction site other than the site in respect of which he or she has been appointed.

A contractor must, after consultation with the client and having considered the size of the project, the degree of danger likely to be encountered or the accumulation of hazards or risks on the site, appoint a full-time or part-time construction health and safety officer in writing to assist in the control of all health and safety related aspects on the site: Provided that, where the question arises as to whether a construction health and safety officer is necessary, the decision of an inspector is decisive.

No contractor may appoint a construction health and safety officer to assist in the control of health and safety related aspects on the site unless he or she is reasonably satisfied that the construction health and safety officer that he or she intends to appoint is registered with a statutory body approved by the Chief Inspector and has necessary competencies and resources to assist the contractor

A construction manager must in writing appoint construction supervisors responsible for construction activities and ensuring occupational health and safety compliance on the construction site.

A contractor must, upon having considered the size of the project, in writing appoint one or more competent employees for different sections thereof to assist the construction supervisor, and every such employee has, to the extent clearly defined by the contractor in the letter of appointment, the same duties as the construction supervisor: Provided that the designation of such employee does not relieve the construction supervisor of any personal accountability for failing in his or her supervisory duties.

Where the contractor has not appointed such an employee, or, in the opinion of an inspector, a sufficient number of such employees have not been appointed, that inspector must instruct the employer to appoint the number of employees indicated by the inspector.

No construction supervisor appointed may supervise any construction work on or in any construction site other than the site in respect of which he or she has been appointed: Provided that if a sufficient number of competent employees have been appropriately designated on all the relevant construction sites, the appointed construction supervisor may supervise more than one site.

### *2.3 Construction Work Permit*

A client who intends to have construction work carried out, must at least 30 days before that work is to be carried out apply to the provincial director in writing for a construction work permit to perform construction work if the intended construction work starts on or after the 7th of February 2017 and the works contract is of a value exceeding R40 million or Construction Industry Grading Board (CIDB) grading level 8.

A client who intends to have construction work carried out, must at least 30 days before that work is to be carried out apply to the provincial director in writing for a construction work permit to perform construction work if the intended construction work starts on or after the 7th of August 2018 and exceeds 365 days; will involve more than 3600 person days of construction work; or the works contract is of a value exceeding R13 million or Construction Industry Grading Board (CIDB) grading level 7.

It is the client's responsibility to apply for this permit from the Provincial Director and construction work may not commence until the permit has been issued by the Provincial Director.

A copy of this permit will be required to be kept in the principal contractor's safety file, and the site specific number issued by the Provincial Director must be displayed at the site entrance.

### *2.4 Assignment of Contractor's Responsible Persons to Manage Health and Safety on Site*

The Contractor shall submit management and supervisory appointments as well as any relevant appointments in writing (as stipulated by the Construction Regulations 2014 and the Occupational Safety and Health Act 1993), prior to commencement of work (refer to **Annexure B** at the end of this Health and Safety Specification).

### *2.5 Competency for Contractor's Responsible Persons*

The Contractor's responsible persons shall be competent in health and safety and be familiar with the Occupational Health and Safety Act 1993, and applicable regulations. Valid proof of pertinent health and safety courses attended by such persons will be required to be presented to the Client.

### *2.6 Compensation of Occupational Injuries and Diseases Act 130 of 1993 (COIDA)*

The successful Contractor shall submit to the Client a valid letter of good standing with the Compensation Insurer prior to appointment.

### *2.7 Occupational Health and Safety Policy*

The Contractor shall submit their Health and Safety Policy, prior to construction commencement, signed by the Chief Executive Officer. The Policy must outline objectives and how they will be achieved and implemented within the company operations.

### *2.8 Health and Safety Organogram*

The Contractor shall submit an organogram, prior to construction commencement, outlining the Health and Safety Site Team that will be assigned to the project, if successful with the tender. In cases where appointments have not been made, the organogram shall reflect the position. The organogram shall be updated, when there is a change in the site team.

### *2.9 Risk Assessments*

***Baseline Risk Assessment***

The Client shall cause a baseline risk assessment to be conducted by a competent person before the design process and tender process commence, and the assessed risks shall form part of the health and safety specifications.

The Contractor must, before commencement of any construction work, and during construction work, have risk assessments performed by a competent person appointed in writing, which risk assessments form part of the health and safety plan to be applied on the site and must include:

- The identification of the risks and hazards to which persons may be exposed to;
- An analysis and evaluation of the risks and hazards identified; based on a documented method
- A documented plan and applicable safe work procedures to mitigate, reduce or control the risks and hazards that have been identified;
- A monitoring plan; and
- A review plan

The Contractor must ensure that, as far as is reasonably practicable, ergonomic related hazards are analysed, evaluated and addressed in a risk assessment.

The Contractor must ensure that all employees under his control are informed, instructed and trained by a competent person regarding any hazard and the related work procedures and/or control measures **before any work commences** and thereafter **at the times determined in the risk assessment monitoring and review plan of the relevant site.**

The Principal Contractor must ensure that all contractors are informed regarding any hazard that is stipulated in the risk assessment **before any work commences** and thereafter **at the times determined in the risk assessment monitoring and review plan of the relevant site.**

The Contractor must consult with the health and safety committee or with a representative trade union or representative group of employees if no health and safety committee exists, on the monitoring and review of the risk assessments for the site.

The Contractor must ensure that copies of risk assessment for this site are available on site for inspection purposes by interested parties (inspector, the client, client's agent, any contractor, any employee, a representative trade union, a health and safety representative or safety committee member.

A Contractor must review the relevant risk assessment where changes are effected to the design and/or construction that result in a change to the risk profile, or when an incident has occurred.

**Preventative measures must first address the elimination of the hazard or risk. Should PPE be required to reduce risk, the equipment or clothing to be used must be SABS approved.**

In general, the Contractor must ensure that the Risk Assessment involves identifying the hazards present in a work activity on site. This is followed by an evaluation of the extent of the risk involved taking into account those precautions already being taken.

The following general principle should be followed when conducting a risk assessment:

- All relevant risks and/or hazards should be systematically addressed;
- The risk assessment should address what actually happens in the workplace during the work activity;

- All employees and those who may be affected must be considered, including maintenance staff, security guards, visitors and subcontractors;
- The risk assessment should highlight those groups and individuals who may be required to work alone or who have disabilities;
- The risk assessment process should take into account the existing safety measures and controls.
- The level of detail on a risk assessment should be appropriate to the level of risk.

### *2.10 Health and Safety Representative(s)*

The Contractor shall ensure that Health and Safety Representative(s) is/are elected and trained to carry out his / her functions. The appointment must be in writing. The Health and Safety Representative shall carry out regular inspections, keep records and report to the supervisor to take appropriate action. He / she shall attend Health and Safety Committee Meetings. The Health and Safety Representative shall be part of the team that will investigate incidents, accidents and non-conformances.

### *2.11 Health and Safety Committee*

Where two or more health and safety representatives have been appointed on site, the Contractor shall ensure that monthly health and safety meetings are held with such representatives and minutes are kept on record. Meetings must be organized and chaired by the Contractor's Health and Safety Committee Chairperson. Minutes of these meetings must be available for the employees of the contractor to refer to.

### *2.12 Medical Certificate of Fitness*

The contractor must ensure that their employees on site have a valid medical certificate of fitness, specific to the construction work being performed, issued by an occupational health practitioner in the form of an Annexure 3 template (refer to the Construction Regulations 2014 on the Department of Labour website for a sample of this form).

### *2.13 Health and Safety Training*

The Contractor shall quarterly conduct a training needs analysis to ascertain what health and safety training is required. A plan of action should be devised and forwarded to the Client for records. Once the identified people have attended the training, the Contractor must provide the Client with copies of certificates obtained.

#### *2.13.1 Induction*

No Contractor may allow or permit any employee or person to enter site unless they have undergone health and safety induction training pertaining to the hazards prevalent on site at the time of entry. This includes visitors to site. The Contractor must ensure that visitors to site have the necessary protective equipment (PPE). A copy of attendance registers of all employees who attend inductions shall be kept.

#### *2.13.2 Awareness*

The Contractor shall conduct periodic toolbox talks on site, preferably weekly or before any hazardous work takes place. The talks shall cover the relevant activity and an attendance register must be signed by all attendees. This record of who attended and the content of the topic will be kept on the site health a safety file as evidence of training.

### *2.14 Competency*

After the Contractor has identified the training to be conducted as part of the competency requirement, and based on Risk Assessment, he shall send the relevant persons on appropriate courses and keep

certificates of training for reference. Familiarity with the Health and Safety Act and Regulations is an integral part of the definition of competence.

### *2.15 General Record Keeping*

The Contractor shall keep and maintain Health and Safety records to demonstrate compliance with the Health and Safety Specification and the Occupational Health and Safety Act. The contractor shall ensure that all records of incidents, spot fines, training etc. are kept on site. All documents shall be available for inspection by the Client, or the Department of Labour's Inspectors.

### *2.16 General Inspection, Monitoring and Reporting*

The Contractor shall carry out inspections as required by **Annexure C** in this Health and Safety Specification, as well as by health and safety legislation.

### *2.17 Emergency Procedures*

The Contractor shall submit a detailed Emergency Procedure for approval by the Client prior to commencement on site. The procedure shall detail the response plan including the following:

- List of key personnel;
- Details of emergency services;
- Actions or steps to be taken in the event of the emergency; and
- Information on hazardous materials / situations, including each material's hazardous potential impact or risk on the environment or human and measures to be taken in the event of an accident.

Emergency procedure(s) shall include, but shall not be limited to, fire, spills, accidents to employees, use of hazardous substances, dangers as a result of riot / service deliver protests / intimidation, etc. The Contractor shall advise the Client in writing of any on-site emergencies, together with a record of action taken, within 24 hours of the emergency occurring. A contact list of all service providers (Fire Department, Ambulance, Police, Medical and Hospital, etc) must be maintained and available to site personnel.

### *2.18 First Aid Box and First Aid Equipment*

The Contractor shall provide first aid box/es and appoint, in writing, First Aider(s) for this project in line with the results of the Contractor's risk assessment for the project, this health and safety specification as well as the provisions of the General Safety Regulations. The appointed First Aider(s) are to be sent for accredited first aid training before starting on site. Valid certificates are to be kept on site.

First Aid box/es must be adequately stocked at all time, accessible and be controlled by a qualified First Aider. If required by the Client, the Contractor shall have a stretcher on site to be used in case of a serious incident.

### *2.19 Accident / Incident Reporting and Investigation*

The Contractor shall, in addition to the prescribed requirements of the Occupational Health and Safety Act and General Safety Regulations, investigate, record and report all Section 24 reportable incidents to the Client within 24 hours of the incident occurring. Incident investigations shall be conducted by the Contractor's appointed Accident Investigator – this Investigator must be a competent person or persons who have sufficient knowledge to carry out an investigation.

In the event of a fatality or a permanent disabling injury the Contractor must submit proof of reporting of incident to Department of Labour as well as proof of preventative measures to the Client. The Client reserves the right to conduct investigations into any incidents that they deem fit and the Contractor is required to provide full co-operation in this regard.

### *2.20 Hazards and Potential Situations*

The Contractor shall immediately notify other Contractors of any hazardous or potentially hazardous situations, which may arise during performance of the activities.

### *2.21 Occupational Health and Safety Signage*

The Contractor shall ascertain and provide adequate on site health and safety signage. This signage shall include, but shall not be limited to, Hard Hat / Helmet Area; Safety Shoes to be worn on site; Dust Masks to be worn in areas where there might be exposure to excessive dust; Ear Plugs / Muffs to be worn where there might be noise exposure over 85 db; Gloves; Safety Goggles; Safety Harness, Workers in Excavation, traffic management, etc. The Contractor shall be responsible to maintain the quality and replacement of signage.

### *2.22 Management of Contractors by Principal Contractor*

The Principal Contractor shall ensure that all contractors under his control are complying with the respective Health and Safety Plans, as well as Health and Safety Legislation.

### *2.23 Stacking of Materials*

In addition to the provisions for the stacking of articles in the General Safety Regulations, 2003, the contractor must ensure that –

- a competent person is appointed in writing with the duty of supervising all stacking and storage on a construction site;
- adequate storage areas are provided;
- there are demarcated storage areas; and
- storage areas are kept neat and under control.

### *2.24 Housekeeping and General Safeguarding on Construction Sites*

A contractor must, in addition to compliance with the Environmental Regulations for Workplaces, 1987, promulgated by Government Notice No. R. 2281 of 16 October 1987, ensure that suitable housekeeping is continuously implemented on each construction site, including-

- the proper storage of materials and equipment;
- the removal of scrap, waste and debris at appropriate intervals;
- ensuring that materials required for use, are not placed on the site so as to obstruct means of access to and egress from workplaces and passageways;
- ensuring that materials which are no longer required for use, do not accumulate on and are removed from the site at appropriate intervals;
- ensuring that waste and debris are not disposed of from a high place with a chute, unless the chute complies with the requirements set out in the regulations;
- ensuring that construction sites in built-up areas adjacent to a public way are suitably and sufficiently fenced off and provided with controlled access points to prevent the entry of unauthorized persons; and
- ensuring that a catch platform or net is erected above an entrance or passageway or above a place where persons work or pass under, or fencing off the danger area if work is being performed above such entrance, passageway, or place so as to ensure that all persons are kept safe in the case of danger or possibility of persons being struck by falling objects.

### *2.25 Construction Vehicles and Mobile Plant*

A contractor must ensure that all construction vehicles and mobile plant-

- are of an acceptable design and construction;
- are maintained in a good working order;
- are used in accordance with their design and the intention for which they were designed, having due regard to safety and health;
- are operated by a person who-
  - has received appropriate training, is certified competent and in possession of proof of competency and is authorised in writing to operate those construction vehicles and mobile plant;
  - has a medical certificate of fitness to operate those construction vehicles and mobile plant, issued by an occupational health practitioner in the form of Annexure 3.
- have safe and suitable means of access and egress;
- are properly organized and controlled in any work situation by providing adequate signalling or other control arrangements to guard against the dangers relating to the movement of vehicles and plant, in order to ensure their continued safe operation;
- are prevented from falling into excavations, water or any other area lower than the working surface by installing adequate edge protection, which may include guard-rails and crash barriers;
- are fitted with structures designed to protect the operator from falling material or from being crushed should the vehicle or mobile plant overturn;
- are equipped with an acoustic warning device which can be activated by the operator;
- are equipped with an automatic acoustic reversing alarm; and
- are inspected by the authorised operator or driver on a daily basis using a relevant checklist prior to use and that the findings of such inspection are recorded in a register kept in the construction vehicle or mobile plant.

A contractor must ensure that-

- no person rides or is required or permitted to ride on a construction vehicle or mobile plant otherwise than in a safe place provided thereon for that purpose;
- every construction site is organized in such a way that, as far as is reasonably practicable, pedestrians and vehicles can move safely and without risks to health;
- the traffic routes are suitable for the persons, construction vehicles or mobile plant using them, are sufficient in number, in suitable positions and of sufficient size;
- every traffic route is, where necessary, indicated by suitable signs;
- all construction vehicles and mobile plant left unattended at night, adjacent to a public road in normal use or adjacent to construction areas where work is in progress, have appropriate lights or reflectors, or barricades equipped with appropriate lights or reflectors, in order to identify the location of the vehicles or plant;
- all construction vehicles or mobile plant when not in use, have buckets, booms or similar appendages, fully lowered or blocked, controls in a neutral position, motors stopped, wheels chocked, brakes set and ignition secured;
- whenever visibility conditions warrant additional lighting, all mobile plant are equipped with at least two headlights and two taillights when in operation;
- tools, material and equipment are secured and separated by means of a physical barrier in order to prevent movement when transported in the same compartment with employees;
- vehicles used to transport employees have seats firmly secured and adequate for the number of employees to be carried; and
- all construction vehicles or mobile plant travelling, working or operating on public roads comply with the requirements of the National Road Traffic Act, 1996.

### *2.26 Electrical Installations and Machinery on Construction Sites*

A contractor must, in addition to compliance with the Electrical Installation Regulations and the Electrical Machinery Regulations, ensure that –

- before construction commences and during the progress thereof, adequate steps are taken to ascertain the presence of and guard against danger to workers from any electrical cable or apparatus which is under, over or on the site;
- all parts of electrical installations and machinery are of adequate strength to withstand the working conditions on construction sites;
- the control of all temporary electrical installations on the construction site is designated to a competent person who has been appointed in writing for that purpose;
- all temporary electrical installations used by the contractor are inspected at least once a week by a competent person and the inspection findings are recorded in a register kept on the construction site; and
- all electrical machinery is inspected by the authorized operator or user on a daily basis using a relevant checklist prior to use and the inspection findings are recorded in a register kept on the construction site.

### *2.27 Use and Temporary Storage of Flammable Liquids on Construction Sites*

A contactor must, in addition to compliance with the provisions for the use and storage of flammable liquids in the General Safety Regulations, 2003, ensure that –

- where flammable liquids are being used, applied or stored at the workplace concerned, it is done in a manner that does not cause a fire or explosion hazard, and that the workplace is effectively ventilated;
- no person smokes in any place in which flammable liquid is used or stored, and the contractor must affix a suitable and conspicuous notice at all entrances to any such areas prohibiting such smoking;
- an adequate amount of efficient fire-fighting equipment is installed in suitable locations around the flammable liquids store with the recognized symbolic signs;
- only the quantity of flammable liquid needed for work on one day is taken out of the store for use;
- all containers holding flammable liquids are kept tightly closed when not in actual use and, after their contents have been used up, are removed from the construction site and safely disposed of;
- where flammable liquids are decanted, the metal containers are bonded and earthed; and
- no flammable material, including cotton waste, paper, cleaning rags or similar material is stored together with flammable liquids

### *2.28 Water environments*

A contractor must ensure that where construction work is done over or in close proximity to water, provision is made for –

- preventing persons from falling into water; and
- the rescuing of persons in danger of drowning.

A contractor must ensure that where a person is exposed to the risk of drowning by falling into the water, the person is provided with and wears a lifejacket.

### *2.29 Fire precautions on Construction Sites*

A contractor must, in addition to compliance with the Environmental Regulations for Workplaces, 1987, ensure that –

- all appropriate measures are taken to avoid the risk of fire;
- sufficient and suitable storage is provided for flammable liquids, solids and gases;
- smoking is prohibited and notices in this regard are prominently displayed in all places containing

readily combustible or flammable materials;
- in confined spaces and other places in which flammable gases, vapours or dust can cause danger-
  - only suitably protected electrical installations and equipment, including portable lights, are used;
  - there are no flames or similar means of ignition;
  - there are conspicuous notices prohibiting smoking;
  - oily rags, waste and other substances liable to ignite are without delay removed to a safe place; and
  - adequate ventilation is provided;
- combustible materials do not accumulate on the construction site;
- welding, flame cutting and other hot work are done only after appropriate precautions have been taken to reduce the risk of fire;
- suitable and sufficient fire-extinguishing equipment is placed at strategic locations or as may be recommended by the Fire Chief or local authority concerned, and that such equipment is maintained in a good working order;
- the fire equipment contemplated above is inspected by a competent person, who has been appointed in writing for that purpose, in the manner indicated by the manufacturer thereof;
- a sufficient number of workers are trained in the use of fire- extinguishing equipment;
- where appropriate, suitable visual signs are provided to clearly indicate the escape routes in the case of a fire;
- the means of escape is kept clear at all times;
- there is an effective evacuation plan providing for all -
  - persons to be evacuated speedily without panic;
  - persons to be accounted for; and
  - plant and processes to be shut down; and
- a siren is installed and sounded in the event of a fire.

### *2.30 Construction Employees' Facilities*

A contractor must, in terms of the Construction Regulations 2014, provide:

- Shower facilities after consultation with the employees or employee's representatives, or at least one shower facility for every 15 persons;
- at least one sanitary facility for each sex and for every 30 workers;
- changing facilities for each sex;
- and sheltered eating area.

A contractor must provide reasonable and suitable living accommodation for the workers at construction sites who are far removed from their homes and where adequate transportation between the site and their homes, or other suitable living accommodation, is not available.

### *2.31 Fall protection*

The Contractor must:
- designate a competent person to be responsible for the preparation of a fall protection plan
- ensure that the fall protection plan contemplated above is implemented, amended where and when necessary and maintained as required; and
- take steps to ensure continued adherence to the fall protection plan.

A fall protection plan contemplated above must include-
- a risk assessment of all work carried out from a fall risk position and the procedures and methods used to address all the risks identified per location;
- the processes for the evaluation of the employees' medical fitness necessary to work at a fall risk position and the records thereof;
- a programme for the training of employees working from a fall risk position and the records thereof;

- the procedure addressing the inspection, testing and maintenance of all fall protection equipment; and
- a rescue plan detailing the necessary procedure, personnel and suitable equipment required to affect a rescue of a person in the event of a fall incident to ensure that the rescue procedure is implemented immediately following the incident.

A contractor must ensure that a construction manager appointed under regulation 8(1) is in possession of the most recently updated version of the fall protection plan.

A contractor must ensure that all unprotected openings in floors, edges, slabs, hatchways and stairways are adequately guarded, fenced or barricaded or that similar means are used to safeguard any person from falling through such openings;

Also that no person is required to work in a fall risk position, unless such work is performed safely as contemplated in above and fall prevention and fall arrest equipment are approved as suitable and of sufficient strength for the purpose for which they are being used, having regard to the work being carried out and the load, including any person, they are intended to bear; and securely attached to a structure or plant, and the structure of plant and the means of attachment thereto are suitable and of sufficient strength and stability for the purpose of safely supporting the equipment and person who could fall, and fall arrest equipment is used only where it is not reasonably practicable to use fall prevention equipment.

### *2.32 Temporary works*

A contractor must appoint a temporary works designer in writing to design, inspect and approve the erected temporary works on site before use.

A contractor must ensure that all temporary works operations are carried out under the supervision of a competent person who has been appointed in writing for that purpose.

A contractor must ensure that-

- all temporary works structures are adequately erected, supported, braced and maintained by a competent person so that they are capable of supporting all anticipated vertical and lateral loads that may be applied to them, and that no loads are imposed onto the structure that the structure is not designed to withstand;
- all temporary works structures are done with close reference to the structural design drawings, and where any uncertainty exists the structural designer should be consulted;
- detailed activity specific drawings pertaining to the design of temporary works structures are kept on the site and are available on request to an inspector, other contractors, the client, the client's agent or any employee;
- all persons required to erect, move or dismantle temporary works structures are provided with adequate training and instruction to perform those operations safely;
- all equipment used in temporary works structure are carefully examined and checked for suitability by a competent person, before being used;
- all temporary works structures are inspected by a competent person immediately before, during and after the placement of concrete, after inclement weather or any other imposed load and at least on a daily basis until the temporary works structure has been removed and the results have been recorded in a register and made available on site;
- no person may cast concrete, until authorization in writing has been given by the competent person contemplated above*;*
- if, after erection, any temporary works structure is found to be damaged or weakened to such a degree that its integrity is affected, it is safely removed or reinforced immediately;
- adequate precautionary measures are taken in order to–
  - secure any deck panels against displacement; and
  - prevent any person from slipping on temporary works due to the application of release agents;
- as far as is reasonably practicable, the health of any person is not affected through the use of solvents or oils or any other similar substances;

- upon casting concrete, the temporary works structure is left in place until the concrete has acquired sufficient strength to safely support its own weight and any imposed load, and is not removed until authorization in writing has been given by the competent person
- the foundation conditions are suitable to withstand the loads caused by the temporary works structure and any imposed load in accordance with the temporary works design.
- provision is made for safe access by means of secured ladders or staircases for all work to be carried out above the foundation bearing level;
- a temporary works drawing or any other relevant document includes construction sequences and methods statements;
- the temporary works designer has been issued with the latest revision of any relevant structural design drawing;
- a temporary works design and drawing is used only for its intended purpose and for a specific portion of a construction site; and
- the temporary works drawings are approved by the temporary works designer before the erection of any temporary works.

No contractor may use a temporary works design and drawing for any work other than its intended purpose.

### *2.33 Excavation*

A contractor must-

- ensure that all excavation work is carried out under the supervision of a competent person who has been appointed in writing for that purpose; and
- evaluate, as far as is reasonably practicable, the stability of the ground before excavation work begins.

A contractor who performs excavation work-

- must take reasonable and sufficient steps in order to prevent, as far as is reasonably practicable, any person from being buried or trapped by a fall or dislodgement of material in an excavation;
- may not require or permit any person to work in an excavation which has not been adequately shored or braced: Provided that shoring and bracing may not be necessary where-
  - the sides of the excavation are sloped to at least the maximum angle of repose measured relative to the horizontal plane; or
  - such an excavation is in stable material: Provided that-
    - permission has been given in writing by the appointed competent person contemplated above upon evaluation by him or her of the site conditions; and
    - where any uncertainty pertaining to the stability of the soil still exists, the decision from a professional engineer or a professional technologist competent in excavations is decisive and such a decision must be noted in writing and signed by both the competent person and the professional engineer or technologist, as the case may be;
- must take steps to ensure that the shoring or bracing contemplated above is designed and constructed in a manner that renders it strong enough to support the sides of the excavation in question;
- must ensure that no load, material, plant or equipment is placed or moved near the edge of any excavation where it may cause its collapse and consequently endangers the safety of any person, unless precautions such as the provision of sufficient and suitable shoring or bracing are taken to prevent the sides from collapsing;
- must ensure that where the stability of an adjoining building, structure or road is likely to be affected by the making of an excavation, steps are taken to ensure the stability of such building, structure or road and the safety of persons;
- must cause convenient and safe means of access to be provided to every excavation in which persons are required to work, and such access may not be further than six meters from the point where any worker within the excavation is working;

- must ascertain, as far as is reasonably practicable, the location and nature of electricity, water, gas or other similar services which may in any way be affected by the work to be performed, and must before the commencement of excavation work that may affect any such service, take the steps that are necessary to render the circumstances safe for all persons involved;
- must ensure that every excavation, including all bracing and shoring, is inspected-
    - daily, prior to the commencement of each shift;
    - after every blasting operation;
    - after an unexpected fall of ground;
    - after damage to supports; and
    - after rain,

  by the competent person, in order to ensure the safety of the excavation and of persons, and those results must be recorded in a register kept on site and made available on request to an inspector, the client, the client's agent, any other contractor or any employee;
- must cause every excavation which is accessible to the public or which is adjacent to public roads or thoroughfares, or whereby the safety of persons may be endangered, to be –
    - adequately protected by a barrier or fence of at least one metre in height and as close to the excavation as is practicable; and
    - provided with warning illuminants or any other clearly visible boundary indicators at night or when visibility is poor, or have resort to any other suitable and sufficient precautionary measure where this is not practicable;
- must ensure that all precautionary measures stipulated for confined spaces as determined in the General Safety Regulations, 2003, are complied with by any person entering any excavation;
- must, where the excavation work involves the use of explosives, appoint a competent person in the use of explosives for excavation, and must ensure that a method statement is developed by that person in accordance with the applicable explosives legislation; and
- must cause warning signs to be positioned next to an excavation within which or where persons are working or carrying out inspections or tests.

### *2.34 Tunneling*

No person may enter a tunnel which has a height dimension of less than 800 mm.

### *2.35 Scaffolding*

A contractor must appoint a competent person in writing who must ensure that all scaffolding work operations are carried out under his or her supervision and that all scaffold erectors, team leaders and inspectors are competent to carry out their work.

A contractor using access scaffolding must ensure that such scaffolding, when in use, complies with the safety standards incorporated for this purpose into these Regulations under section 44 of the Act.

### *2.36 Bulk mixing plant*

A contractor must ensure that the operation of a bulk mixing plant is supervised by a competent person who has been appointed in writing and is –

- aware of all the dangers involved in the operation thereof; and
- conversant with the precautionary measures to be taken in the interest of health and safety.

No person supervising or operating a bulk mixing plant may authorize any other person to operate the plant, unless that person is competent to operate a bulk mixing plant.

A contractor must ensure that the placement and erection of a bulk mixing plant complies with the requirements set out by the manufacturer and that such plant is erected as designed.

A contractor must ensure that all devices to start and stop a bulk mixing plant are provided and that those devices are placed in an easily accessible position and constructed in a manner to prevent accidental starting.

A contractor must ensure that the machinery and plant selected is suitable for the mixing task and that all dangerous moving parts of a mixer are placed beyond the reach of persons by means of doors, covers or other similar means.

No person may remove or modify any guard or safety equipment relating to a bulk mixing plant, unless authorized to do so by the appointed person.

A contractor must ensure that all precautionary measures stipulated for confined spaces as determined in the General Safety Regulations, 2003, are complied with when entering any silo.

A contractor must ensure that a record is kept of all repairs or maintenance to a bulk mixing plant and that the record is available on site to an inspector, the client, the client's agent or any employee.

### *2.37 Rope Access Work*

A contractor must –

- appoint a competent person in writing as a rope access supervisor with the duty of supervising all rope access work on the site, including the duty of ensuring occupational health and safety compliance in relation to rope access work: Provided that the appointment of any such person does not relieve the construction manager of any personal accountability for failing in his management duties in terms of this regulation;
- ensure that all rope access work on the construction site is carried out under the supervision of a competent person; and
- ensure that all rope access operators are competent and licensed to carry out their work.

No contractor may use or allow the use of rope access work unless –

- the design, selection and use of the equipment and anchors comply with the safety standards incorporated for this purpose into these Regulations under section 44 of the Act; and
- he or she is in possession of a site specific fall protection plan developed by a competent person applicable to the specific work and environment prior to the commencement of the work, including records of maintenance and inspections of all the equipment used for the work operations.

A contractor must ensure that adequate measures are in place to allow rescue procedures to commence immediately in the event of a fall incident taking place.

### *2.38 Hazardous Chemical Substances (HCS)*

In addition to the requirements in the HCS Regulations, the principal contractor must provide proof in the Health and Safety Plan that:

Material Safety Data Sheets (MSDS's) of the relevant materials / hazardous chemical substances are available prior to use by the contractor. All MSDS's shall be available for inspection by the agent at all times.

- Risk assessments are done at least once every 6 months.
- Exposure monitoring is done according to OESSM and by an Approved Inspection Authority (AIA) and that the medical surveillance programme is based on the outcomes of the exposure monitoring.
- How the relevant HCS's are being/going to be controlled by referring to:
  - Limiting the amount of HCS
  - Limiting the number of employees

  - Limiting the period of exposure
  - Substituting the HCS
  - Using engineering controls
  - Using appropriate written work procedures
- The correct PPE is being used.
- HCS are stored and transported according to SABS 072 and 0228.
- Training with regards to these regulations was given.

The Health and Safety plan should make reference to the disposal of hazardous waste on classified sites and the location thereof (where applicable).

The First Aider must be made aware of the MSDS and trained in how to treat HCS incidents appropriately.

### *2.39 Noise Induced Hearing Loss*

Where noise is identified as a hazard the requirements of the NIHL regulations must be complied with and the following must be included / referred to in the Health and Safety Plan:

- Proof of training with regards to these regulations.
- Risk assessment done within 1 month of commencement of work.
- That monitoring carried out by an AIA and done according to SABS 083.
- Medical surveillance programme established and maintained for the necessary employees.
- Control of noise by referring to:
- Engineering methods considered
- Admin control (number of employees exposed) considered
- Personal protective equipment considered/decided on
- Describe how records are going to be kept for 40 years.

### *2.40 Explosives and Blasting*

The Contractor shall ensure that the use of explosives and blasting (where required) be undertaken by a specialist contractor or a sub contractor with proven track record in the type of work to be performed.

The Contractor may only use explosives for work purposes where the following conditions in place:

- Explosives Regulations to be complied with in all respects.
- Contractor must be in possession of a Blasting Licence
- Blasting permit to be obtained
- Permit to transport explosives to be obtained
- Method statement to be drawn up and approved by professional team
- Municipal authorities may require advance notice of planned use of explosives
- Contractor must notify Provincial Director of Department of Labour on Annexure 2 at least 7 days prior to blasting taking place
- Contractor must have Workman's Compensation and appropriate insurances in place

### *2.41 Personal Protective Equipment (PPE)*

The Contractor shall carry out PPE or clothing needs analysis in accordance with his risk assessment, to determine the necessary PPE or clothing to be used during construction. The Contractor shall make provision and keep adequate quantities of SABS approved PPE or clothing on site at all times.

The Contractor must ensure that personnel are trained in the correct use of PPE to be used.

The Contractor must ensure that lost, stolen, worn out or damaged PPE is replaced as required and receipt signed for by employees on site.

### *2.42 Pressure Vessels (Including Gas Bottles)*

The Contractor shall comply with Pressure Vessel Regulations, including:

- Providing competency and awareness training to the operators;
- Providing PPE or clothing;
- Providing and maintain appropriate signage in areas where pressure vessels are used, as applicable;
- Inspect equipment regularly and keep records of inspections;
- Providing appropriate fire fighting equipment (Fire Extinguishers).

### *2.43 Fire Extinguishers and Fire Fighting Equipment*

The Contractor shall provide adequate, regularly serviced fire extinguishers located at strategic points on site. The Contractor shall keep spare serviced portable fire extinguishers. The Contractor shall have adequate persons trained or competent to use the Fire Fighting Equipment.

Safety signage shall be posted up in all areas where fire extinguishers are located.

### *2.44 Lifting Machinery and Tackle*

The Contractor shall ensure that lifting machinery and tackle is inspected before use and on a monthly basis. The Contractor shall have lifting machinery and tackle inspector who will inspect the equipment at intervals required by the Driven Machinery Regulations, taking into account that:

- All lifting machinery and tackle have a safe working load clearly indicated;
- Regular inspection and servicing is carried out;
- Records are kept of inspections and of service certificates;
- Thorough examinations are carried out by competent personnel at the frequencies required by legislation
- There is proper supervision in terms of guiding the loads which includes a trained banks man to direct and check lifting tackle if it is safe for use.

### *2.45 Ladders and Ladder work*

The Contractor shall ensure that all ladders are numbered and inspected regularly keeping record of inspections. It should be noted that Aluminium ladders are preferred to wooden ladders.

### *2.46 General Machinery*

The Contractor shall comply with the Driven Machinery Regulations, which include inspecting machinery regularly, appointing a competent person to inspect and ensure maintenance, issuing PPE or clothing and training those that use machinery and enforce compliance.

### *2.47 Portable Electrical Tools*

The Contractor shall ensure that use and storage of all explosive actuating fastening devices and portable electrical tools are in compliance with relevant legislation.

The Contractor shall consider that:

- A competent person undertakes routine inspections;
- Only authorised persons use the tools;

- There are safe working procedures applied;
- Awareness training is carried out and compliance is enforced at all times; and
- PPE and clothing is provided and maintained.

### *2.48 High Voltage Electrical Equipment*

The Contractor shall ensure that, where the work is under, on or near high-voltage electrical equipment the Electrical Installation Regulations, together with safety instructions (Regulations of the Owner of the Equipment) are complied with. Such equipment includes:

- Eskom and the Local Authority equipment
- The Contractor's own power supply; and
- Electrical equipment being installed but not yet taken over from a Contractor by The Client.

### *2.49 Public Health and Safety*

The Contractor shall ensure that each person working on or visiting a site, and the surrounding community, shall be made aware of the dangers likely to arise from on site activities and the precautions to be observed to avoid or minimize those dangers. Appropriate health and safety signage shall be posted at all times.

### *2.50 Night Work*

The Contractor shall not undertake any night work without prior arrangement and a written permit from the Client. The Contractor shall ensure that adequate lighting is provided for all night work and failure to do so shall result in work being stopped.

### *2.51 Environmental Conditions and Flora and Fauna*

The Contractor must be mindful of adverse weather conditions upon the health and safety of the workforce. This includes inclement weather, strong wind, heat stress, extreme cold, etc. The Contractor's risk assessment process must take into account the risks associated with such weather conditions. The same is true when working in an environment where there is a risk to employees' health and safety from presence of poisonous flora, or wildlife (including bees, snakes, etc). The Contractor's risk assessment process must take these risks into account.

### *2.52 Occupational Health*

Exposure of workers to occupational health hazards and risks are very common in any work environment, especially in construction. Occupational health hazards and risks exposure is a major problem and all Contractors are to ensure that proper health and hygiene measures are put in place to prevent exposure to these hazards and risks.

The occupational hazards and risks may enter the body in three ways:

- Inhalation through breathing e.g. cement dust;
- Ingestion through swallowing maybe through food intake;
- Absorption through the skin (pores) e.g. painting or use of thinners.

The contractor is required to ensure that all his personnel are medically fit prior to being allowed onto the work site.

All Contractors should ensure that Occupational Hygiene surveys are conducted as per the Occupational Health and Safety Act to ensure employees are not exposed to hazards. Risk Assessments should identify areas where surveys are to be conducted.

### *2.53 Material Hoists*

A contractor must ensure that every material hoist and its tower have been constructed in accordance with the generally accepted technical standards and are strong enough and free from defects.

A contractor must ensure that the tower of every material hoist is —

- erected on firm foundations and secured to the structure or braced by steel wire guy ropes, and extends to a distance above the highest landing to allow a clear and unobstructed space of at least 900 mm for over travel;
- enclosed on all sides at the bottom, and at all floors where persons are at risk of being struck by moving parts of the hoist, except on the side or sides giving access to the material hoist, with walls or other effective means to a height of at least 2100 mm from the ground or floor level; and
- provided with a door or gate at least 2100mm in height at each landing, and that door or gate must be kept closed except when the platform is at rest at such a landing.

A contractor must cause-

- the platform of every material hoist to be designed in a manner that it safely contains the loads being conveyed and that the combined mass of the platform and the load does not exceed the designed lifting capacity of the hoist;
- the hoisting rope of every material hoist which has a remote winch to be effectively protected from damage by any external cause to the portion of the hoisting rope between the winch and the tower of the hoist; and
- every material hoist to be provided with an efficient brake capable of holding the platform with its maximum load in any position when power is not being supplied to the hoisting machinery.

No contractor may require or permit trucks, barrows or material to be conveyed on the platform of a material hoist and no person may so convey trucks, barrows or material unless those articles are secured or contained in a manner that displacement thereof cannot take place during movement.

A contractor must cause a notice, indicating the maximum mass load which may be carried at any one time and the prohibition of persons from riding on the platform of the material hoist, to be affixed around the base of the tower and at each landing.

A contractor of a material hoist may not require or permit any person to operate a hoist, unless the person is competent in the operation of that hoist.

No contractor may require or permit any person to ride on a material hoist.

A contractor must ensure that every material hoist-

- is inspected on daily basis by a competent person appointed in writing by the contractor and such competent person must have the experience pertaining to the erection and maintenance of material hoists or similar machinery;
- inspection contemplated above, includes the determination of the serviceability of the entire material hoist, including guides, ropes and their connections, drums, sheaves or pulleys and all safety devices;
- inspection results are entered and signed in a record book by a competent person, which book must be kept on the premises for that purpose;
- is properly maintained and the maintenance records in this regard are kept on site.

### *2.54 Explosive Actuated Fastening Device*

No contractor may use or permit any person to use an explosive actuated fastening device, unless-

- the user is provided with and uses suitable protective equipment;
- the user is trained in the operation, maintenance and use of such a device
- the explosive actuated fastening device is provided with a protective guard around the muzzle end, which effectively confines any flying fragments or particles; and
- the firing mechanism is so designed that the explosive actuated fastening device, will not function unless-
  - it is held against the surface with a force of at least twice its weight; and
  - the angle of inclination of the barrel to the work surface is not more than 15 degrees from a right angle.

A contractor must ensure that-

- only cartridges suited for the relevant explosive actuated fastening device, and the work to be performed, are used;
- an explosive actuated fastening device is cleaned and examined daily before use and as often as may be necessary for its safe operation by a competent person who has been appointed for that purpose;
- the safety devices of an explosive actuated fastening device are in good working order prior to use;
- when not in use, an explosive actuated fastening device and its cartridges are locked up in a safe place, which is inaccessible to unauthorized persons;
- an explosive actuated fastening device is not stored in a loaded condition;
- a warning notice is displayed in a conspicuous manner in the immediate vicinity wherever an explosive actuated fastening device is used; and
- the issuing and collection of cartridges and nails or studs of an explosive actuated fastening device are-
  - controlled and done in writing by a person having been appointed in writing for that purpose; and
  - recorded in a register by a competent person and that the recipient has accordingly signed for the receipt thereof as well as the returning of any spent and unspent cartridges.

Both the Client and the Contractor have a duty in terms of health and safety legislation to do all that is reasonably practicable to prevent members of the public and others being affected by the construction processes to be aware and put preventative measure in place. The public or visitors shall go through a brief health and safety induction detailing hazards and risks they may be exposed to and what measures are in place to control these hazards and risks.

**OTHER HEALTH AND SAFETY SPECIFICATION REQUIREMENTS**

The contractor must be aware of the following additional requirements:

| What | When | Output |
|---|---|---|
| Awareness training (Toolbox Talks) | At least fortnightly and before hazardous work is carried out | Attendance Register |
| Health and Safety Committee Meetings | Monthly | Minutes signed by the employer (Contractor) covering:<br>a) Health and Safety Representative Checklist |
| Health and Safety Reports | Monthly | Report covering:<br>a) Incidents/Accidents and Investigations<br>b) Non conformance<br>c) Health and Safety Training<br>d) HIRA Updates<br>e) Internal and External Audits |
| General Inspections | As per Health and Safety Specification and OHSA | Report on Health and Safety Specification and OHSA compliance:<br>a) Scaffolding<br>b) Lifting Machinery<br>c) Excavation |
| General Inspections | Monthly | Covering:<br>a) Fire fighting Equipment<br>b) Portable Electrical Equipment<br>c) Ladders |
| Record keeping | Ongoing | Covering:<br>a) General complaints<br>b) Fines<br>c) General incidents<br>d) MSDS<br>e) Surveillance Medicals<br>f) Inspection Register<br>g) Dept of Labour Notices |
| Permits | Before commencement with certain activities | As stipulated by the Health and Safety Specification and the OHSA / Construction Regulations |

Key:

OHSA – Occupational Health and Safety Act, 1993

**ANNEXURE A**

The Contractor shall submit the info in Annexure A below prior to construction commencement.

| Item No. | Health and Safety Specification Requirement | OHSA Requirement | Submission date |
|---|---|---|---|
| 1. | Notification of Intention to Commence Construction | Construction Regulations 2014 | At least 7 days before commencement on site |
| 2. | Construction Work Permit | Construction Regulations 2014 (but only comes into effect from August 2015, and only with certain size and duration projects) | At least 30 days prior to project commencement |
| 3. | Assignment of Responsible Person to Manage Building Work via Health and Safety Organogram | Construction Regulations 2014 | Before commencement on site |
| 4. | Competency for Health and Safety Positions | Client / Client Agent requirement | Before commencement on site |
| 5. | Compensation of Occupational Injuries and Diseases Act (COIDA) 130 of 1993 | COIDA Requirement | Before commencement on site |
| 6. | Occupational Health and Safety Policy | Client / Client Agent requirement | Before commencement on site |
| 7. | Risk Assessment, Safety Plan and Fall Protection Plan, Demolition Method Statement | Client / Client Agent requirement | Before construction work commences |

| **ANNEXURE B -** The contractor shall make the following appointments, as required: |
|---|

| |
|---|
| Chief Executive Officer (OSHACT 16(1) |
| Contract Director/Manager (OSHACT 16(2) |
| Construction Manager (CR 8(1) |
| Construction Supervisor (CR 8(7) |
| Assistant Construction Supervisor (CR 8(8) |
| Construction Safety Officer (CR 8(5) |
| Traffic Safety Officer |
| Safety Representative (where > 20 employees on site) |
| Temporary work Designer (CR 12(1) |
| Temporary work Supervisor (CR12(2) |
| Construction risk assessor (CR 9(1)) |
| Excavation Supervisor (CR13(1)(a) |
| Demolition Supervisor (CR14(1) |
| Scaffold Supervisor (CR16(1) |
| Suspended Platform Supervisor (CR17(1) |
| Material Hoist Inspector (CR19(8)(a) |
| Material Hoist Operator (CR19(6) |
| Bulk Mixing Plant Supervisor (CR20(1) |
| Bulk Mixing Plant Operator (CR20(2) |
| Controller of Explosive Actuated Fastening Devices Nails, Cartridges or Studs Issue and Collection (CR21(2)(g)(1) |
| Construction Vehicle and Mobile Plant Operator (CR23(1)(d)(i) |
| Controller of Temporary Electrical Installations (CR24(c) |
| Stacking Supervisor (CR28(a) |
| Fire Extinguishing Equipment Inspector (CR29(h) |
| Fall Protection Plan Developer (CR 10(1)(a) |
| Incident Investigator (OSHACT 9(2) |
| Competent Person – Confined Spaces (GAR 5(1) |

## BASELINE RISK ASSESSMENTS

Irrespective of the risk presented on site, it will be ensured that sufficient supervision is in place on site, that personnel are trained in accordance with legislation, including the requirement for site specific inductions on site to inform personnel on site of the risks and hazards applicable to the site. Site supervision is responsible for ensuring that the control measures required below are implemented on site.

Probability X Frequency X Consequences = Criticality Rating

P Scale: 2 Unlikely, 4 Remote possibility, 6 Probable, 8 highly probable, 10 Inevitable
F Scale: 2 Yearly, 4 monthly, 6 weekly, 8 once a day, 10 Many times a day
C Scale: 2 Negligible, 4 Marginal, 6 Serious, 8 Critical, 10Catastrophic

Risk Rating:
H = High – 97 >., M = Medium – 46 > 96, L= Low – 0 > 45.

**Risk Assessment Methodology:**
**Rating the risks**

**Quantitative** risk assessments produce a probability estimate based upon known risk information applied to the circumstances being considered. They can be found in 'safety cases' in high risk industries where, for example, they might indicate the probability of a nuclear incident of serious chemical leak.

**Qualitative** assessments are subjective, based on the personal judgement of the assessor, backed by more general information about probability. These are much simpler to make, and are those normally referred to by legal requirements.

**A descriptive approach** simply uses words such as 'insignificant', 'low', 'medium' and 'high' in their normal sense to evaluate the product of the likely severity of the outcome and the probability of its occurrence. Most people have an appreciation of what 'Medium Risk' means for them in their business context and can appreciate that with controls in place the risk should be lowered – preferably to 'Insignificant' or at the least to 'Low'.
In this assessment, we have used a Descriptive Approach.

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 1. | Asphalting | Fire<br>Burns to skin<br>Skin disease | **P x F x C = 192 = H** | • Suitable fire extinguisher to be in place prior to commencement of works<br>• Ensure competent personnel using materials and competent and trained machinery/equipment operators<br>• Ensure there is a safe place of work at all times<br>• Ensure all personnel wear suitable and sufficient personal protective equipment (PPE)<br>• Health and Safety data sheet required |
| 2. | Bricklaying | Caustic contamination with mortar<br>Contact with sharp bladed tools | **P x F x C = 24 = L** | • Use only trained personnel<br>• Safe means of access to be provided<br>• Safe/Suitable working platform required where working at height<br>• PPE for mortar to include gloves where practicable and goggles/ masks where there is a risk of contamination |
| 3. | Brushcutting | Injury from contact with blade/nylon<br>Fire (where petrol used)<br>Electrocution (where electrical tool used) | **P x F x C = 192 = H** | • Person using brushcutter must be trained and competent<br>• Use personal protective equipment (PPE) such as goggles, safety boots, ear protection, gloves, hard hat<br>• Brushcutter must be in good condition and maintained<br>• Adequate supervision on site at all times.<br>• No smoking when refuelling, fire extinguisher to be on hand (where petrol used as fuel source) |
| 4. | Chainsaw Use | Falling tree or branches causing injury to persons<br>Incorrect use of chainsaw causing injury | **P x F x C = 128 = H** | • Person using chainsaw must be trained and competent<br>• Use personal protective equipment (PPE) such as goggles, safety boots, ear protection, gloves, hard hat, chainsaw trousers and jacket<br>• Chainsaw must be in good condition including guards.<br>• Clear area below area of chainsaw use and where tree felling.<br>• When using chainsaw at height practice safety procedures. |
| 5. | Compacting and Filling | Contact with tipping materials<br>Contact with moving plant<br>Vehicles/personnel falling into excavations<br>Contact with underground services | **P x F x C = 192 = H** | • Trained banksman to control vehicles movement<br>• Only trained personnel use plant<br>• Personal Protective Equipment to be worn<br>• Personnel to stand clear as materials are being tipped<br>• Use stop blocks and signs to warn vehicles of excavations, where applicable<br>• Stand clear of plant whilst materials are being compacted<br>• Establish position of underground services and protect services from damage |

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 6. | Compactor Operations | Crushing of feet | **P x F x C = 192 = H** | • Only trained and competent personnel to use the machine<br>• Ensure operative wears steel toe cap shoes or boots at all times |
| 7. | Concrete Pumping | Sprains and strains<br>Hit by pump<br>Concrete burns<br>Collapse/bursting of structure | **P x F x C = 24 = L** | • Personnel to be in clear vision of pump operator<br>• Trained pump operator<br>• Personnel working with the concrete to wear the appropriate personal protective equipment to protect against cement burns<br>• Design of structure being loaded to be approved by competent designer and inspected before, during and after loading<br>• Pump to be well maintained |
| 8. | Confined Spaces | Suffocation<br>Fumes | **P x F x C = 800 = H** | • Ensure that confined space is sufficiently ventilated<br>• Wear personal protective equipment such as proper masks if air supply insufficient or not of sufficient quality<br>• Test oxygen levels in confined space to ensure that is safe for entry<br>• Ensure that emergency procedures in place |
| 9. | Contaminated Land (Working in) | Inhalation of toxic vapours<br>Contact with toxic solids | **P x F x C = 192 = H** | • Specific advice to be sought from safety advisor |
| 10. | Cutting Kerbs | Saw slipping, Blade disintegrating, Noise and dust | **P x F x C = 192 = H** | • Only trained operators to use saw and change blades.<br>• Personal Protective Equipment must be worn. Gloves, goggles, dust mask and hearing protection.<br>• People to be kept away from the work area.<br>• Work to cease if people have to pass.<br>• Sparks etc. to be directed away from people and any flammable material. |

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 11. | Cutting Off Disc | Noise<br>Cuts from machine<br>Fire (particularly at refuelling)<br>Flying debris<br>Blade shattering<br>Contamination by fume created or exhaust fume | **P x F x C = 192 = H** | • Use competent personnel.<br>• Hot works control- fire extinguisher, fire watchman. (Permit may be required)<br>• PPE to include gloves, eye protection, hearing protection<br>• Solid working position.<br>• Clear working area<br>• Correct grade of blade must be used.<br>• Good ventilation to be provided (forced if necessary).<br>• Changing of wheels to be by competent persons only<br>• Cut off discs must not be used for grinding (grinding disc thicker)<br>• Bystanders to wear hearing protection, as applicable |
| 12. | Diesel | Fire<br>Explosion<br>Skin disease | **P x F x C = 288 = H** | • Suitable fire extinguisher to be in place prior to commencement of works<br>• Ensure competent personnel using materials and competent and trained machinery/equipment operators<br>• Ensure there is a safe place of work at all times<br>• Ensure all personnel wear suitable and sufficient personal protective equipment (PPE)<br>• Health and safety data sheet required |
| 13. | Electric Tools and Electrical Installations | Electric shock<br>Fire | **P x F x C = 192 = H** | • Electric tools and installations to be in good condition<br>• Inspect electric tools before use<br>• Do not use electric tools in wet/damp conditions<br>• Use personal protective equipment such as insulated gloves<br>• Electrical installations register to be maintained, inspected by competent person |
| 14. | Excavations (Working in and around) | Toxic fumes<br>Collapse of trench walls/trapping<br>Falling into excavation<br>Collapse of adjacent structures | **P x F x C = 192 = H** | • Deep excavations / monitor air for toxic fumes<br>• Prevent collapse by battering back sides to a safe angle or install temporary support<br>• Protect vehicles from falling into excavations – provide barriers, signage, etc as necessary<br>• Beware of undermining of other structures (eg: buildings, scaffolds)<br>• Record excavation inspections by competent person on daily basis<br>• Provide suitable means of access/egress in case of emergency.<br>• Excavations formed by explosives must be accompanied by method statement approved by Client |

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 15. | Explosive Actuated Fastening Devices | Noise<br>Being struck by cartridge or fixing | **P x F x C = 288 = H** | • Operators to be trained, competent and wear appropriate protective equipment, eg: goggles, gloves, ear defenders, head protection.<br>• Cartridge gun to be in good condition, inspected for damage and faults regularly and results entered into register<br>• Used and unused cartridges and cartridge gun should be kept in secure place when not in use, maintain register for return and issue. |
| 16. | Explosive use | Injuries to personnel, passers-by by blast<br>Property damage | **P x F x C = 288 = H** | • Blaster must have all relevant permits, permissions and licences in place before blasting.<br>• Method statement must be approved.<br>• Maintain exclusion zone around perimeter of blasting, warn persons away, erect warning signage and barriers.<br>• Obtain permission from local authority and police.<br>• Blaster must be competent in blasting<br>• Ensure that blasting does not affect stability of adjacent structures/buildings |
| 17. | Fire | Injuries to workers, pedestrians, residents, road users, damage to property through fire | **P x F x C = 24 = L** | • No littering on site which could become fire hazard, maintain site in clean condition.<br>• No fires to be lit on site. Have a working fire extinguisher at hand at all times.<br>• No smoking or naked flame near flammable substances or in unauthorised areas<br>• Ensure proper storage/use of Petrol/diesel/flammable substances – post warning notices |
| 18. | Flammable Liquids and Gases (Use of) | Fire<br>Explosion | **P x F x C = 192 = H** | • No littering on site which could become fire hazard, maintain site in clean condition.<br>• Have a working fire extinguisher at hand at all times.<br>• No smoking or naked flame near flammable substances or in unauthorised areas<br>• Ensure proper storage/use of Petrol/diesel/flammable substances – post warning notices<br>• Equipment must be in good condition, maintained<br>• Personnel using substances must be trained in safe use and risks |
| 19. | Hand tools | Injuries caused by use of hand tool<br>Impact with the tool Falls due to access problems<br>Contamination with substance being worked | **P x F x C = 24 = L** | Ensure:<br>• Tool is correct for job<br>• Tool is in good order and suitably sharp<br>• Personnel must be competent/instructed in tool usage and tool safely<br>• Lighting is sufficient<br>• Access is safe, working platform is secure, leading edge is guarded<br>• Operative is wearing all necessary PPE |

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 20. | Hazardous Substances | Injuries to workers through use of hazardous substances, eg: injuries to eyes, skin, etc | **P x F x C = 192 = H** | • Use substances in accordance with data sheet, particularly reference protective clothing required (example: gloves, goggles, etc)<br>• Know what First Aid measures are<br>• Have welfare facilities available for washing of hands, etc |
| 21. | Hot Works | Burns to eyes or other parts of the body | **P x F x C = 96 = M** | • Personal Protective Equipment to include eye, skin and hearing protection<br>• Respirator maybe be required where cutting galvanized steel or anywhere else toxic fumes and gases arise. Dust can also be a problem and forced ventilation may be required. |
| 22. | Kerb Laying | Nips at joints<br>Crushing by kerbs<br>Caustic burns | **P x F x C = 96 = M** | • Impervious gloves and barrier cream to be used to protect hands.<br>• Personnel should be aware of safe manual handling techniques when handling kerbs. |
| 23. | Lifting Operations | Falling material<br>Crushing by materials<br>Hand injuries to the slinger<br>Toppling crane | **P x F x C = 800 = H** | • Check test certificate<br>• Check examination certificate<br>• Check inspection have been carried out<br>• Check certificates for lifting equipment (chains, slings, shackles, etc)<br>• Ensure lifting gear is rated to carry load (SWL)<br>• Ensure materials being lifted are properly packaged and slung.<br>• Be aware that there should be a minimum clearance of 600mm between any slewing parts of a crane and any fixed installation to prevent being trapped.<br>• Access to the work area during lifting operations is to be restricted to those involved with and trained in the work in hand. Do not allow members of the public to gain access to the area.<br>• Only trained banksmen to be used.<br>• The crane driver and the banksman are to ensure that the signals given are clearly understood. |
| 24. | Manhole Rings and Pipes Storage | Rolling of rings<br>Collapse of pipes<br>Crushing of persons<br>Stock pile collapse | **P x F x C = 96 = M** | • Manhole rings must be stored flat to prevent them being rolled.<br>• Banks of pipe stock piles are not to be broken until they are ready for use.<br>• Personnel must stand to the side when breaking bands so as not to be hit by falling pipes.<br>• Pipes must be wedged to prevent rolling |

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 25. | Manual Handling of General Items | Muscular skeletal injuries if the load is too heavy or awkward<br>Operative falling/ tripping<br>Contamination from the substance being carried<br>Fall of material being carried | **P x F x C = 192 = H** | • Personnel should be aware of safe manual handling techniques<br>• Personnel to wear Personal Protective Equipment when carrying items, eg: safety footwear and gloves.<br>• Ensure good housekeeping against tripping/fall hazards.<br>• Operative to get assistance if load too heavy- team lift if necessary.<br>• Utilise mechanical lifting and carrying aids where possible.<br>• Personnel to ensure access equipment, ladders will take weight of operative and load being carried.<br>• Personnel to ensure item being carried is properly bonded or is not be liable to break apart whilst being manually handled. |
| 26. | Members of Public – Protection of | Injury to member of public and road users from site works | **P x F x C = 192 = H** | • Barriers and signage to be in place<br>• Workers must warn away any members of public from the works<br>• Footpaths and bridges which are open to public must be closed off if in area of works or otherwise made safe so that no injury occurs to members of public<br>• Traffic turning into site – traffic management and signage as required.<br>• Signage to be on road at site entrance warning motorists that construction traffic turning into/out of site access. Keep roads free of mud where possible<br>• Refer to plant risk assessment for details on plant safety precautions<br>• NOTE: SIGNAGE TO BE POSTED ON SITE TO WARN OF CONSTRUCTION TRAFFIC MOVEMENTS. SAFE MEANS OF ACCESS FOR BOTH CONSTRUCTION TRAFFIC TO SITE AND PRIVATE HOMEOWNERS MUST BE AGREED. |
| 27. | Mobile Crane Erection and Dismantling and Use | Collapse of structure<br>Overturning of structure<br>Falling materials | **P x F x C = 288 = H** | • Ensure emergency procedures are in place and all operative are aware of the details<br>• Only use trained and competent operators for the erection and dismantling and use of cranes<br>• Ensure crane driver is trained and holds certification as proof. Must have valid medical certificate of fitness.<br>• Ensure there is safe means of access available at all times<br>• Ensure the mobile crane driver has 360° vision if not ensure a fully trained banksman is used<br>• Banksman to wear reflector vest to identify himself to the crane driver<br>• Ensure all personnel wear suitable and sufficient personal protective equipment<br>• Consider creating exclusion areas |

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 28. | Noise and Dust | Breathing in dust can cause long term health problems, noise can damage hearing | **P x F x C = 384 = H** | • Wear respiratory and hearing protection<br>• Dampen down and minimise dust where possible. |
| 29. | Overhead Services (Working near) | Contact with live services causing injury to personnel<br><br>Damage caused to services | **P x F x C = 96= M** | • Maintain safe clearance levels<br>• Establish presence of any services via proper walk through survey of site and/or means of service drawings<br>• Wear personal protective clothing<br>• Ensure height of plant/vehicles does not compromise or exceed clearance levels for overhead services<br>• Obtain information on clearance levels from service provider |
| 30. | Painting | Contact with paint | **P x F x C = 96 = M** | • Refer to safety data sheet for usage instructions, hazards and precautions required.<br>• When working at height, refer to risk assessment addressing this hazard below. |
| 31. | Paving (Laying) | Impact injuries from tile / mallet<br>Caustic burns<br>Sore knees<br>Cuts from cutter | **P x F x C = 96 = M** | • Impervious gloves to be worn/ barrier cream to be used<br>• Kneelers or similar to be available<br>• Personal protective equipment to be worn – for example if saw used to cut pavers |
| 32. | Piling | Falls<br>Struck by machines<br>Exposure to noise | **P x F x C = 192 = H** | • Personnel to be trained and competent, piling rig to be in safe condition and inspected on daily basis on register by competent person<br>• Empty piling holes not to be left unguarded<br>• Only approach piling plant on signal from operator<br>• Personnel to wear personal protective equipment such as ear plugs |
| 33. | Plant or Vehicles and Equipment Operation | Workers injured by passing traffic<br>Road users and pedestrians at risk from plant operation<br>Noise | **P x F x C = 640 = H** | • Implement traffic protection measures<br>• Trained and competent operators must be used<br>• Check plant and vehicles on daily basis before use and record inspections. Maintain vehicles in safe condition.<br>• Medical certificates of fitness required for construction plant.<br>• Crossing of road by construction vehicles or machines must be limited to the practical minimum<br>• Plant and vehicles must be fitted with amber rotating beacons and reverse alarms.<br>• Wear appropriate protective clothing/equipment, eg: goggles, gloves, ear defenders, etc as appropriate. |
| 34. | Plastering | Falling materials<br>Fall from height<br>Contact with materials | **P x F x C = 192 = H** | • Ensure standard safety procedures are followed<br>• Ensure there is a safe working area<br>• Ensure safe access and egress<br>• Ensure competent personnel are used |

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 35. | Plumbing | Falling material<br>Falling from height<br>Fire<br>Burns<br>Exposure to lead fumes | **P x F x C =<br>64 = M** | • Ensure standard safety procedures are followed at all times<br>• Only used trained and competent personnel<br>• Ensure there is a safe working area at all times<br>• Ensure materials are stored neatly<br>• Ensure there is safe access and egress at all times<br>• Ensure all personnel wear suitable and sufficient personal protective equipment<br>• Consider a hot works permit system prior to commencing any hot works<br>• Make sure emergency procedures are in place and ensure all personnel are aware of where to go in case of a fire |
| 36. | Precast Slab / Unit Laying and Fixing | Falls<br>Falling materials<br>Manual Handling | **P x F x C =<br>64 = M** | • Emergency procedures in place and personnel explained details<br>• Use competent personnel<br>• Ensure suitable and sufficient access and egress is provided<br>• Safe place of work must be provided<br>• Ensure all personnel wear correct personal protective equipment<br>• Exclusion zone may be required for protection against risk of falling objects |

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 37. | Site Establishment | Injuries during off loading<br>Damage to Property | **P x F x C = 64 = M** | • competent personnel to be used in offloading personnel<br>• unauthorised personnel to be kept away from area, use barriers and signage as necessary<br>• unloading and establishment to be under control of competent supervision<br>• all equipment and tools used for unloading and site establishment to be in good condition and maintained<br>• safe access and egress to be maintained, traffic management to be considered.<br>• All electrical equipment to be in safe condition<br>• Workers to use safe manual handling techniques when unloading/loading/lifting items |
| 38. | Scaffold Erection/ Dismantling | Personnel falling from a height<br>Items of scaffold falling onto personnel<br>Scaffold collapsing onto those below | **P x F x C = 640 = H** | • Ensure<br>• scaffold is designed to take the imposed loads<br>• scaffolding is constructed properly<br>• scaffold is not overloaded<br>• scaffolders are fully trained<br>• scaffolding is regularly checked by competent person and record of inspection retained. Written inspections to be recorded on weekly basis<br>• scaffolders must adhere to the safe systems of work.<br>• all fall arrest equipment to be checked and certified in good working order<br>• that ALL understand the safe system of work |
| 39. | Shuttering Walls, Beams, Columns | Falling from height<br>Falling materials from height<br>Cuts and abrasions from splinters and nails | **P x F x C = 640 = H** | • Ensure all personnel wear the appropriate Personal Protective Equipment<br>• Ensure at all times there is a safe working platform<br>• Use only trained and competent personnel<br>• If electrical tools are being used ensure they have been tested and safe to use<br>• Ensure timber is de-nailed after use<br>• Ensure safety standards are followed at all times<br>• Ensure there is a safe means of access and egress at all times |
| 40. | Site Strip | Overturning Vehicles | **P x F x C = 64 = M** | • Follow standard safety procedures<br>• Only use trained and competent personnel<br>• Ensure there is a suitable and safe means of access and egress<br>• Ensure banksman used when required<br>• Ensure all personnel wear suitable reflector vests as required |

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 41. | Snakes | Snake bite | **P x F x C = 64 = M** | • Qualified first aider required for site who can treat snakebite<br>• Snake bite kit to be on hand<br>• Check area before working<br>• Find out nearest hospital and get emergency telephone numbers. |
| 42. | Steel Erection | Falls from height<br>Falling components<br>Contact injuries from falling lifting equipment | **P x F x C = 640 = H** | • Adhere to all general precautions for working at height (See risk assessment below)<br>• Barrier off / exclude area below work<br>• All lifting appliances to be examined and inspected<br>• Inspection register in place and up to date<br>• All personnel to be trained and competent and wear clipped on safety harnessed when working at height<br>• Ensure that lifting equipment (slings, chains, shackles) test certificates are current and on site.<br>• Competent persons only to connect loads and direct plant |
| 43. | Steel Fixing | Back injuries caused by manual handling<br>Eye injuries from tie wire<br>Trips / falls<br>Falling form height | **P x F x C = 640 = H** | • PPE must include safety boots and goggles<br>• Manual handling training may be required<br>• Care to be taken when working near over head lines<br>• Use only trained personnel<br>• Provide safe means of access<br>• Maintain and regularly inspect all lifting appliances and equipment<br>• Cap starter bars to prevent injuries where feasible<br>• Construct scaffold walk ways to cross reinforcing mesh, as required |
| 44. | Temporary Works – shoring, scaffold, falsework, formwork | Collapse of form work | **P x F x C = 640 = H** | • Wear personal protective equipment such as gloves and goggles<br>• Formwork must be built by trained person and also be inspected by competent person and results entered into register on site |
| 45. | Tower Crane and Mobile Crane Erection and Dismantling and Use | Collapse of structure<br>Overturning of structure<br>Falling materials | **P x F x C = 640 = H** | • Ensure emergency procedures are in place and all operative are aware of the details<br>• Only use trained and competent operators for the erection and dismantling and use of cranes<br>• Ensure crane driver is trained and holds certification as proof. Must have valid medical certificate of fitness.<br>• Ensure there is safe means of access available at all times<br>• Ensure the mobile crane driver has 360° vision if not ensure a fully trained banksman is used<br>• Banksman to wear reflector vest to identify himself to the crane driver<br>• Ensure all personnel wear suitable and sufficient personal protective equipment<br>• Consider creating exclusion areas |
| 46. | Tunnelling | Entrapment and suffocation<br>Claustrophobia | **P x F x C = 640 = H** | • No persons may enter a tunnel, which has a height dimension of less than 800 millimetres. |

| | HAZARD | RISK | RISK RATING (High / Medium / Low) | MINIMUM CONTROL MEASURES |
|---|---|---|---|---|
| 47. | Underground Services | Striking of buried services | **P x F x C = 216 = H** | • Make all necessary enquiries to establish what services are in the area. Consult drawings and advice from service provider (eg: Municipality or ESKOM) when planning work.<br>• Assume all service to be live (Unless confirmation is received to confirm that services are isolated or otherwise made safe). Do not work near live services without authorisation from site management.<br>• Comply with the requirements of the safe system of work for underground services.<br>• Where available, locate services with a locator<br>• Hand dig around services |
| 48. | Underpinning | Falling Materials | **P x F x C = 216 = H** | • Emergency procedures to be in place and explained to personnel<br>• Only used trained personnel<br>• Ensure there is a safe means of access and egress<br>• Ensure design has been approved by designer before underpinning begins<br>• Ensure all personnel wear suitable and sufficient personal protective equipment<br>• Ensure standard safety procedures are followed |
| 49. | Working at Height | Personnel falling form height<br>Falling debris<br>Those beneath being injured | **P x F x C = 800 = H** | • All access equipment is properly constructed (inspections record must be maintained)<br>• Only trained personnel construct, dismantle or control the access equipment<br>• All access equipment must have full toe boards and guardrails - comply with SANS 10085 on erection, use and dismantling of scaffolding<br>• No access equipment may be loaded above the level of the guardrail<br>• No access equipment to be loaded above its safe working load<br>• Where work involves leaning out on an open leading edge, then all personnel are to be fitted with full body harness. The harness must be connected at all times<br>• All fall arrest equipment to be correctly maintained<br>• Ensure if ladders are being used for access, they are either footed or tied. Also the ladder must be set at the correct level of 1 in 4 or approximately 75° |
| 50. | Work over or next to Water | Drowning | **P x F x C = 216 = H** | • Evaluate depth of water, height above water that work takes place, whether workers can swim or not and then determine safety precautions required: these may include such measures such as barriers, signage, life belts, safety harnesses, etc<br>• When working on river/harbour/dam edge - erect life saving devices and barriers to protect workers and vehicles (stop blocks may also be required). Only trained and competent persons to be used. |

**ISSUE REGISTER**

| Date of Original Safety Specification Compilation | Compiled By | Issue Date | Revision Date |
|---|---|---|---|
| 27 September 2017 | Jayesh Bhana | 27 September 2017 | |
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**Acknowledgement:**

I, _____representing

_____(Contractor), have satisfied myself with the content of this Health and Safety Specification and shall ensure that our employees and contractors on site comply with the requirements of this document, our safety documentation and health and safety legislation.

_____ _____

Signature of Contractor Date

**Comments:**

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# DRAFT ENVIRONMENTAL MANAGEMENT PROGRAMME

## AMATHOLE DISTRICT MUNICIPALITY:

## PROPOSED BUTTERWORTH EMERGENCY WATER SUPPLY SCHEME - NGQAMAKWE REGIONAL WATER SUPPLY PHASE 5,

## EASTERN CAPE

**Prepared for: Aurecon on behalf of the Amathole District Municipality**

**J2017_11**

**JULY 2017**

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# ENVIRONMENTAL MANAGEMENT PROGRAMME
# PROPOSED BUTTERWORTH EMERGENCY BULK WATER SUPPLY PROJECT, EASTERN CAPE
# CONTENTS

# 1 INTRODUCTION

## 1.1 Background Information

Indwe Environmental Consulting CC was appointed by Aurecon on behalf of Amathole District Municipality (ADM) to prepare an Environmental Management Programme (EMPr) for the proposed Butterworth Emergency Bulk Water Supply Project, Eastern Cape.

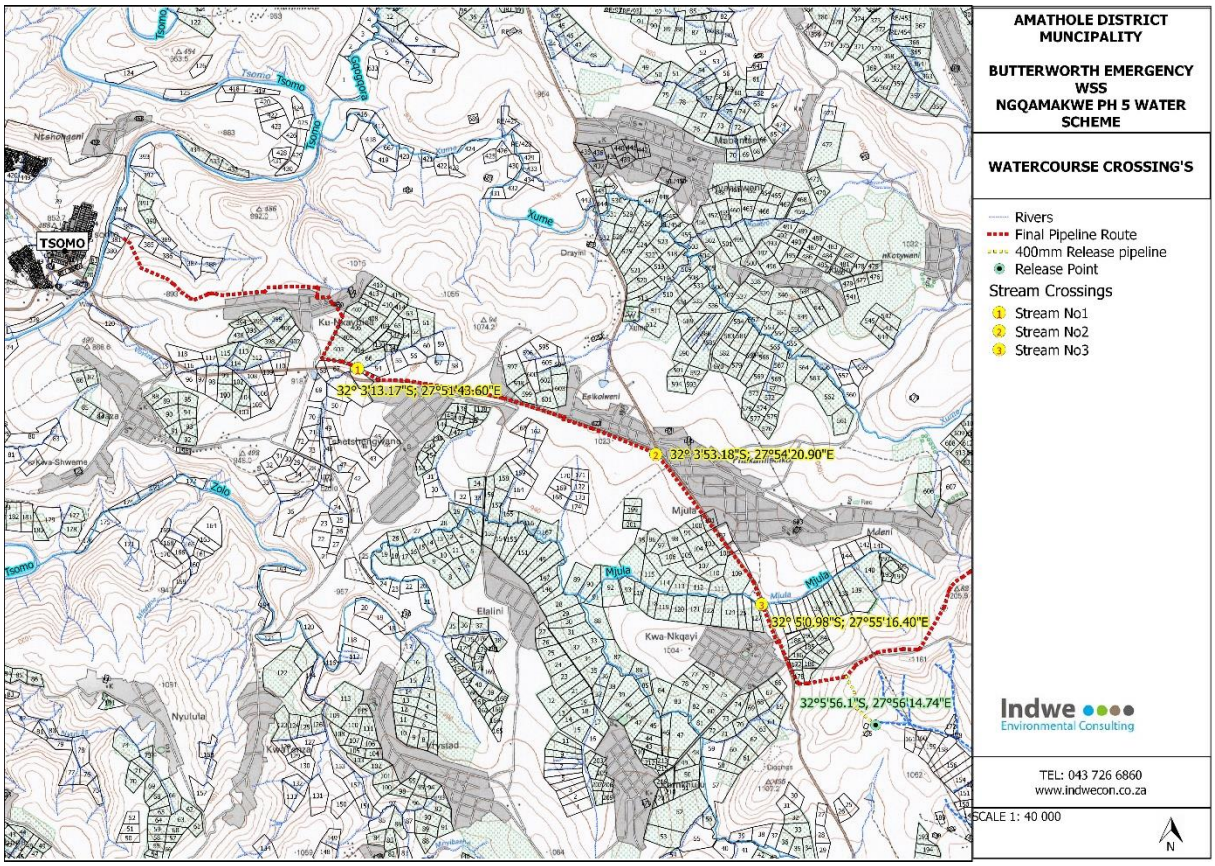


**Figure 1: Topographical view illustrating locality of the study area.**

## 1.2 Project Description

The Butterworth Drought Relief Project proposals include:

a) The construction of approximately 16km of a water supply pipeline from the Tsomo River to the upper Xilinka River, which flows into the Xilinka Dam;

b) The construction of a 7ML Reservoir on a high ridge upslope of the Xilinka River catchment;

c) The proposed release of between 130 l/s and 300 l/s of raw water pumped from the Tsomo River into the upper tributaries of the Xilinka River.

## 1.3 General Environmental Principles

The following principles should be considered at all times during the implementation of this project:

1. The Environment is considered to be composed of both biophysical and social components.
2. Minimisation of areas disturbed by construction and trench digging activities (i.e. the footprint of the construction and trench area) should minimise many of the related environmental impacts of the project and reduce rehabilitation requirements and costs.
3. As minimum requirements, all relevant standards relating to international, national, provincial and local legislation, as applicable, shall be adhered to. This includes the following legislation which can, inter alia, have an effect on construction activities or the environment. This list is not necessarily complete and the onus shall remain on the Contractor to ensure that all relevant legislation is conformed with.
    - National Environmental Management Act (No. 107 of 1998).
    - National Water Act (No 36 of 1998).
    - National Heritage Resources Act (No. 25 of 1999).
    - National Environmental Management: Biodiversity Act (No. 10 of 2004).
    - Mineral and Petroleum Resources Development Act (Act 28 of 2002).
    - Occupational Health & Safety Act (No.85 of 1993).
    - All relevant provincial legislation, Municipal by-laws and ordinances.
4. The crossing of any stream bed, flowing stream or river requires a license from the Department of Water and Sanitation. The Consulting Engineer shall be responsible for obtaining such approvals prior to any work commencing on site.
5. Every effort should be made to minimise, reclaim and/or recycle “waste” material.
6. The Environment is held in public trust for the benefit of people, due care must therefore be exercised to ensure that the rights of others with respect to its use are respected. This requires that a risk averse and cautious approach to the management of activities associated with the project be adopted at all times.

# 2 ROLES AND RESPONSIBILITIES

## 2.1 Project Proponent (ADM)

The Proponent will be responsible for:

1. Appointment of a Consulting Engineer (CE) to oversee the implementation of the works.
2. Appointment of an Environmental Control Officer (ECO).
3. Being familiar with the contents of the EMP.
4. Making sufficient budget available for implementation of the EMP including a provisional sum for additional environmental protection measures that may be necessary as construction and rehabilitation proceeds.
5. Supporting the Consulting Engineer in enforcing the Environmental Specifications.
6. Communicating with all role players in the interests of a co-ordinated effort to protect the environment.
7. Implement and take responsibility for those specifications relating to the operational phase of the project.

## 2.2 Consulting Engineer (Aurecon)

The Consulting Engineer (CE) is required to:

1. Ensure that Contractors are aware of and familiar with the contents of the EMP.
2. Be familiar with the contents of the EMP.
3. Ensure that all permits, authorisations and associated conditions regarding site establishment and construction activities are in place.
4. Assist with monitoring the Contractor's compliance to the specifications contained within this document and enforce compliance when deemed necessary.
5. Together with the ECO, review and approve method statements received from the Contractor.
6. Issue site instructions giving effect to the ECO requirements contained in audit reports.
7. Discuss with the ECO the application of any penalties and other possible enforcement measures when necessary.
8. Facilitate communication between all role-players in the interest of effective Environmental Management.

## 2.3 Contractor (Main Contractor)

The Contractor is required to:

1. Be familiar and comply with the contents of this EMP.
2. Compile an environmental site file and keep accurate and detailed records of all activities on site.

3. Regularly conduct environmental awareness training amongst all site personnel.
4. Prepare method statements and obtain approval from the CE and ECO for all work that will take place in environmentally sensitive areas.
5. Report all incidences of non-compliance with the content of the EMP to the ECO.
6. Timeously implement mitigation measures for non-compliances identified in previous audit reports.
7. Ensure that all subcontractors are aware of the requirements of the EMP.

## 2.4 Environmental Control Officer

The ECO is responsible for:

1. Conducting an induction session with the Consulting Engineer and main Contractor on the content and requirements of the EMP.
2. Confirming that all permits required in terms of the applicable legislation have been obtained by the contractor prior to construction commencing.
3. Undertaking regular site inspections to ensure that the provisions contained within this EMP are complied with throughout the construction period.
4. Undertaking periodic audits to measure the Contractors compliance with the provisions of the EMP and distribute these reports to the relevant parties.
5. Keeping a photographic record of progress on site from an environmental perspective.
6. Checking that the required actions are/were undertaken to mitigate the impacts resulting from non-compliance identified in previous site inspections and compliance audits.
7. Monitoring the Contractors environmental awareness training for all personnel on site.
8. Reviewing and approving construction method statements in conjunction with the Engineer prior to work commencing.
9. Undertaking a detailed close out post construction compliance audit and distribute these reports to the relevant parties.

# 3 ENVIRONMENTAL SPECIFICATIONS – ADMINISTRATION

## 3.1 Environmental Site File

The Main Contractor is to maintain an environmental site file which must contain the following:

1. A copy of this EMP.
2. All relevant authorisations, permits and licences.
3. Records of attendance and proof of on-going environmental awareness training of all personnel.
4. An emergency incidence registers.
5. A register of public complaints.
6. A copy of all previous site inspection and audit reports.
7. A copy of all relevant correspondence of an environmental nature.
8. Any other information of environmental importance.

The environmental file must be kept on site and made available to any authority that requests to review its contents.

## 3.2 Environmental Induction & Training

1. Before construction commences the ECO must coordinate an induction session with the Main Contractor. The ECO must brief the contractor on the specifications contained within the environmental management programme as well as all conditions of authorisation.
2. The Contractor shall be responsible for conducting regular toolbox talks with all employees in order to ensure that they have the necessary knowledge to comply with the specifications contained in this EMP.
3. Copies of all attendance registers as proof of training must be kept in the site environmental file.

## 3.3 Method Statements

1. Work in environmentally sensitive areas (areas of indigenous bush, watercourses, wetlands, etc.) will require method statements that reflect the manner in which the Contractor intends to protect the environment while conducting construction work within the area.
2. Any other aspect of environmental management may require a method statement (i.e. waste disposal, concrete batching, etc.). This especially applies where there is a deviation from the EMP specifications.
3. These method statements are required 7 days prior to any work commencing within sensitive areas, and then the work may only start once the method statements have been approved by the CE and ECO.

# 4 ENVIRONMENTAL SPECIFICATIONS – SITE CAMP

## 4.1 Site Camp Establishment and Management

The following guidelines must be adhered to for site camp establishment and operation:

1. The Contractor shall ensure that the site camp is located in a manner that does not adversely affect the environment and which is easily accessible. (At least 100m away from watercourses/sensitive environments).
2. Prior to site camp establishment, the Contractor must supply the ECO with a layout plan demarcating the location and physical extent of the site camp including access road, offices, workshops, laydown areas, topsoil stockpile areas, etc.
3. This plan must be approved by the ECO prior to any clearing taking place.
4. The Contractor must erect a fence around the site camp and install lockable gates at the entrance.
5. The Contractor is to provide sufficient information and emergency signage at the entrance as well as within the site camp.
6. Topsoil must be removed and stockpiled from all areas within the site camp that will be used for storage purposes (i.e. sand & stone, pipeline sections, diesel bund, containers etc.).
7. Topsoil must be stockpiled in such a manner and in such a place that it will not cause damming of water or lead to erosion.
8. The site camp must be maintained in a clean orderly and presentable condition at all times.

## 4.2 Solid Waste Management

1. The Contractor shall provide sufficient weather and scavenger proof waste bins within the site camp.
2. Litter within the site camp must be picked up on a daily basis.
3. Recycling and waste minimisation practices must be encouraged i.e. separate skips should be available for different recyclable waste.
4. All waste bins shall be regularly emptied and the accumulated waste disposed of at an appropriately permitted waste disposal site. The contractor is to keep documented proof of waste disposal.
5. The burning or burying of any waste within the site camp is strictly prohibited.

## 4.3 Hazardous Materials, Fuel and Waste Management

1. All hazardous material must be stored at a dedicated hazardous waste container/containment area.
2. The hazardous waste container/containment area must be maintained in a clean orderly and presentable condition at all times.
3. Diesel storage tanks shall be bunded with a 110% storage volume and the bund is to be fitted with a drainage control valve.

4. The contractor will be required to conduct all servicing of machines and equipment within a designated area within the site camp.
5. The Contractor shall ensure that there are adequate facilities for the handling and storage of used parts, oils, grease, cleaning fluids and fuels.
6. Drip trays are to be placed under plant and vehicles that are parked overnight and must be available for use at the servicing area. The disposal of the contents of drip trays is to be in accordance with relevant hazardous materials disposal requirements.
7. Hazardous material spill kits must be kept within the site camp and be accessible at all times.
8. Hazardous material spills are to be avoided as far as is practically possible. Where spills occur compromised soil/vegetation should be removed and disposed of in a hazardous waste drum.
9. The Contractor is to record all hazardous material spills in the emergency incidence register.
10. All collected and stored hazardous waste must be disposed of at a registered waste handling facility for toxic/hazardous materials/chemicals.
11. Receipts from such sites must be kept in the environmental file.

### 4.4 Sanitation/Ablutions

1. Adequate toilet facilities for men and women are to be provided for at the site camp.
2. These toilets are to be maintained and serviced by a reputable service provider.
3. Receipts from the service provider must be kept in the environmental file.

### 4.5 Close Out of Site Camp

1. All structures comprising the construction camp are to be removed from site.
2. The area that previously housed the construction camp is to be checked for spills of substances such as oil, paint, etc., and these shall be cleaned up and contaminants disposed of appropriately.
3. All hardened surfaces within the construction camp area should be ripped, all imported materials removed, and the area shall be top soiled and regressed.

# 5 ENVIRONMENTAL SPECIFICATIONS - WORK AREAS

## 5.1 No-Go Areas

1. No-Go Areas are defined as sensitive areas which have aesthetic, historical and/or environmental value, such as indigenous bush/grassland, watercourses, riparian vegetation, historical buildings and grave sites.
2. The ECO is required to assist with the identification of no-go areas that require demarcation.
3. Prior to trench digging and installation activities taking place, the Contractor must clearly demarcate no-go areas.
4. No construction personnel are permitted to access or disturb no-go areas either on foot or in vehicles.
5. Construction personnel may not damage or collect plants within no-go areas including the use of indigenous wood for fire making
6. Construction personnel may not disturb or poach fauna within no-go areas.
7. Practical steps should be taken to protect all streams, drainage lines and wetland areas within the no-go areas from direct or indirect spillage of pollutants (i.e. refuse, garbage, cement, concrete, sewage, chemicals, fuels, oils, aggregate, construction water, etc.).
8. Work within watercourses should be completed timeously and preferably be undertaken when water levels are low.

## 5.2 Vegetation and Flora Clearing and Relocation Plan

1. Once the final planting plan has been determined the botanist will be consulted in order to finalise the plant relocation and vegetation clearing plan.
2. Areas to be cleared of vegetation will be clearly demarcated before clearing commences.
3. Flora search and rescue is to be conducted before vegetation clearing takes place.
4. Plants to be rescued should include both species of special concern requiring removal for relocation as well as species that would be suitable for use in rehabilitation and that are amenable to transplanting.
5. Areas should only be stripped of vegetation as and when required and in particular once species of special concern have been relocated for that area.
6. Once site boundaries are demarcated, the area to be cleared of vegetation will be surveyed by the vegetation and plant search and rescue team clearing under the supervision of the botanist to identify and remove species suitable for rescue and commence removal of plants.
7. Depending on growth form this material should be appropriately removed from its locality and immediately relocated where it may be required elsewhere or into adjacent areas of similar habitat that will not be disturbed by construction.
8. Small trees and shrubs (<1 m in height), where possible will be rescued and planted temporarily in potting bags for later use.

9. Arboreal species (orchids), if identified, will be collected attached to the substrate (i.e. branch) they are growing on and stored (hung) in a moist, lightly shaded area for later relocation or relocated immediately into a similar environment.
10. Wherever possible, any seed-bearing material will be collected immediately and stored for later use, particularly species that occur in low numbers or those that will be well-suited for rehabilitation.
11. Protected plant species will be removed from the site prior to development taking place. A suitable timeframe must be allowed before construction commences (1 month) to undertake the plant rescue and relocation operation. Search and Rescue is best undertaken during Spring/Summer.
12. Should site construction occur in a phased manner, then clearing activities should take place also in a phased manner, ahead of construction work.
13. Rescued plants will be replanted directly into a suitable adjacent area, and will include some non-protected succulent species that will help support the protected species.
14. Succulent species can be temporarily stored for no more than 2 weeks in a suitable area before replanting. The contractor will be responsible for periodic watering of the replanted flora until such time as they become acclimatised and some rain occurs.

### 5.3 Fire

1. The lighting of fires is strictly forbidden.
2. Smoking may only take place in areas that have been cleared of their vegetation.
3. Care must be taken to ensure that completed cigarettes are correctly extinguished.

### 5.4 Cultural and Heritage Areas

These guidelines apply to all areas within the project site at which heritage resources are discovered (e.g. buildings older than 60 years, burial sites, archaeological and paleontological artefacts).

1 Buildings older than 60 years must be respected and may not be disturbed or defaced through construction related activities. Adequate signage demarcating these areas as no-go areas must be erected.

2 All graves sites are to be respected and a minimum distance of 10 metres should be maintained between trenching/construction areas and any ancestral graves. If the distance between a grave and a construction area is less than 10 metres, the grave requires clear demarcation with barrier tape or similar material for the duration of construction.

3 In the event of a grave being disturbed, or artefacts being uncovered, work is to stop immediately and the area must be secured, under no circumstances is the site to be covered over or efforts made to remove or relocate the remains or the artefacts

4 Work at the point of the discovery is to cease, and may not recommence until such time as guidance from the ECO has been received. The point of discovery is to be clearly demarcated and no unauthorised entry should be permitted.

5 The ECO is to contact the national/provincial heritage agency or a suitably qualified and recognised specialist for guidance on the way forward.

6 The recommendations of any heritage permit must be implemented.

### 5.5 Work with Watercourses

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1. No excavation is permitted within watercourses.
2. By definition a "**watercourse**" means -

   (a) a river or spring;

   (b) a natural channel in which water flows regularly or intermittently;

   (c) a wetland, pan, lake or dam into which, or from which, water flows; and any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse as defined in the National Water Act, 1998(Act No. 36 of 1998); and a reference to a watercourse includes, where relevant, its bed and banks.

   ``**riparian habitat**'' includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.
3. Operation activities & storage of equipment in the riparian zone to be prevented as far as possible.
4. Where applicable, disturbed riparian zones (i.e. for those areas that will not form part of the operational footprint but that were disturbed as part of the construction activities) should be re-vegetated using site-appropriate indigenous vegetation.
5. Alien invasive vegetation must be eradicated and not be allowed to colonize the disturbed riparian and in-stream areas.
6. Rehabilitation of disturbed riparian zone must occur during and after completion of construction. An aquatic ecologist must oversee this process.
7. Construction camps must be at least 100m from the edge of the riparian zone.
8. Toilet facilities must be located at least 100m from the edge of the riparian zone.
9. No harvesting of indigenous plants and animals in and adjacent to the construction area.
10. No stockpile areas should be located within 100m from the edge of the riparian zone.
11. Slope/bank stabilization measures must be implemented where necessary, to prevent erosion during the construction and operational phases.
12. The use of machinery within the riparian zone may lead to compaction of soils & vegetation. This will lead to decreases of infiltration of rain water, increases in run-off water and will limit re-vegetation from taking place. It is thus recommended that all compacted areas that do not form part of the footprint activity be ploughed, landscaped to approximate the natural slope of the area and aerated followed by re-vegetation.
13. Methods used during construction of infrastructure must limit turbidity, sedimentation and chemical changes to the composition of the water.

14. Any disturbance to the riparian zone that can cause undercutting and/or bank slumping must be prevented. Disturbed areas should be rehabilitated.
15. All reasonable steps must be made to maintain the wilderness qualities of the river. In particular, visual impacts as seen from a boat in the river should be minimized.
16. All reasonable steps must be made to minimize noise and mechanical vibrations in the vicinity of the river.

### 5.6 External Site Access and Traffic Control

1. The Contractor shall be responsible for protecting the public from anything dangerous to persons or property and for the safe and easy passage of pedestrians, vehicular traffic and rail traffic in those areas affected by the works.
2. Heavy vehicle signs within the specifications of the relevant traffic ordinance should be erected at all work areas/construction sites.
3. All drivers of construction vehicles must maintain reasonable speeds at all times in order to avoid accidents, excessive noise and dust.
4. In the event that the access roads are damaged through construction related activities the contractor will be responsible for repairing the damage.
5. All roads in the surrounding area of the construction activities are to remain accessible to other users.
6. Construction personal will not be allowed to move on any other road or track, other than the established access roads.
7. The contractor is to provide a method statement to the ECO which at a minimum must outline where the access roads will be located with specifications of the track and how it will be rehabilitated.

### 5.7 Construction and Development Footprint

1. Prior to work commencing, the contractor must supply the ECO with a layout plan demarcating the location and physical extent of trenching and construction works.
2. This plan must be approved by the ECO prior to any clearing taking place.
3. In order to avoid unnecessary disturbance all work areas must be clearly demarcated and work is to be limited to within these work areas.
4. For trenches the extent of the working area must be limited to 5 meters in total (2.5 meters on either side).
5. Construction vehicles may only be permitted and managed within the demarcated working areas or on existing roads. No-Go areas are to be strictly avoided.

### 5.8 Vegetation Clearing

1. In order to avoid unnecessary disturbance, vegetation clearing must be strictly contained to work areas.
2. For trenching activities, the topsoil layer containing vegetation must be removed and separately stockpiled. This vegetation must be replanted after the trench has been backfilled

3. In the event that protected vegetation needs to be cleared, the contractor must obtain the necessary permits prior to clearing taking place.

## 5.9 Topsoil Management

1. All removed topsoil must be stockpiled in such a manner and in such a place that it will not cause damming of water.
2. All topsoil stockpiles must be protected against wind/soil erosion as well as weeds.
3. Non-woody vegetation such as grasses and forbs should not be removed prior to stripping topsoil from work areas in order to assist in maintaining viability of the soil during storage.
4. Compaction of the topsoil by, inter alia, driving over it is not permitted.
5. Topsoil stockpiles should not exceed 2 m in height.
6. Topsoil stockpiles should not be located within any of the No-Go areas.
7. Under no circumstances is stockpiled topsoil to be mixed with any other material (e.g. spoil and building rubble).
8. All topsoil stockpiles should be dampened during dry conditions in order to prevent excessive dust.
9. Once construction activities have been completed in areas in which topsoil was removed. The stockpiled soil should be immediately replaced and used for the rehabilitation of the site.

## 5.10 Erosion Management

1. The Contractor is responsible for monitoring all areas at which construction related activities for evidence of rill/sheet erosion.
2. In the event that soil erosion does occur, each case should be managed in as practicable way as possible.
3. All areas along streams and drainage lines that could be impacted upon through trenching and construction activities should be protected against soil erosion.
4. Re-vegetation of disturbed surfaces should occur immediately after the construction activities are completed.
5. In the event of failure to implement timeous erosion control measures the contractor shall be held financially responsible for the necessary rehabilitation.

## 5.11 Wet Works/Concrete Mixing

1. All gravel, sand and stone used during construction must be obtained from a bona fide source.
2. Cement/concrete mixing must take place on an appropriately lined or impermeable surface within the construction footprint.
3. Water contaminated with cement shall not be allowed to enter any natural watercourse or drainage line.
4. Construction waste (i.e. cement bags, litter) must be cleaned up on a daily basis and appropriately disposed of.

5. All remaining construction rubble (i.e. concrete spoil, bricks, gravel, sand and stone) must be neatly stockpiled, collected and appropriately disposed of at a spoil site or permitted waste disposal site.

### 5.12 Trenching

1. In order to avoid unnecessary disturbance, trench work areas must be clearly demarcated and work is to be limited to within these work areas.
2. The extent of the working area must be limited to 5 meters in total (2.5 meters on either side).
3. Topsoil must be excavated to the base of the A-horizon or 150 mm whichever is greater, and appropriately stockpiled for later use in rehabilitation. Care must be taken not to mix topsoil with subsoil and spoil material.
4. Construction vehicles may only be permitted and managed within the demarcated trench working areas or on existing roads. No-Go areas as well as areas zoned as Open Space are to be strictly avoided.
5. Unless otherwise permitted, not more than 750 m of trench per pipe laying gang shall be open at any time.
6. Open trench" includes the period from initial removal of topsoil to replacement of topsoil after backfilling.
7. The testing of pipelines and backfilling of trenches (including topsoil) shall be completed for each section of pipeline without delay.
8. Any work that is authorised to take place through wetlands and streams shall not commence until the Contractor confirms that all the material is on site and that work can commence and be completed with the available material.
9. Once work begins in these areas (wetland or stream) open trench time shall not exceed 14 days from the start date to rehabilitation unless a full motivation is submitted within the 14 day construction period, and that the delay relates to construction issues and not material or equipment.
10. Failure to complete work in sensitive areas within the allocated time will result in daily penalties until the work is completed.
11. Adequate warning demarcation measures along all open trenches must be implemented.
12. Topsoil and associated vegetation must be the final layer that is replaced during the backfilling of trenches.
13. The topsoil layer must be lightly compacted and finished by hand using rakes. The use of vehicles to compact topsoil is strictly forbidden.
14. Care must be taken to ensure that the finished surface has a slight camber and is not below the surrounding ground level.

15. Care must be taken to ensure that all reinstated trenches merge with the immediate environment and that any negative visual impacts will be rectified to the satisfaction of the ECO.

### 5.13 Public Protection

1. The Contractor shall be responsible for protecting the public from anything dangerous to persons or property and for the safe and easy passage of pedestrians and vehicular traffic in those areas affected by the Works.
2. Any excavation, material dumps, spoil dumps or other obstructions likely to cause injury to any persons or thing shall be suitably barricaded.
3. The Contractor's staff shall in no way be a nuisance to residents in the vicinity of construction activities. Any work in public places shall be adequately barricaded and steps shall be taken to minimise the disruptive effects of construction
4. Any complaints received by the Engineer will be addressed and the relevant persons will face suspension from the project.

### 5.14 Existing Services

1. The Contractor shall ensure that existing services, (i.e. road, pipelines, power lines and telephone services) are not damaged or disrupted unless required by the Contract and then they shall only take place with the permission of the Engineer.
2. The Contractor will be responsible for the repair and reinstatement of any existing infrastructure that is damaged or services which are interrupted.
3. Such repair or reinstatement will be to the Contractor's cost, and shall receive top priority over all other activities. A time limit may be stipulated by the Consulting Engineer.

### 5.15 Dust Control

1. The Contractor is responsible for controlling nuisance dust that is created through construction and installation activities.
2. Control of dust may involve spraying with water. The quantities of water used should not be large enough or applied with sufficient force to generate run off which could result in soil erosion.

### 5.16 Noise Control

1. Noise levels are to be kept within reasonable norms as determined by the CE, taking into account the context of the site location.
2. Silencers on all machinery and vehicles shall be well maintained.
3. The Contractor shall inform residents of any excessive noise that is anticipated due to construction activities, for example blasting for excavation. This notice shall be given at least 3 days before the event generating higher noise levels.
4. All work that needs to be undertaken in the vicinity of private residences or public places should be carried out at between 07:00 and 17:00.

### 5.17 Solid Waste Management

1. The Contractor shall provide sufficient waste bins at work areas.
2. Litter at work areas must be picked up on a daily basis.
3. All waste bins shall be regularly emptied and the accumulated waste disposed of at an appropriately permitted waste disposal site. The contractor is to keep documented proof of waste disposal.
4. The burning or burying of any waste at work areas is strictly prohibited.

### 5.18 Hazardous Waste Management

1. Drip trays are to be placed under plant and vehicles that are parked overnight. The disposal of the contents of drip trays is to be in accordance with relevant hazardous materials disposal requirements.
2. Hazardous material spills are to be avoided as far as is practically possible. Where spills occur compromised soil/vegetation should be removed and disposed of in a hazardous waste drum.
3. The Contractor is to record all hazardous material spills in the emergency incidence register.
4. All collected and stored hazardous waste must be disposed of at a registered waste handling facility for toxic/hazardous materials/chemicals.
5. Receipts from such sites must be kept in the environmental file.

### 5.19 Sanitation

1. Adequate toilet facilities for men and women are to be provided for at work areas.
2. These toilets are to be maintained and serviced by a reputable service provider.
3. Receipts from the service provider must be kept in the environmental file.

### 5.20 Rehabilitation & Landscaping

1. All areas that were cleared or disturbed during construction activities must be rehabilitated to an appropriately vegetated state. Care must be taken to ensure that these rehabilitated areas merge with the immediate environment.
2. Anti-erosion measures must be put in place to prevent soil loss from rehabilitated areas.
3. Complete rehabilitation of all work areas will be required to return the site to its former condition. This will include removal of all cement sludge, waste concrete, builders refuse, etc., ripping of compacted surfaces to loosen soil, replacement of topsoil and re-grassing.

# 6 COMPLIANCE

## 6.1 Work Stoppage

1. Through the CE the ECO shall have the right to order work to be stopped in the event of significant infringements of the Project Environmental Specifications, until the situation is rectified in compliance with the specifications. In the event of this happening the Contractor shall not be entitled to claim for delays.
2. Penalties may be inflicted for repeated non-compliances.

## 6.2 Monitoring and Auditing

1. The project proponent must appoint a suitably qualified (Environmental Qualification) individual to be assigned as the Environmental Control Officer.
2. The ECO must visit the construction site in order to monitor the Contractor's performance in relation to the Environmental Specifications on at least a monthly basis.
3. After each inspection a report will be prepared for the Client and incorporated into the monthly site meeting minutes. The ECO must record any issues of non-compliance, and recommend corrective actions and action on these recommendations. These are to be submitted to the Project Proponent, Consulting Engineer and lead Contractor.
4. The ECO is to make recommendations to the CE in order for the contractor to achieve compliance (corrective actions).
5. During site visits the ECO is to look out for any other incidental environmental issues not covered by this EMP.
6. Quarterly throughout the contract the Environmental Control Officer (ECO) will conduct audits of the site and compile an audit report which will be submitted to the Consulting Engineer and Contractor.
7. The ECO must undertake a detailed post construction compliance audit after completion of the relevant phase. This audit report should be submitted to the Proponent, Consulting Engineer and Contractor.

# 7 DETAILS OF AUTHORS

In accordance with regulation 33 of GN R 982 of the NEMA EIA Regulations, 2014, an EMP is required to contain the details and expertise of the persons who prepared the EMP.

## 7.1 Indwe Environmental Consulting

Indwe Environmental Consulting CC is a registered environmental consultancy that specialises in all facets of environmental management. Our focus is on project based environmental studies. Broadly, the services offered are Basic Assessments, full Scoping and Environmental Impact Assessments; Strategic Environmental studies (State of the Environment Reporting, Strategic Environmental Assessments, Environmental Management Frameworks) and integrated waste management planning. Through strategic partnerships with other emerging consultancies we offer specialist environmental services throughout the Eastern Cape and abroad.

## 7.2 Expertise

**Brendon Steytler -** is the principal member of Indwe Environmental Consulting CC. Mr Steytler is a professionally registered Environmental Scientist (Pr.Sci.Nat. No. 400304/06) and holds a Master's Degree in Environment and Development. He has been involved in many diverse EIA's and other environmental studies within the Eastern Cape over the last 12 years.

**Nikita Steele -** is currently employed at Indwe Environmental Consulting as an Environmental Consultant. Nikita holds a Master's Degree in Marine Biology with experience in Wildlife Ecology and Environmental Consulting and is a Registered Certificated Environmental Scientist with the South African Council for Natural Scientific Professions.

| **QUALITY CONTROL** | | |
|---|---|---|
| **COMPILED BY:** | **REVIEWED BY:** | **AUTHORISED BY:** |
| Nikita Steele | Brendon Steytler | Brendon Steytler |
| **ROLE:** | **ROLE:** | **ROLE:** |
| Environmental Consultant | Director | Director |
| **DATE:** | **DATE:** | **DATE:** |
| 19/07/2017 | 24/07/2017 | 24/07/2017 |

# PARTICULAR SPECIFICATIONS

# PD BUILDING WORK

**CONTENTS**



## PD 01 SCOPE

This is a Particular Specification and covers the various construction activities associated with the erection of buildings which form part of this Contract.

Building work shall be carried out in accordance with the National Building Regulations, SANS 10400, the applicable clauses of the SANS Standardized Specifications and the information contained in this Specification.

Work appurtenant to the erection of buildings such as earthworks, concrete work, structural steelwork, etc shall be carried out as specified in the appropriate Standardized Specifications and will be measured and paid for under those Specifications.

## PD 02 BRICKWORK, PLASTER WORK AND FLOOR SCREEDS

### PD 02.1 MATERIALS

(a) Bricks

Bricks shall comply with SANS 227 and shall be of the class scheduled or shown on the drawings.

Satisfactory proof of the load-bearing capacity of the bricks offered shall be submitted before deliveries are made to the site.

Air bricks shall be well-burnt terracotta and shall be free from cracks and blemishes and lined with copper mosquito gauze.

Three samples of each type of brick shall be submitted to the Engineer for approval. All subsequent deliveries shall be of a standard equal to or better than that of the approved samples.

(b) Cement

Cement shall comply with the requirements of SANS 50196, 50197 and SANS 50413 and shall be stored under cover. The use of Portland blast-furnace cement (PBFC) which complies with the requirements of SANS 50197 will only be allowed if approved by the Engineer.

(c) Aggregate

Fine aggregate shall consist of natural sand, or crushed rock or gravel, and shall be hard, clean and free from adherent coatings or other deleterious matter. Sand for plaster and mortar shall comply with the requirements of SANS 1090, whereas the aggregates for normal and granolithic floor screeds shall comply with the requirements of BS 1199 and BS 1201 respectively.

(d) Mortar

Mortar shall be Class II unless otherwise specified. Mortar plasticisers may only be used with the approval of the Engineer.

(e) Water

Water shall be clean and free from clay, silt, oil, acid, alkali, organic or other matter which would impair the required strength and durability of the mortar, plaster or floor screed.

(f) Wall ties

Wall ties shall be of the galvanized, crimped, single-wire type, 3,5 mm in diameter and shall comply with the requirements of SANS 28.

(g) Brickwork Reinforcement

Brickwork reinforcement shall be hard drawn steel wire conforming to BS 785 and consist of two 2.8mm diameter wires with 2.5mm diameter cross wires at 300mm centres welded at intersections.

Brickwork reinforcement shall be lapped not less than 300mm at end joints and be continuous at corners.

**PD 02.2 CONSTRUCTION OF BRICKWORK**

(a) Cement mortar

Cement mortar shall consist of one part Portland cement to four parts sand (1:4) by volume unless otherwise specified for normal brickwork and one part Portland cement to three parts sand (1:3) by volume for reinforced brickwork. The ingredients for cement mortar shall be measured in proper gauge boxes on a boarded platform and thoroughly mixed. Alternatively, mixing may be by means of an approved mechanical batch mixer. Only when the dry ingredients have been thoroughly mixed and a mixture of uniform colour has been obtained may the water be added in sufficient quantity to obtain mortar with the required consistency.

Cement mortar shall be used within two hours of adding water to the mix and shall not be used after two hours or if it has begun to set. Mortar shall be turned over frequently to prevent it from setting until it is used.

(b) Brickwork

Dimensions of all the brickwork shall be set out and built as shown on the drawings. Bricks shall be kept wet before laying and the top of brickwork shall be wetted before any further bricks are laid. Bricks shall be well buttered with mortar before being laid and all joints shall be thoroughly flushed up as the work proceeds. All joints to face brickwork shall be neatly made and key-drawn with a 6 mm key.

Brickwork shall be carried up in a uniform manner with no portion being raised more than 1 m above an adjacent portion. All perpends, quoins, etc., shall be kept strictly true and square and the whole properly bonded together.

Brickwork shall be built in stretcher bond or english bond where specified and shown on the Drawings, and bats shall not be used except where required for the bond. All joints shall be 10 mm wide and four courses shall measure 340 mm.

Brickwork for cavity walls and solid walls built in stretcher bond shall be tied with wall ties placed not more than one metre apart in every third course, and shall be staggered vertically. At openings, the ties shall be positioned not more than 300 mm apart along the periphery of the opening and 150 mm from the opening.

Where cavity walls are specified, the cavities shall be kept free of all mortar droppings, etc. Mortar joints to brickwork shall be not less than 8mm or more than 12mm thick.

Face brickwork shall be kept perfectly clean and rubbing down of the brickwork shall not be allowed. Scaffold boards shall be turned back during heavy rain to avoid splashing. Soiled brickwork shall be cleaned at the Contractor's expense, and the cleaning method shall be approved by the Engineer.

(c) Reinforced brickwork

Brickwork over door and window openings shall be reinforced with steel rods, welded or expanded mesh, etc. Reinforcement shall be placed in each course of brickwork for a minimum of four (4) courses or as shown on the drawings. Reinforced brickwork shall continue at least 300 mm on each side of the openings.

Brick lintels shall be built upon rigid temporary supports left in position for not less than seven (7) days after brick-laying. Prestressed concrete lintels may be used where approved by the Engineer.

(d) Key for plaster

Joints of all brickwork receiving plaster shall be raked out, or the brick surfaces shall otherwise be prepared with an acrylic slurry or any other approved bonding agent.

(e) Damp-proofing

A damp-proof course shall be laid over the full width of all the walls at a minimum height of 150 mm above the final ground level or wherever else it may be required, and it shall be lapped for at least 150 mm at angles and joints. A damp-proof course shall also be laid and stepped up under all external sills.

(f) General

Rough and fair cutting shall be performed as required, and the brickwork shall be fitted around any steel work. Face brickwork shall be carefully cut and fitted to suit fittings.

Chases shall be left or formed for edges of concrete floors, staircases, etc. Chases shall also be provided wherever they may be required for pipes, conduits, switch boxes, distribution boards, and the like. Joints shall be raked out for flashings.

**PD 02.3 PLASTER WORK**

(a) Surface Preparation

Surfaces shall be clean and free of oil and thoroughly wetted before any plastering or other in-situ finishes can commence. Concrete surfaces shall be slushed with a mixture of one part cement and one part sand or otherwise treated with an approved substrate primer.

(b) Plaster coats

A plastered finish shall consist of a single coat, comprising one application of a 1:6 cement sand mixture with a wood or steel-float finish as specified on the drawings.

(c) Thickness

The total thickness of the plaster finish shall be 13 mm minimum and 20 mm maximum.

(d) Workmanship

All plaster work shall be finished smooth and ready to receive paint. Plaster shall be flush with the faces of all switch and plug boxes, the interiors of which shall be kept free from plaster. Plastered surfaces shall be plumb and jambs and reveals shall be formed square.

The plasterer shall cut out and make good all cracks, blisters and other defects and leave the plaster work, on completion, in a state which is acceptable to the Engineer.

(d) Gypsum skim plaster

A Gypsum skim plaster shall consist of a single coat pure gypsum plaster with a steel-float finish.

**PD 02.4 FLOOR SCREEDS**

Floor screeds shall have a mix proportion by mass consisting of one (1) part Portland cement and three (3) parts (1:3) fine aggregate. A minimum amount of water is to be used, but it shall be sufficient to allow adequate compaction.

Screeds shall be laid on clean hardened bases in panels not exceeding 14 m² and shall be steel-trowelled to a true and smooth finish. In monolithic construction, the panels shall not exceed 30 m². Joints in screeds shall coincide as nearly as possible with joints in the bases. The thickness of screeds shall be as shown on the drawings or as directed by the Engineer.

The entire screed surface shall be free from loose or raised particles of aggregate, trowel marks or any irregularities, humps or depressions exceeding 5 mm when measured from a 3 m long straight edge.

Screeds shall be cured for three (3) to seven (7) days as may be directed by the Engineer, and shall be protected from damage.

No moisture-sensitive floor finish shall be laid on screeds unless a reliable moisture test shows that the screed is sufficiently dry to receive the covering.

Skirting shall not exceed 25mm thick and shall have a fair edge with rounded angle at top edge or v-joint to finish flush with plaster and covered or square junction with floor finish.

**PD 03 WATERPROOFING**

**PD 03.1 MATERIALS**

The waterproofing of building (including damp proofing and vapour barrier installation) shall comply with SANS 10021.

Bituminous waterproofing Damp-proof sheeting shall comply with SANS 248, type FV for fibre felt. Damp-proof sheeting below brickwork, at weepholes, sills shall comply with SANS 952-1 type B for embossed polyethylene sheeting. Damp-proof membranes below concrete surface beds shall comply with SANS 952-1 type C.

**PD 03.2 CONSTRUCTION**

Waterproofing to concrete roofs and basements, etc shall be laid by approved Contractors. A written and approved 10-year guarantee shall be issued by manufacturer after approval of waterproofing. Waterproofing to roof shall be laid to even fall to outlets, etc. with necessary ridges, hips and valleys.

**PD 04 DOORS AND WINDOWS**

**PD 04.1 MATERIALS**

(a) General

All steel and iron work shall be delivered clean and free from rust, pitting or other defects. Shop primings shall be applied before delivery and shall consist of a coat of red oxide paint, or any other approved anti-rust paint on all surfaces.

Fire rated doors specified shall be designed, manufactured and tested to the requirements of SANS 1253.

Unless otherwise specified, all materials shall conform at least to the appropriate SANS or BS standards where such standards apply to ironmongery, or steel, cast iron and any other related materials.

(b) Pressed-steel door frames

Pressed-steel door frames shall comply with SANS 1129 and shall be manufactured from 1,6 mm thick mild-steel sheeting, pressed to the required shapes, properly mitred, welded and reinforced, with all welding neatly cleaned off.

Frames shall be of the widths required to suit the thickness of the walls into which they are built and shall be fitted with suitable tie bars and braces at the bottom. Three lugs to be built into the brickwork shall be provided on each jamb.

Rebates in frames and transoms for doors shall be of the widths required to suit the thicknesses of the doors and shall be fitted with a pair of approved steel butt hinges set flush into recesses in the frames. 4,5 mm thick reinforcing plates shall be welded to the backs of the frames at hinge positions.

Heads of frames over double doors shall be drilled where required to form keeps for bolts and shall be fitted with one rubber buffer for each leaf of the door.

Frames for single doors shall be fitted with approved chromium striking plates and an adjustable striking-plate keeper boxed in at the back of the frame by a welded-on sheet-metal box. The frames shall be fitted with a minimum of two rubber buffers.

Frames shall be protected against twisting and damage during transit and erection. The finishing colour of the door frame shall be as shown on the drawings, or as directed by the Engineer.

(c) Pressed-steel doors

Pressed-steel doors shall be manufactured from 1,6 mm thick steel plate. The doors shall be of standard design, pressed to shape with 40 mm reveals all round. The doors shall be strengthened with full-length vertical V-shaped or other approved sectional strengthening ribs projecting to the outer face. Two horizontal stiffening rails shall also be welded to the inner face of the doors.

A door shall be hung on a pair of 100 mm long steel butt hinges with loose pins. The leaves of the hinges shall be welded to both the door and the door frame, and a 1,6 mm thick steel plate shall be welded to the inner face of the door to protect the lock.

One leaf of double doors shall be fitted at the top and bottom with approved 150 mm cast brass barrel bolts in an approved manner and the other leaf shall be fitted with a lock, the striking plate of which shall be fixed to the first leaf.

Where indicated on the drawings, doors shall be fitted with louvred ventilation grills of approved design, backed with 6mm insect and vermin-proof gauze wire mesh. The bottom of the door shall be fitted with a rubber weather seal strip. The finishing colour of the door shall be as shown on the drawings, or as directed by the Engineer.

(d) Steel window frames

All steel window frames shall comply with SANS 727 and shall be of the types and sizes shown on the drawings.

Standard industrial types of steel window frame shall be constructed from rolled mild-steel industrial sections, 35 mm wide by 3 mm thick, with opening sections constructed from standard residential sections, 25 mm wide by 3 mm thick, welded at angles and properly jointed at intersections.

Window frames shall be formed perfectly flat, truly square and properly jointed at all angles, and the opening portion shall fit properly on all faces and shall open and close freely.

Glazing bars shall be continuous with jointed intersections, the ends being neatly tenoned into the frame and securely welded in position.

Frames shall be fitted with standard fixing lugs.

Opening sections shall open as indicated on the drawings, and shall be fitted with steel hinges with brass pins. Pivots shall be fitted with bronze ring centres.

Side hung or top hung opening sections shall be fitted with brass handles and friction stays. Bottom hung sections shall be fitted with friction pivots and spring catches.

Weather bar drips shall be attached to the fixed frames for the complete width of the window at the head of outward opening sections.

Composite windows shall preferably be delivered to the Site fully assembled, complete with mullions and transoms.

(e) Aluminium windows and doors

Aluminium windows and doors shall be manufactured from extruded aluminium members of 6063-T6, 6261-T6 or 6082-T6 alloy and temper. Aluminium sheets and strips shall be of 1200-H4 alloy and temper complying with BS 1470.

Joints in all aluminium members shall be formed in an approved manner so that the joints are practically invisible. Screw heads, pins, rivets, etc shall be concealed as far as possible. Stainless steel screws and bolts (300 series) shall be used for jointing and fixing aluminium work,

The surface of all aluminium which are in contact with other materials when fixed shall be suitably insulated with a non-absorbent insulating material to prevent corrosion. All aluminium work shall be suitably protected against damage, deterioration or discolouration caused by mortar droppings, paint, etc by taping with removable tape, covering with temporary casings or by covering with motor oil.

Aluminium described as anodized shall be treated with Grade 25 coating thickness for exterior use or Grade 15 for internal use as specified to the required colour finish.

Windows and doors shall be of an approved standard system, manufactured by an approved supplier and shall meet the minimum recommended performance requirements as set out by the Association of Architectural Aluminium Manufacturers of South Africa (AAAMSA) in the latest edition of the Selection Guide.

Openings of windows and doors shall be fitted with approved channel section aluminium glazing beads sufficient in size and profile to suit the method of glazing employed, finished to match windows, doors, etc and neatly mitred.

Aluminium doors shall be fitted with a with a rubber weather seal strip.

(f) Steel roller shutters doors

Roller shutters shall be supplied and installed by an approved manufacturer. The roller shutter door shall be constructed of 1mm thick machine rolled galvanised interlocking slats with steel end locks spot welded to alternate strips with vertical channel guides and top pulley mechanism. The bottom shall be provided with a galvanised rail riveted on and vertical edges shall glide in galvanised channel guides formed of steel not less than 2.5mm thick bolted to sides of the door opening. The door shall be wind resistant and fitted with a rubber weather seal strip.

The mechanism shall be covered in a galvanised mild steel sheet iron canopy box (continuous length) with a minimum thickness of 1mm. The opener shall either be by means of a crankable gearbox or motorised as specified. Motorised doors shall have a manually crankable override gearbox with an anti-fall back safety brake mechanism and up/down switch control box. Motorised doors to incorporate electronic locking with the motor and switching. Doors to be manufactured

All finishing colours shall be as shown on the drawings, or as directed by the Engineer.

(g) Door-locks and handles

All door-locks shall comply with the requirements of SANS 4 and shall be of approved manufacture and pattern. All locks shall be supplied with two keys. Keys shall be distinctly numbered with consecutive numbers and each key shall be stamped with the same number as that of the lock which it controls. No two locks in any one building may have the same key.

External doors shall be fitted with four-lever heavy-duty mortice locks, which shall be master-keyed. Internal doors shall be fitted with three-lever mortice locks.

All locks shall be properly installed and, after completion, striker plates shall be adjusted and the locks serviced. Door-handles shall be of cast zinc of approved manufacture and pattern.

(h) Miscellaneous fittings

All retaining devices for doors and windows as well as fittings such as coat hooks, retaining hooks, etc. shall be of stainless steel. All fittings shall be secured by screws or set screws of the same material and finish as the fitting.

Fittings to be fixed to plastered walls, masonry or floors shall be fixed direct by means of patent plastic or fibre plugs fitted into drilled holes.

Door stops shall be provided at every door and shall be 40 mm diameter rubber stops.

**PD 04.2 INSTALLATION OF DOORS AND WINDOWS**

All built-in door and window frames shall be set straight, plumb and level, and shall operate to the satisfaction of the Engineer after fixing has been completed.

Fittings shall be either removed, or wrapped and protected from damage, until all rough trades have been completed.

**PD 05 GLAZING**

**PD 05.1 MATERIALS**

(a) Glass

Glass shall comply with the requirements of SANS 50572-1 to 5. The quality of all window glass shall be such that surface deterioration will not develop after glazing.

All glass shall be free from bubbles, waviness, scratches, stains or other imperfections.

Unless otherwise specified, sheet glass for glazing shall be flat-drawn clear glass of ordinary glazing quality and of the thicknesses indicated below:

| | |
|---|---|
| For panes not exceeding 0,75 m² in area | 3 mm |
| For panes exceeding 0,75 m² but not exceeding 1,5 m² in area | 4 mm |

(b) Laminated Safety Glass

Laminated Safety Glass shall comply with the requirements of SANS 1263-1 to 3. The quality of all window glass shall be such that surface deterioration will not develop after glazing.

Laminated glass shall be manufactured by permanently bonding one or more polyvinyl butyral interlayer between sheets of clear, coated or tinted glass under heat and pressure.

Unless otherwise specified, safety glass shall have a nominal thickness of 6.38 mm.

(c) Putty

All putty shall comply with the requirements of SANS 680.

Putty shall not be too hard or soft or caked when used, and shall dry evenly without crazing or cracking.

Defective putty shall be cut out and replaced by the Contractor at his own expense, and any broken glass shall also be so replaced and putty so repainted.

(d) Mirrors

Silvered glass mirrors for general use shall comply with the requirements of SANS 1236.

**PD 05.2 GLAZING**

Glass shall be cut in panes to suit all glazed openings with sufficient clearance all round to prevent cracking by expansion, contraction or vibration.

In all cases the glass shall be well bedded and back-puttied and installed as specified in SANS Code of Practice 10137.

All putty shall be carefully trimmed, cleaned off and neatly finished off straight with smooth surfaces and sharp mitres. A paint primer shall be applied as soon as the putty has dried out sufficiently to prevent shrinkage cracks from forming.

The entire glazing operation shall be cleaned before the premises are handed over for occupation.

**PD 06 CARPENTRY AND JOINERY**

**PD 06.1 GENERAL**

(a) Materials

All timber used for structural purposes shall be of merchantable grade and shall comply with the requirements of SANS 1783 and SANS 1245. Structural timber shall be carefully selected and of the best quality, free from large or dead knots, shakes, waney edges or other defects. Structural timber shall be in single lengths and jointing of the timbers will only be permitted when the required length cannot be obtained. Only the absolute minimum of joints to obtain a particular length will be permitted and such joints are to be evenly spaced along the length of the timber.

Purlins and brandering shall comply with the requirements of SABS 1783. Finger-jointed structural timber shall comply with the requirements of SANS 10096 and laminated timber with the requirements of SABS 1089.

Hardwoods and softwoods for joinery shall comply with SANS 1099 and SANS 1359 respectively and suitable species shall be used for the various purposes.

Unless otherwise specified, all materials shall conform to the appropriate SANS or BS Specification where such standards exist for nails, screws, bolts, adhesives, etc.

(b) Preservative treatment

All structural timber shall be given a preservative treatment suitable for the duty for which the timber is intended in accordance with SANS 10005, and no untreated timber shall be used. The preservative treatment shall not impair the final finish. The timber shall be impregnated throughout. When surface coating is specified, the compounds applied on the surfaces of the timber shall form an unbroken film.

(c) Priming

The jointing surfaces of all joints exposed to the weather and built-in portions of frames shall be thickly primed except where adhesives are specified.

Carpentry and joinery items which are prepared for painting by the manufacturer, shall be knotted and primed before being dispatched to the Site.

Primed surfaces shall be touched up where necessary during the progress of the work or where site adjustments have been made.

**PD 06.2 CARPENTRY WORK**

(a) Scope of work

Carpentry work shall be carried out in a manner consistent with good workmanship and in compliance with the drawings.

The carpenter shall perform all cutting away and making good in attendance upon all other trades and he shall provide and maintain temporary coverings required for the protection of any finished work that might be damaged if left unprotected during the progress of the work.

(b) Dimensions

Unwrought timber shall be as sawn and shall be to the dimensions and within the tolerances specified in the relevant SANS Standard Specifications.

(c) Jointing

Unless otherwise specified, all joints shall be secured by means of a suitable type and a sufficient number of approved connectors. All joints shall be carefully made in such a way that they will not impair the strength and stiffness of the beams or members.

(d) Timber roof construction

The plates, joists, rafters, purlins, brandering and other pieces used for the construction of the roof and trusses shall be of the dimensions, spacing and construction as shown on the drawings.

All the joints in the framework shall be of the most appropriate type, accurately formed and adequately secured with fasteners as specified.

**PD 06.3 JOINERY WORK**

(a) Scope of work

Joinery work shall consist of the manufacture, delivery to the site, and fixing in the buildings, of all joinery shown on the drawings.

Except where a special finish is specified, the Contractor shall have all stairs, landings, doors, shelves and other joinery work cleaned and scrubbed down and shall leave all his work in a good order to the satisfaction of the Engineer.

(b) Dimensions

All wrought timber shall be sawn, planed, drilled or otherwise machined or worked to the correct sizes and shapes shown on the drawings.

Reasonable tolerances shall be provided at all connections between joinery works and the building structure to compensate adequately for any irregularities, settlements or any other movements.

(c) Manufacture

The joiner shall perform all the necessary mortising, tenoning, grooving, matching, tonguing, housing, rebating and all the other works necessary for correct jointing. He shall also provide all metal plates, screws, nails and other fixings that may be necessary for doing the specified joinery work properly.

(d) Joints

Where joints are not specifically indicated, they shall be the recognised forms of joints for each position. The joints shall be so made as to comply with Part 2 of BS 1186.

(e) Doors and frames

Door frames, linings, panel doors, framed, ledged and braced doors, flush doors, sliding doors, etc. shall be supplied or made by the joiner and shall be installed, fitted or hung as detailed on the drawings.

All timber shall be wrought and prepared for oiling, staining, varnishing or painting.

(f) Skirting, cornices, etc.

Skirting's, cornices, etc. shall not be installed until after the wall coverings have been applied, the flooring laid and ceilings installed, unless otherwise specified.

(g) In-situ joinery

In-situ joinery work shall not be executed until after all floor, wall and ceiling surfaces have been formed or constructed, unless otherwise instructed.

(h) Plate nailed timber roof trusses

Plate nailed timber roof trusses shall be constructed with softwoods structural timber by an approved and competent manufacturer.

The design of the roof trusses shall include for all live loads, wind loads and for dead loads imposed by roof covering, purlins, ceiling, etc. Shop Drawings of the roof design are to be provided for the Engineers approval.

The manufacturer to provide a certificate after installation confirming the erection is according to the design.

(i) Ceilings

Ceilings shall consist of plaster board or fibre-cement panels as shown on the drawings and shall be nailed to the brandering or suspended from the roof structure. The panels shall be separated by exposed tees and insulated with a 50 mm thick fibreglass wool blanket where shown on the drawings.

## PD 07 ROOF SHEETING AND ACCESSORIES

Roof sheeting and accessories shall comply with and will be measured and paid for under SANS 1200 HB.

A written and approved five year guarantee of water-tightness shall be issued after approval of roofs by the manufacturer or similar approved.

## PD 08 ELECTRICAL WORK

The electrical wiring of buildings shall be carried out by registered and licensed electricians in accordance with the requirements of SANS 10142-1 and the regulations of the Employer.

The electrician shall work in close co-operation with the Contractor to ensure that all conduits, switchboards, plug boxes and switch boxes are installed in their correct position.

The work shall be carried out in accordance with the drawings and to the satisfaction of the Engineer and the local authority.

## PD 09 PLUMBING AND DRAINAGE

### PD 09.1 MATERIALS

(a) General

All materials shall be of the best quality and shall be approved by the Engineer before installation. Cracked, chipped, dented or faulty items or materials shall be replaced at the Contractor's expense. Glazed ceramic sanitary ware shall comply with the requirements of SANS 497 and all other materials shall comply with the standards as specified, scheduled or shown on the Drawings.

(b) Water closet (WC) suites

WC shall be of the type detailed or scheduled, of white glazed vitreous china, closed coupled 90 degree outlet closed rim wash down pan, S or P trap and seat lugs, matching 2kg quality wooden seat and matching 7 litre pushbutton flushing cistern complete with lid and flushing mechanism, or a suspended enamelled cast-iron cistern with the flush pipe connected to the flushing rim of the closet with rubber cone joints, and a solid heavy-duty plastic seat with cover, hinges and buffers.

(c) Urinals

Urinals shall be of the type detailed or scheduled, of white glazed vitreous china, wall mounted, with an automatic or a manual flushing system, and chromium-plated fittings.

(d) Wash-hand-basins

Wash-hand-basins shall be the type detailed or scheduled, of white glazed vitreous china or enamelled cast iron, wall mounted on a pair of cast-iron brackets, and fitted with chromium-plated fittings consisting of two taps, outlet and chain, and supplied with a plug and an anti-siphon trap, all as detailed or as scheduled.

(e) Sinks

Sinks shall be the type detailed or scheduled, complying with the requirements of SANS 242 and shall be complete with cabinet, chromium-plated outlet, anti-siphon trap, plug, chain and two bib taps or one mixer tap, all as detailed or as scheduled.

(f) Taps, valves, etc.

Taps and valves shall be the type detailed or scheduled, complying with the requirement of SANS 198, SANS 226, SANS1240 and SANS 1480.

(g) Electric water heaters

Electric Water heaters shall be the type detailed or scheduled, complying with the requirement of SANS 151.

(h) Pipes and fittings

Cast-iron and steel pipes used in plumbing work shall comply with the requirements of SANS 746 and SANS 62 respectively. Copper tubing shall comply with the requirements of SANS 460 and malleable cast-iron fittings with SANS 509. Polyethylene and polypropylene pipes and couplings shall comply with the requirement of SANS 4427 and 1315 respectively. Sewer and drain pipes (PVC-U) shall comply with the requirements of SANS 791.

The water supply and drainage of the building shall comply with SANS 10252.

(i) Rainwater system

Rainwater systems shall be the type detailed or scheduled, complying with the requirements of SANS 11 for plasticized poly (vinyl chloride) (PVC-U) components for external rainwater system.

Aluminium gutter and pipes sheets shall be formed from 3003H14-3H4 strip alloy of 0,7 mm thickness, continuous lengths with formed angles, stop ends, offsets, bends, outlets, etc. All joints and fittings to be pop-riveted to gutter and sealed with mastic.

(j) Fire System

Pipes shall be class medium, threaded and coupled conforming to SANS 62, pipe size shall be detailed or scheduled. All pipes exposed to be painted fireCOTE red or similar approved.

Portable fire extinguishers shall be the type detailed or scheduled, complying with the requirement of SANS 1910 and SANS 1151.

Fire hose reels shall be the type detailed or scheduled, complying with the requirement of SANS 543.

Fire and directional signage shall be the type detailed or scheduled.

**PD 09.2 CONSTRUCTION**

Plumbing shall be carried out strictly in accordance with the Drawings and with the National Building Regulations, with specific reference to Government Notice R1875 dated 31 August 1979.

Steel pipes and their malleable cast-iron fittings shall be joined with red lead and hemp, lead pipes shall have wiped soldered joints, and cast-iron pipes shall be joined by caulking with hemp and metallic lead.

Soil pipes from WCs shall have an internal diameter of at least 100 mm and shall be fitted with a pan connector and an access bend (or an access junction where a vent pipe is used), and carried through walls and into the ground for connection to the sewer. Vent pipes shall be fitted with approved balloon gratings.

Waste pipes from basins and sinks shall have an internal diameter of at least 32 mm and shall discharge into gulley's. Bends for waste pipes shall incorporate cleaning eyes. A 350 x 350 x 75 mm thick concrete to be placed around inspection eye.

Cisterns, basins and sinks shall be connected to the pipe system with 12 mm diameter copper service pipes, and angle valves with braided pipe connections shall be installed for isolation and maintenance purposes.

The as built location of all piping and drainage built or cased into walls are to be recorded by the Contractor.

Sewerage pipes, sanitary plumbing and fire system shall be inspected, tested and approved by the Engineer or Principal Agent including all material and labour required.

**PD 10 PAINTING**

**PD 10.1 GENERAL**

No paint shall be applied to any surface containing traces of dust, grit, grease, oil, loose rust, millscale or corrosion products of any kind or to any surface that is not free from moisture. Where necessary, surfaces shall be thoroughly washed to remove all traces of soluble salts and/or corrosive air-borne contaminants prior to painting, and the surfaces shall be dried and painted immediately thereafter.

Welding shall be completed in so far as it is possible before painting commences, but in cases where welding can be done only at a later stage, no paint shall be applied to within 75 mm of the proposed weld position unless otherwise specified. Welds and adjacent parent metal shall be abrasive blasted and/or ground and all contaminants such as flux shall be removed prior to painting.

Surfaces of members which are to rest on concrete or other floors or which will be otherwise inaccessible after erection shall receive the full paint system prior to erection.

Damaged paint areas on metal surfaces shall be cleaned, rust spots removed where applicable and the surrounding paint which is still intact shall be feathered for a distance of 20 mm beyond the damaged area. Spot priming and repair shall consist of all the coats previously applied and shall overlap the damaged area.

Damaged galvanised areas shall be cleaned and any rust spots and any flakes of the coating surrounding the damaged area removed. The coating shall then be restored by zinc spraying or soldering, or painting with a zinc-rich paint, as may be approved by the Engineer.

Where the shop coat is allowed to age for a few months before the final painting is done, light sanding or rubbing with steel wool or scrubbing with clean water using a bristle brush shall be carried out.

Steel to be embedded in concrete shall not be painted below 50 mm from the final level of the concrete.

Each priming coat and each undercoat of paint shall be inspected and approved by the Engineer before any subsequent undercoat or finishing coat is applied. All finishing colours shall be as shown on the drawings, or as directed by the Engineer.

**PD 10.2 MATERIALS**

Paints shall comply with the requirements of the appropriate Specifications below:

(a) Primers

| | | |
|---|---|---|
| SABS 312 | : | Red-lead based for structural steel |
| SANS 678 | : | For wood |
| SANS 679 | : | Zinc chromate for steel |
| SABS 723 | : | Etch-wash primer for metals |
| SABS 912 | : | Calcium plumbate for galvanized iron |
| SABS 926 | : | Zinc-rich epoxy for steel |

(b) Undercoats

| | | |
|---|---|---|
| SANS 681 | : | For all undercoats |

(c) Finishing coats

| | | |
|---|---|---|
| SANS 515 | : | For interior use, flat and egg-shell finish |
| SANS 630 | : | For interior and exterior use, high-gloss enamel |
| SABS 631 | : | For interior and exterior use, oil gloss paint |
| SANS 1586 | : | For emulsion paint (interior and exterior use) |
| SABS 684 | : | For exterior use on structural steel |
| SABS 801 | : | For interior and exterior use, epoxy-tar paint |
| SABS 802 | : | For interior and exterior use, bituminous aluminium paint |
| SABS 887 | : | For interior use, glossy and egg-shell varnish |

The Contractor shall furnish the Engineer with the following information and details regarding the paints and decorative materials for the painting system he proposes to use, for written approval:

(i) The name of the manufacturer and trade name

(ii) The brand, type or grade of paint and the appropriate SANS Specification

(iii) Manufacturer's data sheets, colour references, instructions for use, including surface preparation, sealers, primers, undercoats, finishing coats, coat thicknesses and curing periods, which shall all be considered as being part of these Specifications if approved by the Engineer

(iv) Safeguards to protect the applied paint from damage until the work is accepted by the Engineer

(v) The shelf or pot life of materials, if applicable

(vi) An undertaking that the proposed paint system is suitable for its intended use and that the various coats of paint are compatible with one another

Where proprietary brands are used, the manufacturer's priming and all subsequent coats of paint suitable for that particular brand shall be employed in accordance with the manufacturer's instructions.

No other materials of a similar nature and quality or from another manufacturer may be used instead of those approved, unless written permission to do so has been obtained from the Engineer.

All materials shall be brought onto the site in containers sealed by the manufacturer. Paints of a different quality, type, brand or colour shall not be mixed, or thinned and shall not be adulterated in any way, but shall be used as supplied by the manufacturer. Any mixing or tinting required shall be carried out by the manufacturer.
Tinting of paint on the site by the Contractor will only be allowed with the written permission of the manufacturer and the Engineer.

**PD 10.3 INSPECTION AND PRELIMINARY WORK**

Before commencing paintwork, the Contractor shall carefully inspect the surfaces to be painted to satisfy himself that the surfaces are in a satisfactory or acceptable condition to receive the paint system specified.

All metal fittings and fastenings shall be removed where applicable before the preparatory processes are commenced. On completion, the metal fittings and fastenings shall be cleaned and refitted in position.

**PD 10.4 WORKMANSHIP AND FINISHES**

Paint may be applied by spray, brush or roller depending on the materials used, the surface to be painted, and the manufacturer's instructions.

Every coat of paint, irrespective of the method of application, shall be adequately and permanently keyed or bonded to the base material or previously applied coat, and shall be evenly distributed, continuous, free from sags, runs, brush marks, pin holes or other imperfections, and shall dry to a smooth finish.

An approved water trap and air-regulating valve shall be furnished and installed on all equipment used in spray painting.

Before painting the interiors of buildings they shall be cleaned and the floors shall be washed and kept free from dust during the progress of the interior work.

The Contractor shall protect all nearby surfaces against disfigurement by spatters, splashes and smirches of paint or paint materials. The Contractor shall be responsible for any damage by paint or dirt caused by his operations to vehicles or property or injury to persons and he will be required to provide protective measures to prevent any such damage or injury and make good, where required, at his own expense.

If passing traffic creates dust which may harm or spoil the appearance of external painted surfaces, the Contractor shall sprinkle the adjacent areas with water, at his own cost, for a sufficient distance on each side of the location where painting is being done.

Undercoats shall be tinted by the manufacturer to distinguish between successive coats.

The final coats or finishing coats of paint shall be applied after all the other work in the vicinity has been completed.

The painter shall keep some of the final paint in reserve in the event of his having to make good any patching which may be required as a result of damage or unforeseen circumstances.

Upon completion, the Contractor shall, in the case of buildings, clean all glass, remove all paint spots from walls, floors and fittings, and leave the premises clean and fit for occupation.

All inflammable materials, comprising solvents, thinners, wiping cloths, etc, shall be placed in tightly closed containers and properly disposed of.

## PD 10.5 PAINTING OF PLASTER, CONCRETE OR BRICK SURFACES

(a) Surface preparation

Surfaces for painting shall be prepared by sandpapering, scraping or wire-brushing to remove loose material, dust, laitance, scum or other deleterious materials or high spots. Defective areas shall be cut out where necessary and made good with an approved non-shrink filler. Cracks shall be cut out, suitably keyed, and given a coat of an approved bonding agent before the filler is applied. All patches shall be rubbed down to an even surface. Surfaces shall be washed and allowed to dry.

Surfaces shall be treated with neutralising liquid for walls, and if the surface is coarse or textured, either one full coat of pigmented wall sealer or one full filler coat shall be applied in addition to the neutralising liquid.

(b) Paint application

Prior to the emulsion paint being applied, the surface shall be sealed with an approved clear sealer and primed with an undercoat diluted to 50%. Emulsion paint (PVA or acrylic) shall then be applied in two finishing coats.

Egg-shell finish (alkyd oil-based), oil gloss paint or enamel gloss paint shall be applied as follows: one coat of universal undercoat shall be applied and it shall be followed by one coat of a mixture comprising 50% of the undercoat and 50% of the paint to be used for the finishing coat. A finishing coat of semi-gloss egg-shell, or oil gloss paint or enamel gloss paint shall then be applied.

## PD 10.6 PAINTING OF WOODWORK

(a) Surface preparation

The surfaces shall be cleaned, sandpapered and rubbed down to a smooth, even face before painting. The moisture content of the timber shall not be more than 20% at the time when the first coat is applied. All cracks, shakes or scars shall be filled flush with a filler approved by the Engineer before painting. The surface shall then be washed with cleaner and allowed to dry.

(b) Primer application

One coat of an approved wood primer shall be applied.

After open-grained timber has been prepared and primed, the grain shall be stopped and filled with synthetic filler and rubbed down with water paper.

All new woodwork shall be properly primed on all surfaces and edges before being fixed in position. All woodwork not previously painted shall be given a prime coat, well brushed in.

(c) Paint application

One coat of universal undercoat shall be applied followed by one coat of a mixture of 50% of the undercoat and 50% of the paint to be used for the finishing coat. A finishing coat of oil gloss paint or enamel gloss paint or semi-gloss egg-shell (alkyd oil-based) paint shall then be applied.

(d) Varnish finish

Two coats of gloss varnish or egg-shell varnish shall be prepared, stopped and applied.

## PD 10.7 PAINTING OF METAL SURFACES

(a) General

Wherever possible, all painting shall be done at the manufacturer's works, but where this is not feasible, the Engineer may permit the application of the undercoat and finishing coats to be carried out on the Site, in which case a prime coat shall be applied at the manufacturer's works prior to the members being despatched to the Works.

(b) Surface preparation

The preparation of metal surfaces shall comply with SANS Code of Practice 10164 and shall receive the greatest care to ensure rust-free conditions prior to the paint system being applied.

All surfaces shall be prepared by removing loose paint, rust, plaster, scale, dust, dirt, grease, etc. and by repairing or patching defective paint surfaces before painting or repainting. Damaged shop-primed surfaces shall be thoroughly cleaned of rust and patched with a prime coat.

(c) Paint application

(i) Iron and steel work

All iron and steel work shall be properly primed with a red-lead-based primer where steel work is likely to be exposed to the elements for longer than 30 days. Zinc-chromate primer may be used where overpainting will be completed within 30 days of priming. Metal-etch wash primers may be used under dry conditions where overpainting will be completed within 24 hours of priming. The dry-film thickness of the prime coat shall not be less than 0,300 mm.

After priming, one coat of universal undercoat shall be applied. If necessary, the undercoat shall be tinted to a shade just lighter than the desired finish with approved liquid stainers. The dry-film thickness shall not be less than 0,250 mm.

The two finishing coats shall either be of alkyd resin-based synthetic enamel, gloss or matt oil paint, or as specified elsewhere. The dry-film thickness shall not be less than 0,250 mm per coat.

When mating surfaces are brought together, both surfaces shall have been given the full treatment specified, but where this cannot be done, each surface shall be given a copious coating of primer and the surfaces drawn together while the paint is still wet.

The portion of structural steel members to be buried in soil, and all bases to a height of 500 mm shall be given two coats of an epoxy-tar primer instead of the zinc-chromate primer specified for other surfaces.

The surfaces of steel and cast-iron articles, such as floor gratings, grids and manhole covers, shall, after a thorough brushing to remove loose rust, be painted with two coats of epoxy-tar paint, each at least 0,230 mm thick.

(ii) Galvanized iron and steel

All traces of protective coating shall be removed with galvanized iron cleaner, and two coats of calcium plumbate primer shall be applied. One coat of tinted universal undercoat and two finishing coats of alkyd resin-based synthetic enamel gloss paint shall be applied.

(iii) Non-ferrous metals

Surfaces of aluminium, copper, etc. shall be prepared and cleaned, and one coat of self-etch zinc-chromate wash primer shall be applied. One coat of universal tinted undercoat and two finishing coats of enamel gloss paint shall then be applied. Where non-ferrous metals are not to be painted, the surfaces shall be cleaned, polished and two coats of lacquer applied.

**PD 10.8 PAINTING OF FLOOR SCREEDS**

Where chemicals could cause damage to floors, such floors shall be painted with an approved epoxy paint. The type of paint to be used will be shown on the drawings and will depend on the types of chemical that are used.

The preparation of such floor screeds for painting and the subsequent application of paints shall be carried out strictly in accordance with the manufacturer's instructions.

**PD 10.9 PAINT THICKNESS**

Unless otherwise specified, all coats of paint, whether prime coat, undercoat or finishing coat, shall have a dry-film thickness of not less than 0,200 mm, irrespective of the method of application.

**PD 10.10 INSPECTION**

The Contractor shall provide the necessary equipment to establish whether the primers, undercoats and finishing coats have been applied to the correct thickness according to the correct applications. The Engineer may take samples of the paints during painting operations for testing and quality control.

**PD 11 MEASUREMENT AND PAYMENT**

**PD 11.01 Brickwork:**

(a) (Thickness, type and class indicated) ..... Unit: m²

(b) Etc. for other thicknesses, types and classes

The unit of measurement shall be the square metre of each type and thickness of brickwork built or per cubic metre in the case of brick piers, columns and supports for pipework. Areas of pipes, windows, doors, etc. built into brickwork shall not be included in the areas measured. At corners and intersections common to more than one brick wall, the areas shall be measured only once.

The tendered rates shall include full compensation for the construction of the brickwork complete as specified, including pointing, the building-in of conduits, beams, lintels, pipe sleeves, doors, windows, the raking-out of joints, damp-proof course, brickforce reinforced as specified, etc.

**PD 11.02 Plaster work:**

(a) (plaster and finish indicated) ..... Unit: m²

(b) Etc. for other plaster and finishes

The unit of measurement shall be the square metre of each type of coat completed as specified.

The tendered rates shall include full compensation for the construction of the plaster work, including supplying all materials, mixing, applying, finishing, forming reveals, joints, narrow widths, rounded angles, V-joints, etc. complete as specified.

**PD 11.03 Floor screeds:**

(a) (Description and thickness indicated) ..... Unit: m²

(b) Etc. for other thicknesses

The unit of measurement shall be the square metre of floor screed laid, as specified, on floors, steps or areas shown on the drawings or as designated by the Engineer.

The tendered rates shall include full compensation for constructing the floor screeds, including supplying all materials, mixing, laying, finishing, and forming nosings, reedings, skirtings, etc.

**PD 11.04 Waterproofing:**

(a) Damp proofing under surface beds (Type and thickness indicated) ..... Unit: m²

(b) Damp proofing under brickwork (Type and thickness indicated)..... Unit: m²

(c) Waterproofing of roofs (Type and thickness indicated)..... Unit: m²

(d) Etc. for other types and thickness

The unit of measurement shall be the square metre of each type of type as specified.

The tendered rates shall include full compensation for the supply, installation, labour, turn-ups and turn-downs etc. complete as specified.

**PD 11.05 Doors and windows:**

(a) (Type and size indicated) ..... Unit: number

(b) Etc. for other types and sizes

The unit of measurement shall be the number of doors and windows installed complete as specified.

The tendered rates shall include full compensation for manufacturing and installing steel doors, windows, and frames complete with hinges, handles, locks, barrel bolts, retaining devices, door stops, stays and any other work necessary to complete the work as specified or as shown on the drawings. The tendered rate for windows shall also include full compensation for glazing, window sills as specified, and damp-proof sheeting.

**PD 11.06 Structural timber:**

(a) Plates (sizes indicated) ..... Unit: m

(b) Beams (sizes indicated) ..... Unit: m

(c) Joists (sizes indicated) ..... Unit: m

(d) Rafters (sizes indicated)..... Unit: m

(e) Purlins (sizes indicated) ..... Unit: m

(f) Roof trusses complete (drawing number indicated)..... Unit: number

The unit of measurement shall be the metre of individual types of timber element or the number of complete trusses installed.

The tendered rates shall include full compensation for supplying all materials and manufacturing, cutting, wasting, jointing and installing the timber as shown on the drawings.

**PD 11.07 Ceilings:**

(a) Plaster-board ceiling (type and thickness indicated):

(i) Fixed ceiling..... Unit: m²

(ii) Suspended ceiling ..... Unit: m²

(b) Fibre-cement ceiling (thickness indicated):

(i) Fixed ceiling..... Unit: m²

(ii) Suspended ceiling ..... Unit: m²

The unit of measurement shall be the square metre of fixed or suspended ceiling installed complete as scheduled.

The tendered rates shall also include full compensation for the construction of the ceilings, including the exposed tees, insulation blanket and brandering as specified, as well as the suspension system where applicable.

**PD 11.08 Joinery:**

(a) Items measured by number:

(i) Doors (type and size indicated) ..... Unit: number

(ii) Etc. for other items measured by number

(b) Items measured by length:

(i) Skirtings (type and size indicated) ..... Unit: m

(ii) Etc. for other items measured by length

The units of measurement shall be the metre of each type and/or size of joinery item specified.

The tendered rates shall include full compensation for supplying all materials, and manufacturing, cutting, wasting, fixing and installing the joinery items.

**PD 11.09 Electrical Work:**

(a) Electrical work..... Unit: sum

The tendered sums shall include full compensation for the supply of all materials, for transport, storage, all equipment and labour, all temporary work and safety precautions, replacement of defective work, protection of completed work and clean-up after completion.

**PD 11.10 Plumbing and drainage:**

(a) Sanitary fittings, items measured by number:

(i) Sanitary fittings (type indicated) ..... Unit: number

(ii) Waste connections and traps (type indicated) ..... Unit: number

(iii) Taps and valves (type indicated) ..... Unit: number

(v) Electric water heater (type indicted)..... Unit: number

(iv) Etc. for other items measured by number ..... Unit: number

(b) Installation, items measured by sum:

(i) Plumbing and drainage ..... Unit: sum

(ii) Fire system ..... Unit: sum

The supply and installation of sanitary ware, water heater, etc are measured elsewhere but the Contractor shall allow for the internal plumbing and drainage installation of all sanitary ware and water heaters, the connection thereto complete including the fixing and fitting of traps and waste, etc.
The tenderer is responsible for the internal design of the internal plumbing and fire reticulation.

The tendered sums shall include full compensation for the design, submission of shop drawings for approval by the Engineer/Principal agent, supply of all materials, for transport, storage, all equipment and labour, all temporary work and safety precautions, replacement of defective work, protection of completed work and clean-up after completion.

(c) Rainwater system, items measured by number:

(i) Gutters (type and size indicated) ..... Unit: number

(ii) Downpipes (type and size indicated) ..... Unit: number

(iii) Fittings for gutters and pipes (type indicated)..... Unit: number

The tendered sums shall include full compensation for the supply of all materials, for transport, storage, all equipment and labour, all temporary work and safety precautions, replacement of defective work, protection of completed work and clean-up after completion.

**PD 11.11 Painting:**

(a) Items measured by number:

(i) Description (Type, Paint description, coats and surface type) ..... Unit: $m^2$

(ii) Etc. for other items measured by number

(b) Items measured by area:

(i) (Paint description, coats and surface type) ..... Unit: $m^2$

(ii) Etc. for other items measured by area

The tendered rates shall include full compensation for the supply of all materials including cleaners and primers, transport, storage, all equipment and labour, all temporary work and safety precautions, replacement of defective work, protection of completed work and clean-up after completion.

**PD 11.12 Miscellaneous items:**

(a) Items measured by number:

(i) (Description of item) ..... Unit: number

(ii) Etc.

(b) Items measured by area:

(i) (Description of item) ..... Unit: square metre ($m^2$)

(ii) Etc.

(c) Items measured by length:

(i) (Description of item) ..... Unit: metre (m)

(ii) Etc.

The unit of measurement shall be the number, linear metre and square metre as applicable to each item.

The tendered rates shall include full compensation for all labour, plant, equipment, transport, etc, manufacturing or providing and installing each item complete as scheduled and shown on the drawings, and shall include all corrosion protection where applicable.

**PARTICULAR SPECIFICATION**

**PF FENCING**

**CONTENTS**



## PF 01 SCOPE

This is a Particular Specification and covers the erection of new fences.

## PF 02 TYPE OF FENCE

The fence shall be a security fence with a vandal resistant wire panel and post system with advanced anti-corrosion properties and shall be erected in accordance with the specification and instructions of the manufacturer in order to maintain and achieve a 10 year guarantee against corrosion.

## PF 03 MATERIALS

### PF 03.1 POSTS, STAYS AND STANDARDS

Posts, stays and standards shall be of the type and size indicated on the Drawings. Posts shall include gate posts, straining posts and corner posts.

Metal posts, stays and standards shall comply with the requirements of CKS 82 and SABS 280. "Acceptable" in CKS 82 means "acceptable to the Engineer".

Tubular posts, standards and stays shall be galvanized in accordance with SABS ISO 1461:1999 Table 1 for type B articles. All rail and Y-sections shall be provided with a protective coating of tar or other approved material.

Corner, gate and straining posts shall be suitably pre-drilled for stay bolts or gate fittings as indicated on the Drawings.

Posts shall be Hot dipped Galvanised in accordance with ISO-1461, and then coated with a Fusion Bonded Epoxy (FBE) coating of minimum DFT of 350 microns. Posts shall be pre-drilled with holes for fixing panels to posts. Panels should be fixed to posts with either stainless steel countersunk flushlock bolts and shear nuts, or by means of double and single bolt comb clams using anti-vandal bolts.

### PF 03.2 BOLTS FOR STAYS

Bolts shall be of stainless steel. The length and diameter of the bolts shall be as shown on the Drawings. All the necessary bolts, together with nuts and washers, shall be supplied with each post.

### PF 03.3 WIRE

All wire shall conform to the requirements of SABS 675 and shall be class B galvanized, except where otherwise specified below.

**PF 03.4 WIRE PANELS**

Wire Diameter: Minimum 3mm
Apertures: 76.2mm x 12.7mm (centre to centre)
Standard widths: 2500mm to 3500mm
Height: Minimum 2400mm
Coating: Galvanised 30g/m^2 with Zincalu coating – Zincalu coating = 95% Zinc and 5% Aluminium according to SANS 10244-2: 2004, plus Fusion Bonded Epoxy coated to minimum DFT of 350 microns.
Tensile Strength of wire: 650 – 750 N/mm2
Solidity: 35%
Weld Strength 60 – 80%
Weight 10.61 kg/m2
10 year guarantee against corrosion
Panels shall be reinforced with 4 x 50mm deep 'V' formation horizontal recessed bands for rigidity

Wire Panels shall comply with the requirements of SABS 1373.

**PF 03.5 TOPING**

Toping shall be Cochrane Ripper Razor Coil, galvanised medium blades fabricated from high tensile wire attached to support bracket fixed to posts. Support bracket shall be galvanized and then polymeric 8000 coated.

**PF 03.6 GATES**

Gates shall comply with the requirements of CKS 146 and shall be manufactured to the dimensions shown on the Drawings.

Gates shall be complete in every respect, and shall include hinges, washers, bolts and the locking mechanism shown on the Drawings.

The required width of the gates, as specified on the drawings, shall mean the actual required clearance.

**PF 03.7 CONCRETE**

Concrete used for fencing shall comply with the requirements of SABS 1200 G.

## PF 04 CLEARING OF FENCE LINE

Strip clearing for the fence shall be carried out in accordance with SABS 1200 C and will be measured and paid for under Section 1200 C of the Schedule of Quantities.

## PF 05 INSTALLING POSTS AND STANDARDS

Posts shall be accurately set in holes and, where indicated, shall be provided with concrete bases to the dimensions shown on the Drawings.

Holes shall be dug to the full specified depth. Where, due to the presence of rock, the holes cannot be excavated by hand or by pneumatic tools and the Contractor has to resort to the use of explosives, he will be paid separately for the drilling and blasting operations required.

Standards shall be firmly planted in the ground at the spacing shown on the Drawings or as directed by the Engineer. The spacing of standards between any two straining posts shall be uniform. In rock or hard material standards shall either be driven or set in holes

drilled into the rock. The size of drilled holes shall be such that a tight fit is obtained. Care shall be taken not to buckle or damage the standards when driven. Where indicated, standards shall be provided with concrete bases to the dimensions shown on the Drawings.
All posts and standards shall be accurately aligned and set plumb and shall be planted with the overhang as shown on the Drawings and at right angles to the direction of the fence. After posts and standards have been firmly set in accordance with the aforegoing requirements, the fencing wire shall be attached thereto as described below.
Installation to be done all according to the manufacturer's instructions and specifications to achieve and maintain a 10 year guarantee against corrosion.

**PF 06 INSTALLING OF ANTI-DIG**

A 600mm deep, 300mm wide soilcrete anti-dig barrier is to be constructed between fence posts.

**PF 07 INSTALLING WIRE PANELS**

Installation to be done all according to the manufacturer's instructions and specifications to achieve and maintain a 10 year guarantee against corrosion.

**PF 08 INSTALLING GATES**

Gates shall be installed at the positions indicated on the Drawings or pointed out on Site. The gates shall be hung on gate fittings in accordance with the details shown on the Drawings. Gates shall be so erected that they swing in a horizontal plane at right angles to the gate posts and clear of the ground in all positions. Double swing gates shall close to have a gap of not more than 25 mm between them, and other gates shall close to be no further than 25 mm from the gate post.

**PF 09 GENERAL REQUIREMENTS AND TOLERANCES**

The completed fences shall be plumb, taut, true to line and to the ground contour, and with all posts, standards and stays firmly set.

The height of the lower fencing wire above the ground at posts and standards shall not vary by more than 25 mm from that shown on the Drawings. Other fencing wires shall not vary by more than 10 mm from their prescribed relative vertical positions.

Anchoring of a fence to structures shall be done as shown on the Drawings.

The Contractor shall, on completion of each section of fence, remove all cut-offs and other loose wire or mesh so as to leave the fence with a neat and finished appearance.

**PF 10 MEASUREMENT AND PAYMENT**

**PF 10.1 Installation of fencing units Complete To Specification:**

(a) Fencing Type (drawing number indicated) .....Unit: m

(b) Gate Type (drawing number indicated).....Unit: m

The rates submitted are to be fully inclusive of all labour, material, equipment and traveling cost for the complete installation of the product as specified. Rates are to include for all related work to the product inclusive of all excavations, backfilling, levelling of the terrain on completion, concrete works, curing, keeping safe, and installation of all structural/fastening elements to specification as well as the clearing of the site on completion.

The unit of measurement will be per linear meter of the installed product.

# PARTICULAR SPECIFICATION

# PS SECURITY DOORS

**CONTENTS**



## PS 01 SCOPE

This is a Particular Specification and covers manufacture, supply and installation of security single doors.

## PS 02 TYPE OF SECURITY DOOR

The security doors shall be installed in accordance with the dimensions shown on the Drawings. The door shall be an Interlock Systems “TDL” type door or similar approved.

## PS 03 MATERIALS

### PS 03.1 GENERAL

The door shall be designed, manufactured and installed by a competent manufacturer who is experienced in this type of installations. All steel and iron work shall be delivered clean and free from rust, pitting or other defects. The door will be exposed to corrosive environment and shall be protected with corrosion proof coatings as specified in this specification. Unless otherwise specified, all materials shall conform at least to the appropriate SABS or BS standards where such standards apply to ironmongery, steel, cast iron or any other related materials. Door frames shall comply with SABS 1129 unless specified differently. **Full Quality Control Procedure documentation shall be provided for the product.**

### PS 03.2 DOOR FRAME

Frames shall be of the widths required to suit the thickness of the walls in which they are built and shall be fitted with suitable tie bars and braces at the bottom, or as a retrofit type for existing openings in a wall. Retrofit frames shall use M16 fasteners on the outside and inside of the building for added security. Heads of frames over double doors shall be drilled where required to form keeps for bolts and shall be fitted with one rubber buffer for each leaf of the door. Frames shall be protected against twisting and damage during transit and erection.

### PS 03.3 HINGES

All security doors shall be fitted with full length stainless steel 304 strip hinges. The hinge material shall be a minimum of 3 mm thick and shall have a hinge pin diameter of at least 8 mm. The hinges should allow some lateral and vertical adjustment. The hinge shall be treated with dry lubricant for smooth and maintenance free operation.

### PS 03.4 FRONT PANEL

The front door panel shall be manufactured from minimum 3mm thick stainless steel (3CR12). A magnitude of 10kN rated structural fasteners shall be provided to ensure security.

**PS 03.5 CORROSION PROTECTION**

Before any door assembly, every single part of the door shall be fully painted to eliminate cavity corrosion problems. All stainless steel parts shall be fully pickled and passivated before painting. All paint jobs shall be done with top quality epoxy undercoat and two-pack polyurethane top coat layers to a paint thickness of at least 1.0mm.

**PS 03.6 LOCK SYSTEM**

The door lock system shall comprise of lock rods and have 4 or more lock points. The lock rods shall extend with at least 45 mm of travel. The door shall lock with high security padlocks enclosed in 6 mm stainless steel protection cover. **The door shall have a "panic bar" for emergency exit that can disable the lock system even if the door is locked from the outside.**

**PS 03.7 MISCELLANEOUS FITTINGS**

The doors shall have automatic door catches and weather strips.

**PS 04 INSTALLATION OF DOORS**

Doors shall be installed at the positions indicated on the Drawings or pointed out on Site. The doors shall open outwards (of the building). Doors shall be so erected that they swing in a horizontal plane at right angles to the door frames.

Fittings shall be either removed, or wrapped and protected from damage, until all rough trades have been completed.

**PS 05 GENERAL REQUIREMENTS AND TOLERANCES**

All built-in door frames shall be set straight, plumb and level, and shall operate to the satisfaction of the Engineer after fixing has been completed.

The Contractor shall, on completion of each section of the door, remove all temporary brackets holding the door to ensure a neat and finished appearance.

**PS 06 MEASUREMENT AND PAYMENT**

**PS.6.01 Supply and installation of new security door:**

(a) (Type and size indicated).....Unit: No

(b) Etc.

The unit of measurement shall be the number of doors installed complete as specified.

The tendered rates shall include full compensation for the manufacturing, delivery and installation of the steel doors and frames complete with hinges, handles, locks, barrel bolts, retaining devices, door stops, stays, corrosion protection and any other work necessary to complete the work as specified or as shown on the Drawings.

# SPECIFICATION: Aur 0001

## GENERAL MECHANICAL REQUIREMENTS

## Contents

  

  

  

  

# 1. SCOPE

Aur 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 (Aur 0001).

b) Aur 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

c) Aur 7001: Design and Manufacture of Medium Pressure Steel Specials.

d) Aur 7024: Pipe Supports.

The following South African National Standards are referred to in this specification:

- SANS 200
- SANS 936/7
- SANS 989/992
- SANS 1034
- SANS 1062
- SANS 1123
- SANS 1186
- SANS 1200H
- SANS 1465
- SANS 1700
- SANS 10044
- SANS 10104
- SANS 10160
- SANS 10108
- SANS 10268
- SANS 12944
- SANS 15874
- SANS 50025
- SANS 60034
- SANS 61241
- SANS/ISO 4427

The following British Standards are referred to in this specification:

- BS 1400
- BS 1452
- BS 1490

- BS 2035
- BS 2789
- BS 3100
- BS 3790
- BS 4515
- BS 4872
- 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 GENERALLY

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

### 3.3.1 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.

### 3.3.2 Certification

The Contractor shall provide spectroscopic analyses of stainless steel materials. The analysis shall be undertaken by a local materials laboratory and shall be submitted to the Engineer.

Stainless steel supplied shall be clearly and permanently marked with the grade of stainless steel and cross referenced to the applicable test certificate.

## 3.4 3CR12

This is the titanium stabilised, 12 % chrome steel. It shall be supplied with an annealed and pickled finish.

If 3CR12 is to be coated, it shall be suitably abrasive blasted to ensure adherence of the prime coat.

## 3.5 PLASTICS

Thermoplastics and fibre reinforced polymers shall be UV resistant, have adequate tensile strength and high impact strength and generally suit the application.

PVC is regarded as too brittle and shall not be used unless called for in this Specification or approved in writing by the Engineer before supply.

# 4. CASTINGS

Castings shall comply with the relevant South African or international standard for the material used, including the following:

| | |
|---|---|
| Grey Cast Iron | SANS 1034; BS 1452 |
| S. G. Iron | SANS 936/7; BS 2789 |
| Steel (General Purpose) | SANS 1465; BS 3100 |
| Aluminium | SANS 989/992; BS 1490 |
| Stainless Steel | DIN 17 445 |
| Copper and Copper Alloy | SANS 200; BS 1400 |

Castings shall be clean and sound and shall be neatly fettled and dressed. Surfaces shall be smooth and irregularities caused by mould washaways, and the presence of porosity, inclusions and sharp edges will not be tolerated. Areas under bolt heads, nuts and washers, shall be machined or spot faced to ensure a flat and smooth pressure bearing area, and sufficient space shall be provided for the use of ring or socket spanners.

All pressure retaining castings shall be hydrostatically tested to not less than 1,5 times the maximum working pressure after machining and shall be pressure tight.

No repairs shall be undertaken to castings without the written permission of the Engineer. Cast iron castings shall not be welded.

Castings shall be heat treated to provide optimum corrosion resistance and toughness combined with reasonable machinability. In particular stainless steel castings shall be heat treated so as to ensure that all carbides are in solution, to ensure optimum grain size, and to provide maximum corrosion resistance.

The Contractor shall provide a test certificate for each casting or batch of castings, except for those made of grey cast iron, giving details of the material analysis, the heat treatment and any mechanical tests carried out.

# 5. FABRICATION OF CARBON STEEL & STAINLESS STEEL

## 5.1 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.

## 5.2 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.

## 5.3 AUSTENITIC STAINLESS STEELS

Fabrication of austenitic stainless steels shall comply with the recommendations in "The Stainless Steel User Manual" issued by Columbus Stainless. Compliance with publications from equivalent authorities will be acceptable.

Stainless steel fabricators shall use permanently dedicated storage and fabrication areas and shall use machines, tools and handling equipment which are suited and permanently dedicated to this type of material.

Fabrications shall be pickled and passivated over their full surface to achieve an even colour. If grinding is required before pickling, the final grinding shall be done with a fine disc in order to remove coarse grinding marks.

### 5.4 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.

### 5.5 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.

## 6. WELDING

### 6.1 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.

### 6.2 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.

Crevices, including those arising from welding on one side only, shall be eliminated. This requirement applies to the welding of all metals and welding procedure shall be designed to prevent unacceptable deformation.

Welds which are only accessible from one side shall be prepared so that the root run provides an acceptable profile and prevents the formation of crevices. Pipework shall be designed so that such welds can be inspected and, where applicable, pickled and passivated.

In special cases only, non-continuous welding might be approved in writing by the Engineer. The resulting crevices shall be sealed with a two part solvent free epoxy which can be applied at thicknesses of up to 600 µm and above such as Sigmaline 523 or Corrocoat Zip E or Sigmacover 1000 or equivalent.

### 6.3 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.

### 6.4 SITE WELDING

Site welding shall be kept to a minimum and shall only be undertaken with the approval of the Engineer.

### 6.5 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.

### 6.6 INSPECTIONS

The Contractor shall arrange for all fabrications to be inspected by the Engineer prior to transport from the fabrication workshop.

## 7. CORROSION PROTECTION

### 7.1 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 Aur 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.

### 7.2 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.

### 7.3 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.

The coat shall extend over flange faces.

Stainless steel valves, strainers and other items of equipment shall be similarly coated.

## 8. INSTALLATION

### 8.1 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 Aur 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.

### 8.2 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.

# 9. CIVIL AND BUILDING WORKS

## 9.1 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.

## 9.2 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.

## 9.3 PUDDLE PIPES

The Contractor shall install the puddle pipes required by the design into concrete structures. For this purpose, the Contractor shall provide the details of box-outs required in the structure to the Engineer. Puddle flanges shall be of the same dimensions as standard flanges and the box-out shall be designed accordingly and with allowance for civil tolerances of $\pm$ 40 mm.

Concrete structures will generally be constructed by others and, if required, it will be tested for water tightness by the Engineer before handover to the Contractor by temporary closure of the box-outs.

Upon receiving access to the Site, the Contractor shall install the pipework and shall grout the puddle pipes into the structure using a suitable non-shrink grout to the approval of the Engineer. The Contractor shall provide a water tight installation and shall be responsible for rectifying any leakage at the puddle pipe.

## 9.4 BASEFRAMES, PIPE SUPPORTS, ETC.

The design requirements for baseframes and pipework supports are specified elsewhere in Aur 0001.

The Contractor shall be responsible for grouting of baseframes, 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 baseframes, pipe supports, etc. to concrete shall be submitted to the Engineer for approval and shall incorporate the details of the grout proposed. The material used for the primary grouting of the anchors shall be a non-shrink, cementitious grout such as ABE Duragrout 1000, or equivalent. ABE Epidermix 324, or equivalent, is acceptable if an epoxy grout is required.

The secondary grout shall be applied only after each anchor fastener has been tested for integrity. The design and grouting shall eliminate collection points for water or dirt.

If called for by the Engineer, the initial grouting shall be overseen by the grout supplier's technical representative.

## 10. PIPEWORK SUPPORTS

Supports for steel pipework and for plastic pipework shall comply with Aur 7024.

## 11. STEEL PIPEWORK; DN 150 AND LARGER

### 11.1 GENERAL

Design and manufacture of steel pipework which is DN 150 or larger shall comply with Aur 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.

### 11.2 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 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.

## 11.3 PUMP SUCTION PIPEWORK

### 11.3.1 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.

### 11.3.2 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.

## 11.4 PUMP DISCHARGE PIPEWORK

Two mechanical couplings or one rubber tyre type coupling shall be provided on each pump's discharge pipework.

## 11.5 REDUCERS

Reducers shall have a maximum angle of divergence of 10º unless otherwise shown on the drawings.

Reducers shall not have more than two longitudinal weld seams.

The taper shall not be welded directly to the flange; i.e. a short cylindrical length of pipe shall be provided between the taper and each flange.

## 11.6 NOZZLES/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.

## 11.7 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.

## 11.8 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.

## 11.9 PUDDLE PIPEWORK

Puddle pipes to be permanently cast into concrete shall be of EN Grade 1.4401 (316), or of EN Grade 1.4462 (2205 duplex), or of cast iron.

Puddle pipes shall be a straight length, flanged both ends and with a puddle flange. Adequate clearance shall be provided between the wall surface and the flanges for inserting flange bolts and for the handwheel/actuator of the isolation valve but the length shall be kept as short as feasible.

The puddle flange shall be of the same diameter of a normal flange and shall be positioned in the central plane of the wall. It shall be of the same material as the pipe. Puddle flanges shall have a plate thickness of at least half the thickness of the standard flange.

The surfaces not directly protected by encasement in concrete shall receive the full corrosion protection system. The coating shall extend about 50 mm into the concrete but the area in contact with the concrete shall otherwise be uncoated. The uncoated area shall be abrasive blasted to promote bonding.

Puddle pipes shall be cast into structures only after the Engineer has approved the Contractor's proposed method statement for the grouting process.

Refer, also, to the clause "Civil and Building Works".

## 11.10 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 Aur 7023.

  

## 11.11 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.

## 11.12 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.

## 11.13 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.

## 11.14 MARINE PIPEWORK

Pipework containing sea water or brine shall be of EN Grade 1.4410 (2507).

One bolted hatch shall be provided upstream of each valve and shall be sized to allow entrance of a large human hand.

## 11.15 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.

## 11.16 CORROSION PROTECTION OF PIPEWORK

Corrosion protection shall comply with Aur 0003.

## 11.17 SITE WORKS

In accordance with FIDIC General Condition 4.7, the Contractor shall make allowance for the misalignment of other pipework to which the Contractor’s pipework is to be connected.

## 11.18 INSPECTION AND TESTING REQUIREMENTS

Where dispute arises regarding acceptance of welds, the requirements of SANS 10044 Part 3 shall be complied with.

The Contractor shall make all arrangements and carry transport and accommodation costs for the Engineer to inspect the pipework after fabrication but before any corrosion protection.

  

The Contractor shall perform the following (in the presence of the Engineer unless otherwise agreed):

a) Pre-manufacturing approval of quality control documentation.

b) 100 % dye penetrant testing of all welds.

c) 10 % of welds to be X-rayed (this percentage will reduce if welds are found to be in order during initial testing). On discovery of defective welds the Engineer may call for radiographic examination until it is shown that the necessary standard is being maintained. Repairs of welded joints will be permitted and the repair procedure and performance of repairs shall be in accordance with Section 10 of API Specification 5L.

d) Visual inspection of pipework.

e) Paint thickness measurements.

f) Pipelines which are not fully visible and/or below ground shall be pressure tested to 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.

g) Provide inspection reports.

## 11.19 FLOW VELOCITY IN PIPEWORK

### 11.19.1 Water

Where the pipe diameter is not specified, the design flow velocities for grit free water (water, effluent, centrate and supernatant) and for high solids water (wastewater and sludge) shall be as follows:

| DESIGN FLOW VELOCITY [m/s] | | | | |
|---|---|---|---|---|
| | *flow = 0 - 2,5 ℓ/s* | *flow = 2,5 - 15 ℓ/s* | *flow = 15 - 100 ℓ/s* | *flow = 100 - 500 ℓ/s* |
| grit free | < 0,75 | < 1,25 | < 1,5 | < 2 |
| high solids | 0,8 – 1,5 | 0,8 – 1,5 | 1 – 1,75 | 1 - 2 |

### 11.19.2 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.

# 12. 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.

# 13. PLASTIC PIPEWORK

Polyethylene or Polypropylene pipes shall comply with SANS/ISO 4427 and SANS 15874 respectively and shall carry the SABS mark.

PVC pipework is not acceptable for applications involving vibration or shock, including hydraulic shock.

An operating life of 50 years shall be designed for and appropriate de-rating factors shall be applied to suit the application. The class of pipe selected shall be not less than 1,5 times the actual maximum operating pressure.

Plastic pipework installed externally shall be provided with protection against ultraviolet light.

Tappings, for example for gauges, shall be provided with welded, external doubler plates. The plates shall have a thickness at least equal to the wall thickness of the pipe.

Welding of thermoplastic pipework shall comply with SANS 10268.

# 14. 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".

# 15. ELECTRIC MOTORS SMALLER THAN 30 KW

## 15.1 PREAMBLE

Induction motors smaller than 30 kW shall comply with this clause.

## 15.2 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 ºC rise capability) with a designed Class B temperature rise (80 ºC). 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.

## 15.3 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 ºC and at an altitude of at least 1 500 masl.

## 15.4 OPERATION AND CONTROL

Protection against both starting overload and running overload shall be provided.

## 15.5 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.

## 15.6 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.

Bearings shall comply with the clause "Bearings" in Aur 0001.

## 15.7 CORROSION PROTECTION

Motors shall be provided with a corrosion protection system which is suitable for the high corrosivity category, C4, of SANS 12944-2.

The fan cowl shall preferably be of cast iron or of stainless steel. For internal applications, plastic fan cowls are acceptable. Carbon steel cowls are acceptable if hot-dip galvanised. Painted carbon steel cowls are not acceptable.

## 15.8 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.

### 15.9 SAFETY

Rotating parts shall be guarded as required by legislation.

## 16. ELECTRIC MOTORS OF 30 KW AND LARGER

### 16.1 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.

### 16.2 GENERAL REQUIREMENTS

Motors shall be in accordance with SANS 60034.

The type of motor and starter to be provided by the Contractor shall be determined by the requirements of the application specified and by any starting limitations specified. In the absence of such specifications, a squirrel cage motor shall be provided. If a special motor is required to obtain special starting characteristics and/or variable speed, this shall be to a standard at least equal to this specification and shall incorporate all aspects of electrical protection.

Motors with a rating below 1 000 kW shall be squirrel cage motors with cooling to IC 0141 (similar to “tefc”). Ingress protection shall be IP 55 or higher.

Motors with a rating above 1 000 kW shall be squirrel cage motors of CACA configuration with an ingress protection rating of at least IP 55 and shall be provided with oil lubricated sleeve bearings.

Motors shall be suitable for both "continuous running duty", Duty Class S1, and "intermittent periodic duty", Duty Class S3. Windings shall be insulated with Class F material (100 ºC rise capability) with a designed Class B temperature rise (80 ºC). The motors shall be suitable for 6 starts per hour, two of which shall be consecutive.

Wound rotor motors shall have a separate enclosure for the slip-ring assembly to ensure that dust from the slip ring followers does not enter the motor. The enclosure shall have the same ingress protection as the main motor enclosure but shall have covers for direct access. The rings shall preferably be of stainless steel.

Motors shall be structurally suitable for DOL starting regardless of the specified starting system.

The frame and end covers shall locate on a spigotted register to ensure concentricity and parallelism.

Motors shall be provided with lifting eyes or lugs.

An earth terminal shall be provided on the frame.

Access shall be provided to the winding neutral point.

All monitored motor parameters; e.g. bearing temperature, winding temperature, current, etc.; shall be appropriately indicated.

Motors shall be of the reduced noise level type.

At least one internal cooling circuit fan shall be provided for frame sizes 355 and larger.

Motors of size 75 kW and above shall be fitted with "pocket" heaters. These shall be arranged to switch on when the motor stops operating and switch off when the motor starts operating.

A stainless steel rating plate shall be secured to the frame with stainless steel fasteners. This shall include the machine's lubrication details. If the manufacturer's nameplate does not comply with these requirements, 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.

## 16.3 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 ºC 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.

## 16.4 400 VOLT MOTORS

400 Volt motors shall be designed to operate on a 3-phase, 4-wire, 400/230 volt, 50 Hz, AC supply.

## 16.5 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.

## 16.6 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.

## 16.7 VFC DRIVEN MOTORS

Motors fed by frequency converters shall comply with the following:

- 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.
- Motors shall incorporate an insulated bearing and an earthing brush (or other approved protection against damage to the bearings from induced currents).
- Motors, unless submersible or immersible, shall be cooled by auxiliary constant speed motor driven fans.

The Contractor shall submit the following to the Engineer.

- Confirmation that the motors comply with the requirements of SANS 60034-25 for the application.
- 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.
- 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.
- Guaranteed VFC dip ride through capability curve.
- Copy of VFC type test certificate (this is required if type tests have been carried out on the model).

## 16.8 BEARINGS

Bearings shall comply with the clause "Bearings" in Aur 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.

## 16.9 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.

## 16.10 CORROSION PROTECTION

Motors shall be provided with a corrosion protection system which is suitable for the high corrosivity category, C4, of SANS 12944-2.

## 16.11 HAZARDOUS LOCATIONS

If the specification calls for a motor tor 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.

## 16.12 SAFETY

Rotating parts shall be guarded as required by legislation.

# 17. PLINTHS & BASEFRAMES

## 17.1 GENERAL

Rotating equipment shall be mounted on a metal baseframe and shall not be mounted directly onto concrete.

The Contractor shall provide the baseframe, anchor fasteners, grouting, chemical anchor, etc. and is responsible for all installation work, including anchoring of the baseframe 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 baseframes. This requirement applies to both direct coupled and to belt driven machines.

Separate baseframes may be provided for equipment above 1 000 kW. Base frames for units of this size shall be grouted within (encapsulated in) their concrete plinths.

The Contractor shall submit the baseframe workshop drawings to the Engineer for acceptance.

## 17.2 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).

## 17.3 SOLEPLATES

Sole plates; i.e. plate supports for equipment feet which are individually anchored into the concrete plinth; are acceptable as baseframes 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.

## 17.4 ANCHORED BASEFRAMES

### 17.4.1 General

The baseframe 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.

Baseframe 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 baseframe 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.

### 17.4.2 Dimensions

Baseframes 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 baseframe.
- The longitudinal member shall have a height of at least 0,18 times the width of the baseframe.

Baseframes 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 baseframe (but with a minimum of 4,5 mm).

### 17.4.3 Materials

Carbon steel baseframes shall preferably be fabricated from steels complying with SANS 50025 for grade S 355 JR or for grade S 355 JO.

Baseframes may also be fabricated of 3CR12 or of EN Grade 1.4162 (LDX 2101) stainless steel.

### 17.4.4 Fabrication

Fabrication and welding shall comply with the requirements elsewhere in Aur 0001.

### 17.4.5 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 baseframes shall be hot-dip galvanized in accordance with Aur 0003. Baseframes 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 Aur 0003.

EN Grade 1.4162 (LDX 2101) stainless steel and other stainless steels need not be coated.

### 17.4.6 Anchor Fasteners

Baseframe 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.

Baseframe anchor fastener size shall be in accordance with the table below.

| Pump Inlet Size | Minimum Fastener Size |
|---|---|
| DN 50 | M10 |
| DN 100 | M12 |
| DN 200 | M12 |
| DN 300 | M16 |
| DN 400 | M20 |
| DN 500 | M24 |
| DN 600 and larger | M30 |

The number of baseframe 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 |

### 17.4.7 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.

### 17.4.8 Installation

Not more than three shims may be used at any point and these shall be of a corrosion resistant material.

The baseframe and plinth shall form a structural unit (i.e. the baseframe and plinth vibrate as a unit) and, to achieve this, the baseframe anchors must transfer force into the concrete. It is not acceptable to provide a nut below the baseframe for level adjustment as this will prevent correct anchoring.

Concrete surfaces under baseframes shall be scabbled before the baseframe is placed and shall be clean. Dust shall be removed from the surface by compresed air immediately before grouting.

Baseframes shall be grouted in a manner which will eliminate collection points for water or dirt.

The material used for grouting shall be a non-shrink, cementitious grout (ABE Duragrout 1000, or equivalent). ABE Epidermix 324, or equivalent, is acceptable if an epoxy grout is required. The first unit grouted shall be overseen by the grout supplier's technical representative.

Final equipment alignment shall be done after installation and grouting has been completed.

### 17.4.9 Inspections

The Contractor shall arrange for the Engineer to inspect the fabrication of the baseframe before corrosion protection.

## 18. SKID MOUNTED EQUIPMENT

Skid baseframes shall comply with the design requirements for anchored baseframes. They shall be single fabricated units.

The baseframe shall be provided with four jacking points and four lifting points.

Equipment shall be secured to the baseframe on anti-vibration mounts.

Skid baseframes shall be placed on anti-vibration rubber mats, “Tico pad” or equivalent. These shall provide a gap between the skid and the concrete in order to prevent pooling of liquids (in addition to vibration isolation). The elastomeric materials shall be resistant to oil.

## 19. 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.

## 20. SHAFT COUPLINGS

Shaft couplings shall be selected to reduce transmission of misalignment forces and of torsional oscillations between the driving and the driven machine. Couplings shall, wherever practical, be of the rubber tyre or rubber compression type, keyed to the shafts.

Elastomeric elements shall be urethane based. Flexible metallic elements shall be of stainless steel. Couplings shall not require lubrication.

Spacer couplings shall be used where required for disassembly of the equipment. It shall be possible to dismantle the coupling without having to move either the driver or the driven equipment.

Coupling guards shall comply with the requirements of the OHS Act and shall be to the approval of the Engineer.

After installation, the alignment of all couplings shall be checked by the Contractor in the presence of the Engineer or a person delegated by him. Alignment shall be accurate and to the approval of the Engineer.

## 21. 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 taperlock pulleys with taperlocks keyed to the shaft.

Where alternative pulley diameters can be selected, preference must be given to the larger pulley diameters to minimize the belt loading on bearings.

The bearing arrangements of driving and driven machinery shall 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.

# 22. DRIVEN GEARBOXES

## 22.1 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.

## 22.2 SERVICE FACTOR

### 22.2.1 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.

### 22.2.2 Engine driven gearboxes

The service factor to be used for engine driven gearboxes shall not be less than 2.

## 22.3 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.

## 22.4 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.

## 22.5 OIL CHANGE

The Contractor shall drain and replace oil in all gearboxes during the Defects Notification Period.

## 22.6 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 micron.

# 23. MANUAL GEARBOXES

An over-torque limiting device shall be incorporated.

Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel.

A breather designed to prevent moisture from entering shall be fitted.

# 24. BEARINGS

## 24.1 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.

## 24.2 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.

## 24.3 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.

## 24.4 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.

## 24.5 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:

$T_{trip} = T_{equilibrium} + (40^oC - T_{ambient}) + 10^oC$.

(This assumes that the bearing is operating correctly.)

### 24.6 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.

## 25. LUBRICATION

### 25.1 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.

### 25.2 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.

### 25.3 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.

### 25.4 SUBMERGED BEARING HOUSINGS

Submerged bearing housings shall be grease lubricated by motorised lubrication. The seals shall be arranged to avoid overgreasing 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.

# 26. GAUGES

## 26.1 CONSTRUCTION

Gauges shall be of industrial construction. The case and bezel shall be of stainless steel unless this material is unsuitable for the application.

Pressure, vacuum or compound gauges shall comply with SANS 1062 and shall bear the Standards mark. Gauges shall be of Accuracy class 1.6 and Durability grade A.

The gauge reading shall indicate gauge pressure unless absolute pressure measurement has been called for.

Gauges shall have a scale diameter of not less than 100 mm.

Calibration shall be in mWC (metres Water Column). The units of measurement shall be clearly marked on the dial.

The scale shall be chosen so that the expected pressure is not less than half full scale reading but the full scale reading for a gauge on the discharge leg of a centrifugal pump shall be higher than the pump shut off head.

Wherever applicable, gauges shall be clearly strip marked in green to indicate the normal operating range and in red to indicate the non-permissible range of values.

Gauges shall be suitable for continuous operation and shall be glycerine filled on all pump applications and where fluctuations in pressure may cause damage.

Scale markings shall be radial, plain, straight, black lines on a white background and shall be spaced so that one scale division represents approximately 1,5 % of the maximum scale value in values of 1, 2 or 5 multiplied by any power of 10 to suit the maximum operating rating. On circular gauges the scale shall be concentric and the maximum and minimum scale values shall be near the bottom of the gauge, with the scale symmetrically disposed about the vertical centre line of the gauge. The tip of the pointer shall be of the knife edge type extending across the scale divisions and shall be as close as practical to the dial.

## 26.2 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.

# 27. ELECTRONIC INSTRUMENTATION

Environmental protection of electronic instrumentation shall be as follows:

a) Instrumentation and associated displays and transmitters which are either located inside or located outside and above ground level shall have IP 55, or higher, rating.

b) Instrumentation and associated displays and transmitters which are located in underground chambers shall have IP 68 environmental protection. The instrument shall be mounted in an enclosure which shall provide physical protection and shall be self-draining.

c) Instruments and associated displays and transmitters which are located outside buildings shall be mounted in enclosures. Enclosures shall be of polycarbonate construction with transparent front, Fibox EK or equivalent. The complete enclosure installation shall have an IP 55 rating or higher. The enclosure size shall be chosen to provide a clearance of at least 100 mm all around the instrument.

Instruments and their cabling shall be protected so that electromagnetic interference does not affect their operation and signal transmission.

Instruments shall have permanently affixed nameplates.

Calibration certificates shall be included in the Manual.

# 28. GUARD RAILS

## 28.1 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.

## 28.2 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.

## 28.3 DESIGN REQUIREMENTS

Guard railing shall be designed to resist the loadings set out in SANS 10160.

Hand and knee rails shall have an outside diameter of not less than 33 mm and a wall thickness of not less than 2,5 mm and a maximum span of 1 500 mm (greater spans will be acceptable if heavier tube dimensions are used).

Tubular stanchions shall have a wall thickness of at least 3,0 mm.

  

On platforms, walkways, landings or around dangerous areas the vertical height, measured from the top of the hand rail to the floor or surface, shall be at least 1 000 mm.

On stairways and fixed ladders the rails shall be parallel to the strings, and the vertical height, measured from the top of the hand rail to the nosing of the tread, shall be at least 900 mm.

No opening between rails shall allow the passage of a ball of diameter 600 mm.

Stanchions and rails shall be smoothly finished and free from sharp corners, edges and projections which may injure persons or damage clothing. Stanchion bases shall have the corners rounded or sheared off.

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.

## 28.4 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:

a) The structural design shall be done in accordance with the requirements of SANS 10104.

b) No opening in guard railing installed in public places shall allow the passage of a ball of 100 mm diameter.

## 28.5 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.

  

### 28.6 STAINLESS STEEL AND 3CR12 GUARD RAILS

Fabrication and welding shall comply with the clauses “Fabrication of Carbon Steel and Stainless Steel” and “Welding”.

### 28.7 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.

## 29. 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. Fasteners shall be of EN Grade 1.4401 (316), or better.

GRP grid flooring is not acceptable.

## 30. FASTENERS

### 30.1 STANDARDS

Bolts and nuts shall be hexagon head type complying with SANS 1700 with threads of the coarse pitch series.

### 30.2 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.

### 30.3 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.

## 30.4 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.

## 30.5 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 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.

## 30.6 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.

## 30.7 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.

  

### 30.8 ANTI-SEIZE COMPOUND

Before assembly, stainless steel threads shall be treated with a nickel-based, anti-seize/corrosion protection compound such as Chesterton 725 : Nickel Anti-Seize Compound, or equivalent. Copper based compounds are not acceptable.

A small amount of the compound shall be applied along the full length of the exposed thread before fastening. Excessive compound visible on the thread after the nut has been applied is unacceptable and indicates that the compound has not been used correctly.

### 30.9 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.

### 30.10 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.

## 31. 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 baseframe and the concrete plinth. When mounted on the vibration isolators, distortion of the baseframe 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.

## 32. NOISE CONTROL

### 32.1 GENERAL

Noise emitted by equipment shall be kept to a minimum and shall not exceed the noise levels specified in these documents.

### 32.2 NOISE LEVELS

The sound power of any equipment shall not exceed 89 dB(A) (referred to $10^{-12}$ Watts) unless specifically approved by the Engineer. This is approximately equivalent to a sound pressure level of 81 dB(A) at a radius of one metre from the acoustical centre assuming uniform hemispherical propagation in a free field on a hard floor. In certain instances, a lower noise level may be called for.

Where the Contractor is unable to restrict the noise level of the machines to the maximum specified by the appropriate selection of suitable equipment; e.g. by selecting slow speed or silent type machines, quiet type cooling fans, suitable silencers, etc.; the Contractor shall inform the Engineer so that appropriate steps can be taken to counteract the effects of noise.

### 32.3 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 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.

### 32.4 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.

## 33. 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 ºC.

Pipe insulation shall consist of pre formed insulation material having a thermal conductivity of approximately 0,040 W/m ºK at 60 ºC. The insulation material shall not have any corrosive effect on the pipework and, in particular, it must be noted that fibreglass may not be used on stainless steel.

Inside buildings, or in other protected areas, pipe insulation shall be supplied with a canvas covering having a 50 mm lap at one end and along the longitudinal seam. The laps shall be sealed using a suitable lagging adhesive. On bends the insulation material shall be neatly mitred and covered with canvas. At all flanges the insulation shall be closed off. Flanges, couplings, tees and valves shall be insulated using a removable canvas blanket or jacket fastened in place with brass hooks and eyes.

All insulation shall be coated with a suitable sealer and then painted in accordance with the colour code. The manufacturer shall advise regarding the paint types and system to be used.

Outside buildings or in other exposed areas pipe insulation shall be fixed in position using three bands per section or a suitable adhesive and then clad with aluminium. All longitudinal and circumferential joints shall incorporate a 50 mm lap with each edge grooved. The longitudinal joints shall be positioned in the "twenty past" position with the lap and groove downwards. All ends next to couplings or flanges shall be closed off and sealed before fitting muff type insulation and cladding over the couplings and flanges. All bends, tees and other fittings shall also be insulated and clad but valves need not be insulated. All joints shall be primed and sealed using a silicone or other appropriate sealer and the contractor shall generally ensure that the lagging is weatherproof with particular attention being paid to all joints and pipework support or anchor points.

With large exposed items such as vessels mounted outside, a suitable system incorporating a 20 mm thick, smooth layer of weatherproof, reinforced plaster covered with a scrim cloth and overcoated with at least two coats of fibre reinforced resin sealer shall be acceptable.

## 34. 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.

## 35. SIGNAGE

### 35.1 GENERAL

All signs as specified below shall be installed prior to commissioning.

## 35.2 OPERATING INSTRUCTIONS

Operating instructions shall be framed and shall be attached to the wall in the control room using brass screws. The frame shall be of wood or aluminium with a glass front and hardboard backing. They shall include the following:

a) 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.

b) A layout drawing of the equipment installation.

c) A process flow diagram.

d) A P&ID.

## 35.3 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:

a) All statutory and special safety warning instructions.

b) Course of action during/after electrical shock.

c) Any operating restrictions for equipment.

d) Operating instructions in cases of plant trip and electrical supply failure.

e) Spares list.

# SPECIFICATION: AUR 0002

## OPERATING AND MAINTENANCE MANUAL

CONTENTS LIST

## 1. INTRODUCTION

Aur 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.

## 4. FORMAT AND CONTENTS

The Manual shall comply with the following format:

| 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:<br>**S**tart-up, adjustment, operating and shut-down procedures for manual and automatic operation - **E**mergency operating procedures - **P**rocess verification - **S**ettings, setpoints, protection, alarms and trips.<br>A paper copy of this document shall be provided to each trainee. |
| 2.2 | Commissioning | Trainee attendance registers & Commissioning results. |
| **3** | **Maintenance Schedule** | |
| | | Schedule of routine maintenance for all **mechanical**, **electrical**, **instrumentation** and **control** equipment, broken down into daily, weekly, monthly and annual periods.<br>The schedule shall be all-inclusive but may refer to manufacturer's standard manuals in other parts of the Manual.<br>The schedule shall include **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.<br>- Dimensioned drawing.<br>- A photograph of the nameplate.<br>- Manufacturer's operating and maintenance manual.<br>- Operating curves, test results, etc. |
| 4.2 | Equipment item 2 (e.g. mixers) | ditto |
| 4.3 | etc. | ditto |
| **5** | **Electrical Equipment** | |
| 5.1 | Equipment item 1 (e.g. transformer) | As for 4.1 above; *PLUS:*<br>**C**ontrol and electrical details, including logic sequence, circuit diagrams and software, as applicable - **E**lectrical reticulation drawings - **E**quipment overall dimensions - **W**iring diagrams - **S**witchboard layout drawings - **S**LDs. |
| 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; *PLUS:*<br>**C**ircuit diagrams of instrumentation systems and of individual instruments - **I**nstallation arrangement - **N**ormal operating range - **C**alibration 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 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. |

# SPECIFICATION: AUR 0004

## Operation and Control

CONTENTS LIST

## 1. INTRODUCTION

Aur 0004 specifies the standard requirements for control systems.

## 2. SCOPE OF WORKS

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 (Aur 0004).

b) The Occupational Health and Safety Act and Regulations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. EQUIPMENT ELIGIBILITY

Equipment provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Equipment which does not satisfy these requirements is not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

## 5. REQUIREMENTS FOR ALL CONTROL SYSTEMS

Control Systems shall incorporate the following:

- Emergency stop stations shall be provided near to each motor driven unit.
- Manual operation of all items of equipment shall be provided in addition to any automatic and/or motorised operation which is specified.
- Equipment which is controlled automatically shall be provided with protections against damage during start up.

- Shut down shall be engineered to occur safely and without damage. This applies to normal conditions, emergency conditions and also to power failure.

Protection systems which prevent damage to equipment shall be active during manual operation of equipment (unless this is not feasible or sensible).

Setpoints for equipment and process parameters which are required for the operation of control systems shall be obtained once the equipment is operational and these shall be provided in the Manual.

# 6. CONTROL PANELS

Each motor starter cubicle shall include the following equipment:

- Circuit breaker (complete with auxiliary contacts for control circuits).
- Contactor.
- Overload relay with manual reset.
- Ammeter (CT based, if above 40A).
- Starter alive indicating light (Red).
- Motor running indicating light (Green).
- Running hour meter.
- Selector switch.
- Stop push button.
- Start push button.

# 7. SYSTEMS WITH PLC/SCADA CONTROL

## 7.1 DESIGN

Control systems utilising PLC/SCADA systems shall be configured so that the installation will be able to operate under PLC control following a failure of the SCADA system.

## 7.2 MIMICS

Mimic screens provided for SCADA systems shall include the following:

- Overview; including the process flow diagram and indicating all electronically monitored parameters which are not included in a sub-system.
- Overview of each plant grouping.
- Individual unit (Centrifuge, compressor, pumpset, etc.).
- Equipment sequence selection.
- Equipment start interlocks.
- For each motor larger than 55 kW, motor status and, where applicable, motor protection relay diagnostic.
- Electrical reticulation schematic.
- Hardware diagnostic.
- Alarms.

- Set points for alarm, trip and control loop functions (including password protected alteration facility).
- Event log.
- Record of equipment and process parameters at instant of equipment trip and station trip.
- Communication status of control system hardware.
- SCADA security system current settings, including personnel names.
- Ancillary equipment status; e.g. security, fire detection, UPS.
- Printing.

Any of the above mimic screens which are not applicable to a particular Contract may be excluded.

### 7.3 TRENDING

Trend screens of monitored parameters shall be provided for 3 hours, for 7 days and for 3 months (unless the nature of the parameter demands different scales).

### 7.4 PRINTERS

One colour printer for graphs, mimics, etc. and one printer for events and alarms shall be provided.

### 7.5 ALARMS

The control system shall provide an alarm if an instruction to an item of equipment to start or stop does not cause that item to start or stop.

Alarm conditions which lead to an equipment trip shall be logged. The condition which caused the trip shall be described with respect to the:

- Item of equipment.
- Trip setpoint reached.
- Description of parameter; i.e. flow, temperature, etc.
- Time of event.

Subsequent alarms which occur as a result of the tripping action shall be logged as subordinate alarms.

### 7.6 DIGITAL INDICATION OF PARAMETERS

Three significant places shall be used for representation of values on SCADA systems.

## 8. SPARES

The spares which are to be provided are specified elsewhere.

# 9. TESTING REQUIREMENTS

## 9.1 FACTORY TESTING

The Contractor shall make all arrangements and carry all costs for the Engineer to attend a factory inspect test in the workshop.

## 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) |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

# SPECIFICATION: Aur 1001

## Permanent Ladders

CONTENTS LIST



  

# 1. INTRODUCTION

Aur 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 (Aur 1001).
- Aur 0001: General Mechanical Requirements.
- Aur 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. CONSTRUCTION & DESIGN

## 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).

Rungs for hot-dip galvanised carbon steel ladders shall be one of the following (in order of preference):

- 20 mm carbon steel rebar,
- 20 mm carbon steel round bar,
- 20 mm carbon steel square bar (with sides horizontal and vertical; i.e. not diamond configuration).

Rungs shall be welded to strings. It is not required that rungs penetrate strings.

The top rung shall be level with the upper landing. Additional rungs shall be provided in the same horizontal plane as the top rung in order to close the gap behind the ladder. These additional rungs shall have a spacing of approximately 75 mm.

## 4.2 TOP STRUCTURE

The strings shall extend to at least 1 100 mm above the upper landing and shall complement any guard rails at this level.

The top structure shall be rigid and shall be designed so that the climber's hand slides along the gripped members without snagging.

Access to the head of ladders from platforms and walkways shall be protected by self-closing gates or by chains.

Ladder/guard rail connections between stainless steel and hot-dip galvanised steel shall be bolted.

Footings onto concrete shall have minimum dimensions of 150 mm X 150 mm X 10 mm plate thickness. If the horizontal surface to which the foot is to be fastened is less than 150 mm wide, the foot shall be designed to be seated securely on at least two surfaces. Four fasteners, of minimum size M16, shall be used to anchor the foot.

Footings onto steel structures shall have minimum dimensions of 150 mm X 60 mm X 8 mm plate thickness. Two fasteners, of minimum size M16, shall be used to secure each foot. Neatly fitting packing, Denso tape or equivalent, shall be fitted under the feet to completely seal the crevices between the two metallic surfaces.

## 4.3 CAGE

If the ladder exceeds 5 000 mm in length, it shall be provided with a cage which extends from 2 300 mm above ground level to at least 1 100 mm above the upper landing served by the ladder. The cage shall comprise no fewer than five vertical elements in addition to the strings. The vertical distance between horizontal hoops shall not be greater than 1 000 mm.

The safety cage "shall afford firm support along its whole length for the back of the person climbing the ladder, and for which purpose no part of the cage shall be more than 700 mm away from the level of the rungs." (as per OHS General Safety Regulations). The preferred dimension is 650 mm.

Hoops and verticals shall be formed from 50 mm X 8 mm flat bar, or larger.

  

### 4.4 PLATFORMS

Platforms shall be provided in accordance with the requirements of the OHS Act.

Ladders with a height greater than 10 metres shall be provided with intermediate landings which are spaced apart by not more than 8 metres.

Platforms and landings shall be 850 mm X 850 mm or larger. They shall be provided with guard rails and kick plates complying with Aur 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 Aur 0003.

### 4.6 FABRICATION

Fabrication and welding shall comply with Aur 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 Aur 0001.

## 5. INSTALLATION

Installation work shall comply with Aur 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.

## 6. 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 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).

## 7. 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.

# SPECIFICATION: AUR 1003

## Lifting Equipment

  

  

## 1. PREAMBLE

Part A of Aur 1003 specifies general requirements for all lifting equipment to be provided by the Contractor.

Part B of Aur 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 (Aur 1003).

b) Aur 0001: General Mechanical Requirements.

c) Aur 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

d) Aur 1001: Permanent Ladders.

e) SANS 50025: Hot Rolled Products of Structural Steels.

f) SANS 2063: Metallic and other inorganic coatings – Thermal spraying – Zinc, aluminium and their alloys.

g) SANS 4310: Cranes – Test Codes and Procedures.

h) BS 466: Specification for Power Driven Overhead Travelling Cranes, Semi-Goliath and Goliath Cranes for General Use.

i) BS 2573: Rules for the Design of Cranes. Specification for Classification, Stress Calculations and Design Criteria for Structures.

j) BS EN 1011: Welding. Recommendations for welding of metallic materials.

k) BS 4872: Specification for approval testing of welders when welding procedure approval is not required.

Equipment, materials and operational methods shall comply with the latest edition of the relevant national 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 STANDARD

In accordance with 18. (1) (a) of the Driven Machinery Regulations, lifting equipment shall be designed and constructed in accordance with a generally accepted technical standard for lifting equipment.

The standard used shall be noted on all Contractor's drawings submitted for review.

### 6.2 MANUFACTURER'S IDENTIFICATION PLATE

In accordance with 18. (1) (c) of the Driven Machinery Regulations of the Occupational Health and Safety Act, the manufacturer's identification plate shall be fixed to the equipment and shall display the manufacturer, the design standard, the serial number and the country of origin

### 6.3 GENERAL

Lifting equipment shall be in accordance with the Occupational Health and Safety Act and Regulations and, in particular, with Regulation 18 of the Driven Machinery Regulations.

The guidelines given in the Southern African Steel Construction Handbook may be used where applicable and where these do not conflict with the technical standard.

The safe working load of the lifting equipment ("SWL") shall exceed the heaviest load to be lifted by at least 30 %. The SWL shall be permanently marked on all components.

The lifting equipment will be used intermittently.

The lifting equipment, when erected and installed, shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.

## 6.4 TEST LOAD

The complete installation shall be designed to handle the test load.

## 6.5 FABRICATION

Fabrication and welding shall comply with Aur 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 Aur 0001.

Steel foot-plates for securing steel structures to concrete shall have a minimum of four anchor bolts.

Anchor fasteners shall have a diameter of not less than M16 and shall be of EN Grade 1.4401 (316), or better. Other fasteners, including high tensile fasteners, shall be of stainless steel or of hot-dip galvanised steel. Fasteners which form standard parts of proprietary equipment and do not comply with these material requirements will require an additional anti-corrosion coating to suit the environment.

Chemical anchor shall not be used where the fastener is in tension; i.e. where the load is hung on the anchor fastener. Such anchors shall preferably be through-bolted. Mechanical anchors will also be acceptable but application of the test load on the completed installation shall not cause the loading on the anchor to exceed 45 % of the anchor manufacturer's recommended loading at any position of the load.

## 6.8 CORROSION PROTECTION

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Aur 0003.

## 6.9 MOTORS

Motors shall comply with Aur 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.

## 7. 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.

## 8. ELECTRICAL EQUIPMENT

Electrical Equipment shall comply with the electrical specifications.

## 9. INSPECTIONS

### 9.1 WORKSHOP/FACTORY

The Contractor shall arrange for the Engineer to inspect fabrications at the following stages:

a) after fabrication. During this inspection and in the presence of the Engineer, the Contractor shall conduct dye penetrant testing of all welds on structural members. This includes welding of peripheral items onto structural members (such as brackets for attachment of platform supports).

b) after blasting.

c) after the final coat (but before the items are transported from the coatings yard).

The Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect the equipment for acceptance prior to despatch 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 despatch 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 despatched from the manufacturer's works, this report shall be submitted to the Engineer and shall confirm compliance of the equipment with the specifications.

### 9.2 SITE

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site prior to commissioning.

### 9.3 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.

## 10. TESTING, CERTIFICATION AND USE OF EQUIPMENT

### 10.1 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.

### 10.2 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.

### 10.3 EMPLOYER'S USE OF LIFTING EQUIPMENT

Upon commissioning/taking over/start of the Defects Notification Period, the lifting equipment shall be available.

The Contractor shall provide the following:

- the required inspections [18.(6) of the Driven Machinery Regulations] within the previous three months, and;
- the testing required by [18.(5) of the Driven Machinery Regulations] within the previous six months,

so that the equipment can immediately be used by the Employer fitly and legally. The Contractor shall provide confirmatory documentation at commissioning.

# PART B

# ADDITIONAL REQUIREMENTS FOR PARTICULAR TYPES OF LIFTING EQUIPMENT

## 11. STEEL GANTRIES

### 11.1 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.

### 11.2 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.

### 11.3 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 Aur 1003.

## 12. TRAVELLING CRANES

### 12.1 REQUIREMENTS FOR ALL TRAVELLING CRANES

#### 12.1.1 Preamble

Travelling cranes shall comply with the General Requirements for All Lifting Equipment and with the additional requirements of this clause.

"*Travelling Cranes*" refers to:

- Overhead travelling cranes.
- Goliath cranes
- Semi-goliath cranes.

#### 12.1.2 General

The SWL shall be greater than the weight of the heaviest item of equipment to be lifted, as specified elsewhere in Aur 1003.

### 12.1.3 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.

### 12.1.4 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.

### 12.1.5 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.

### 12.1.6 Operation

All three directions of travel shall be driven by squirrel cage induction motor preferably fed by electronic variable speed drives. Starting and stopping shall be smooth. Inching capability shall be provided for all three directions of travel. Both long and cross travel shall revert to low speed prior to contact with the end stops.

### 12.1.7 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.

### 12.1.8 Crane Hoists

Crane hoists are specified elsewhere in Aur 1003.

### 12.1.9 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.

### 12.1.10 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.

### 12.1.11 Corrosion Protection

The Contractor shall arrange for the fabrication of the crane to be inspected by the Engineer for acceptance at the fabricator's premises prior to corrosion protection.

Smaller items, such as cable brackets and protective covers, shall be hot-dip galvanized.

Crane rails shall be hot-dip galvanized.

The crane beam and end carriages shall be hot-metal zinc-sprayed and sealed and coated. The thermal spray metal coating shall be in accordance with SANS 2063. The minimum zinc coating thickness shall be 150 µm. The sealant shall consist of the application of a two-part epoxy primer to a dry film thickness of 40 µm; (Carboline Rustbond Penetrating Sealer, Intergard 269, thinned Carboguard 545, or equivalent. The coating shall consist of at least two coats of a two-part polyurethane enamel to a minimum combined dry film thickness of 70 µm.

Corrosion protection shall comply with Aur 0003.

### 12.1.12 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 45º chamfer. The Engineer shall be notified prior to application of the grout.

Shims shall be fully grouted in to provide corrosion protection.

### 12.1.13 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.

## 12.2 OVERHEAD TRAVELLING CRANES – ADDITIONAL REQUIREMENTS

### 12.2.1 Preamble

Overhead travelling cranes shall comply with the Requirements for All Travelling Cranes and with the additional requirements of this sub-clause.

### 12.2.2 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 carrriages.

The **end carriages** at each end of the crane beam shall travel on the crane rails.

The **crane rails** shall be supported on the crane rail beams. These beams shall be of hot dip galvanised steel unless the drawings indicate that they are of reinforced concrete. If the beams are of reinforced concrete, they will be provided by others but the Contractor shall timeously submit the requirements for fixing and installation of the crane rails to the Engineer and shall be responsible for performing this work.

The **rail beams** shall be supported on the gantry.

The **gantry** shall be founded on the ground.

### 12.2.3 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.

### 12.2.4 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 Aur 0001. Guard rails shall be provided on the platform and shall comply with Aur 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 Aur 1001.

The design shall ensure that persons on the platform cannot be injured by crane movement.

## 12.3 GOLIATH AND SEMI-GOLIATH CRANES – ADDITIONAL REQUIREMENTS

### 12.3.1 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.

### 12.3.2 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.

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 Aur 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.

## 13. *HOISTS*

### 13.1 PREAMBLE

Hoists, including crane mounted hoists, shall comply with the General Requirements for All Lifting Equipment and with the additional requirement of this Clause.

### 13.2 GENERAL

Hoists shall be provided with an overload prevention device.

The bottom hook shall swivel on a ball or roller bearing through 360º 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.

### 13.3 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.

### 13.4 POWERED HOISTS

Powered hoists shall comply with applicable aspects of the Driven Machinery Regulation 18 of the 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.

## 14. *MANUAL HOIST TROLLEYS*

### 14.1 PREAMBLE

Manual Hoist Trolleys shall comply with the General Requirements for All Lifting Equipment and shall comply with the additional requirements of this clause.

### 14.2 REQUIREMENTS

Manual hoist trolleys shall have chain/gear operated movement.

The operating chain shall be as short as feasible in order to prevent entanglement.

## 15. *CRAWL BEAMS*

### 15.1 PREAMBLE

Crawl Beams shall comply with the General Requirements for All Lifting Equipment and shall comply with the additional requirements of this clause.

### 15.2 REQUIREMENTS

Crawl beams shall be standard hot rolled I-Sections or standard hot rolled H-Sections.

Crawl beams shall be hot-dip galvanised after all fabrication is complete. If the steel is exposed after galvanising by drilling or welding or any other activity, the complete beam shall have the zinc removed by abrasive blasting to bare steel and it shall be returned to the galvanisers for hot-dip galvanising.

Crawl beam anchors shall preferably be through bolted. Expanding bolts are acceptable on condition that the loading during testing does not exceed forty percent of the manufacturer's maximum recommended load. Chemical anchor is only acceptable if the load is perpendicular to the anchor.

Crawl beams fastened to steel support structures shall be secured using hot-dip galvanised fasteners.

Fasteners which secure crawl beams shall be provided with spring washers in addition to the flat or fender washer.

# 16. *DAVITS*

## 16.1 PREAMBLE

Davits shall comply with the General Requirements for All Lifting Equipment and shall comply with the additional requirements of this Clause.

## 16.2 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.

# 17. *HAND CRANKED WINCHES*

## 17.1 PREAMBLE

Hand Cranked Winches shall comply with the General Requirements for All Lifting Equipment and shall comply with the additional requirements of this clause.

## 17.2 REQUIREMENTS

Hand cranked winches shall be rated for a SWL of at least 100 % in excess of the maximum working load. All gears, clutches, etc., shall be enclosed in a robust cast iron, cast steel or fabricated stainless steel casing which shall be grease filled and sealed against ingress of dirt and moisture.

The winch shall hold the load stationary when the hand crank is released during both raising and lowering. In addition, an operator controlled positive locking arrangement to lock the position of the load at any point shall be provided. A simple ratchet alone is not adequate.

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.

# SPECIFICATION: Aur 7012

## Nozzle Check Valve

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## 1. INTRODUCTION

Aur 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 400.

## 2. SCOPE OF WORKS

See project specification.

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 (Aur 7012).
- Aur 0001: General Mechanical Requirements.
- Aur 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- Aur 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.

## 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.

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.

## 6. DESIGN AND CONSTRUCTION

Bodies shall be of ductile iron, cast steel or of cast stainless steel.

Seats and seals shall be of stainless steel.

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.

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 Aur 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 Aur 0001.

## 8. MATERIALS AND COATINGS

### 8.1 GENERAL

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Aur 0003.

Materials shall comply with Aur 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 250 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 |
| 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.<br>Metal plating of ferrous materials is not acceptable as the corrosion protection system.<br>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. | | |

## 9. FASTENERS

Fasteners shall comply with Aur 0001.

## 10. SPARES

The spares to be provided are specified elsewhere.

## 11. INSTALLATION

Installation work shall comply with Aur 0001.

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.

## 12. SAFETY

The Contractor shall design and install equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations.

## 13. INSPECTIONS

### 13.1 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 despatch 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 despatch 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 despatched from the manufacturer's works, this report shall be submitted to the Engineer and shall confirm compliance of the equipment with the specifications.

### 13.2 SITE

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site for acceptance prior to commissioning.

### 13.3 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.

## 14. TESTING REQUIREMENTS

### 14.1 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.

## 14.2 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.

# SPECIFICATION: AUR 7023

## Pipe Couplings

CONTENTS LIST

# 1. INTRODUCTION

Aur 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

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:

a) Amendments, Additions and Detailed Requirements (Aur 7023).

b) Aur 0001: General Mechanical Requirements.

c) Aur 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

# 4. EQUIPMENT ELIGIBILITY

The couplings provided shall have a successful record of use locally in similar applications and shall also have had at least three years of technical support locally. Service and spares shall currently be available locally. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Couplings which do not satisfy these requirements are not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

# 5. PERFORMANCE REQUIREMENTS

The coupling shall provide a flexible joint between the two items being connected.

The coupling shall withstand the pipework pressure rating.

# 6. CONSTRUCTION AND DESIGN

## 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.

# 7. FABRICATION

Fabrication and welding shall comply with Aur 0001.

## 8. FASTENERS

Fasteners shall comply with Aur 0001.

## 9. CASTINGS

Castings shall comply with Aur 0001.

## 10. CORROSION PROTECTION

Corrosion Protection shall comply with Aur 0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

## 11. INSTALLATION

Installation work shall comply with Aur 0001.

Pipework shall be aligned correctly and the pipe coupling shall not be used to accommodate visible misalignment in any direction.

## 12. INSPECTIONS

The Contractor shall make arrangements for the Engineer to inspect the couplings for compliance prior to payment being made.

## 13. 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.

# SPECIFICATION: AUR 7024

## Pipework Supports

CONTENTS LIST

# 1. INTRODUCTION

Aur 7024 specifies the requirements for supports for pipework to be provided by the Contractor.

# 2. SCOPE OF WORKS

See project specification.

# 3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

a) Amendments, Additions and Detailed Requirements (Aur 7024).

b) Aur 0001: General Mechanical Requirements.

c) Aur 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

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 pipewok.

# 5. CONSTRUCTION AND DESIGN

## 5.1 GENERAL

In order to achieve the specified performance requirements, the Contractor shall analyse the forces at isolation valves, check valves, bends and at reducers which are present during normal operation, during dormant conditions, during testing, during start up and during shut down of each

pump individually and during operation of the pump station as a whole. The supports shall be designed to transfer all such forces to the concrete structure.

Pipe supports shall be designed and located so that when an item of mechanical equipment, such as a pump or blower, is removed, the associated pipework and equipment is still adequately supported.

Supports shall be provided at or close to all heavy items such as valves of size DN 200 and larger.

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:

Spacing (mm) = 1 500 + 6d.

This applies to pipe only. Valves and other heavy items shall be supported separately.

## 5.3 SUPPORTS FOR PLASTIC PIPEWORK

The maximum allowable spacing between pipe supports for plastic pipe of diameter, d [mm], shall be calculated as follows:

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 baseframe 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.

## 6. FABRICATION

Fabrication and welding shall comply with Aur 0001.

Supports will be inspected by the Engineer after fabrication is complete.

## 7. FASTENERS

Anchor fasteners shall be of EN Grade 1.4401 (316) stainless steel.

Nuts for anchor fasteners shall be provided with both a spring washer and a flat or fender washer.

Fasteners shall comply with Aur 0001.

## 8. CORROSION PROTECTION

Corrosion Protection shall comply with Aur 0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

## 9. INSTALLATION

Installation work shall comply with Aur 0001.

## 10. INSPECTIONS

The Contractor shall make arrangements for the Engineer to inspect the supports for compliance prior to payment being made.

## 11. DOCUMENTS TO BE PROVIDED

Proposed designs of pipe supports, preferably indicated on the General Arrangement design drawings, shall be submitted to the Engineer for review prior to manufacture. The calculations for pipe supports designed to withstand the thrust from reducers, bends and check valves shall also be submitted to the Engineer for review.

# SPECIFICATION: AUR 7030

## Plunger Valves

TABLE OF CONTENTS

# 1. INTRODUCTION

Aur 7030 specifies the requirements for plunger valves of size DN 200 and larger for flow regulation and modulation and which are to be provided by the Contractor.

# 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

# 3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (Aur 7030).
- Aur 0001: General Mechanical Requirements.
- Aur 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- Aur 6004: Actuators.
- Aur 7024: Pipe Supports.
- The Occupational Health and Safety Act and Regulations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

# 4. EQUIPMENT ELIGIBILITY

The valves provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Valves which do not satisfy these requirements are not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

# 5. PERFORMANCE REQUIREMENTS

## 5.1 GENERAL

The valve shall be capable of performing the specified duties and shall be rated for continuous operation at those duties unless non-continuous operation is specified or is inherent in the system design.

## 5.2 PRESSURE REDUCTION

No cavitation damage shall result at any point in the valve's operating range.

## 5.3 LEAKAGE

Valves shall be droptight when closed.

Spindle seals shall not leak.

## 5.4 OPERATION

Valves shall operate smoothly, evenly and without snatch. Excessive vibration is unacceptable.

Valves and their method of actuation shall be designed to open and close at a differential pressure equal to the full pressure rating of the valve.

Handwheels shall not require a peripheral force greater than 250 Newtons during operation (i.e. the sum of the forces on both sides shall not be greater than 250 Newtons) at the full differential pressure rating of the valve.

# 6. OPERATION AND CONTROL

The valve's detailed operating requirements are specified elsewhere.

The plunger operating mechanism shall provide self-locking of the plunger in any position. It shall not rely on the actuator to keep it in position.

Clear indication of current valve position shall be provided.

Valve opening and closing direction shall be indicated.

End of travel indication shall be provided.

Actuated valves shall be provided with manual override. Electric actuators shall also be provided with manual start and stop functions on the actuator.

# 7. VALVE DESIGN AND CONSTRUCTION

## 7.1 GENERAL

Valves shall be double flanged.

The manufacturer's name, valve size and working pressure shall be cast on the valve body or otherwise permanently indicated on the valve.

Valves shall be provided with a DN 50 bypass which shall incorporate an isolating valve. The valve shall be a metal seated wedge gate valve and shall be manually operated.

The plunger shall be guided along its complete travel distance.

The elastomer seal shall be out of the water flow path.

The body shall incorporate storage feet and lifting eyes.

The body shall incorporate a drain and an air release. Both shall be of stainless steel.

A control device with slotted or circular orifices shall be provided if the duty is for continuous operation at pressure differences above 80 metres.

## 7.2 GEARBOXES

Gearboxes shall have ingress protection to IP 55.

Motor driven gearboxes shall comply with Aur 0001. Gearbox service factors shall be chosen in accordance with Aur 0001 or shall comply with the guidelines of AGMA.

Manual gearboxes shall comply with Aur 0001. Suitable gearboxes shall be fitted to achieve the specified operating torque for manual operation.

## 7.3 AUTOMATIC CLOSING

Valves incorporating a weighted lever for automatic closing shall be provided with a protection cage which completely surrounds the lever up to 1 800 mm above floor level. The lever shall be provided with a double bearing arrangement and shall not be cantilevered on the valve shaft.

# 8. VALVE SUPPORTS

Each valve of size DN 300 and larger shall be provided with a separate, dedicated pipe supports.

The pipe supports shall be designed to withstand all thrust forces under all operating conditions unless these forces are directly transferred via pipe flanges to another thrust restraint. Thrust forces shall not be transferred via flange adaptor restraints.

Valve supports shall be of hot-dip galvanised steel.

The valve supports shall comply with Aur 7024.

## 9. ACTUATOR

Actuators shall comply with Aur 6004.

## 10. PIPE COUPLINGS

Adequate couplings shall be provided in order to facilitate dismantling of the valve from the pipework.

The couplings shall not transfer the thrust forces on the valve and shall not be used to support the weight of the valve.

## 11. PRESSURE GAUGES

One pressure gauge shall be provided upstream of the valve and one shall be provided downstream of the valve.

The gauges shall be positioned so that they provide pressure measurement at the valve even if an upstream or downstream isolation valve has been closed.

The gauges shall comply with Aur 0001.

## 12. MATERIALS AND COATINGS

### 12.1 GENERAL

Components shall be designed for corrosion resistance in the application.

Materials shall comply with Aur 0001.

Corrosion protection shall comply with Aur 0003.

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

Metal plating of ferrous materials is not acceptable.

### 12.2 ENVIRONMENT

Environmental corrosion protection shall be suitable for the high corrosivity category (C4 of SANS 12944-2).

## 12.3 EQUIPMENT

Equipment shall comply with the table below.

| ITEM | MATERIAL | COATING |
|---|---|---|
| Valve body | Ductile iron for pressure ratings up to PN 40.<br>Cast steel is acceptable for bodies above PN 40. | Internal and external surfaces of the valve body shall be protected with a water resistant, non-toxic and non-tainting, fusion bonded epoxy pipe coating to a dry film thickness of at least 200 micron (i.e. the minimum readings shall not be less than 200 micron). Specialist applied Rilsan coatings and glass flake coatings will also be acceptable. |
| Plunger | Stainless steel | N/A |
| Plunger guides | Non-ferrous metal or stainless steel (of a different hardness to the plunger) | N/A |
| Seal retaining ring | Stainless steel | N/A |
| Linkages | Stainless steel or coated cast iron. | Stainless steel: N/A.<br>Cast iron: Protected by a water resistant, non-toxic and non-tainting, fusion bonded epoxy pipe coating to a dry film thickness of at least 200 micron (i.e. the minimum readings shall not be less than 200 micron). Specialist applied Rilsan coatings and glass flake coatings will also be acceptable. |
| Pins | Stainless steel | N/A |
| Drive shaft | Stainless steel. | N/A |
| Bushes | Bronze (not brass) or a load bearing engineering plastic. | N/A |

| | | |
|---|---|---|
| Valve trim (seat ring and control sleeve) | Martensitic stainless steel if any one of the following applies:<br>- The pressure difference across the valve is greater than 45 metres at any point in the designed operating regime.<br>- The valve is used for flow regulation more often than once per month.<br>- The system incorporates pump start up against the closed valve which is then opened under full pump shut off head.<br>- The manufacturer recommends martensitic trim<br><br>Austenitic stainless steel for less strenuous duties. | N/A |
| Handwheel | Cast iron or cast aluminium | Manufacturer's standard corrosion protection. |
| Fasteners | EN Grade 1.4401 (316) | N/A |
| External metal components | EN Grade 1.4401 (316) | N/A |

## 13. FABRICATION

Fabrication and welding of fabrications such as valve supports and guards shall comply with Aur 0001.

## 14. FASTENERS

All fasteners on the valve shall be of EN Grade 1.4401 (316), or higher corrosion resistance in the application.

Flange fasteners shall be of hot-dip galvanised steel.

Fasteners shall comply with Aur 0001.

## 15. SPARES

The spares which are to be provided are specified elsewhere.

## 16. INSTALLATION

The design of the pipework installation shall ensure that cavitation damage to the pipework does not occur.

Installation work shall comply with Aur 0001.

## 17. CIVIL AND BUILDING MATTERS

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer.

## 18. SAFETY

The Contractor shall design and install all equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations.

The cage which shall be provided if the valve incorporates a weighted lever shall be designed to ensure that persons are not harmed by the weight raising or lowering unexpectedly.

# 19. INSPECTIONS

## 19.1 WORKSHOP/FACTORY

### 19.1.1 General

The Contractor shall make all arrangements and carry all costs for the Engineer to inspect equipment and fabrications prior to despatch to Site and prior to payment being made.

Fabrications must be inspected by the Engineer after fabrication is complete but prior to corrosion protection.

If the equipment is manufactured in the country, the Contractor shall make all arrangements and carry all costs for the Engineer to inspect equipment in the manufacturer's works prior to despatch to Site.

If the equipment is not manufactured in the country, the Contractor shall make all arrangements and carry all costs for the Engineer or an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to dispatch. The inspection authorities' inspection shall include a full report on compliance of the equipment with the specifications and this report shall be submitted to the Engineer prior to dispatch from the manufacturer's works.

## 19.2 SITE

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site prior to commissioning.

## 19.3 INSPECTION DURING DEFECTS NOTIFICATION PERIOD

The Contractor shall inspect the operation of the Works three months after the start of the Defects Notification Period and shall provide a condition report on all equipment to the Engineer.

# 20. TESTING REQUIREMENTS

## 20.1 FACTORY, ETC.

The valve body shall be pressure tested to 1,5 times the valve's nominal pressure rating.

The valve seating shall be droptight tested to 1,0 times the pressure rating.

The Contractor shall submit reports for all specified factory tests to the Engineer prior to the equipment being transported to Site and prior to payment being made.

## 20.2 SITE

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

a) operation of all equipment.

b) achievement of the specified performance requirements.

c) correct operation of the control system.

The Contractor shall submit site test reports to the Engineer and shall provide copies in the Manual.

## 21. DOCUMENTATION TO BE PROVIDED

The standard technical brochure giving the construction details and the dimensions of the valve shall be provided to the Engineer for review and acceptance.

The valve manufacturer's installation, operation and maintenance instructions for the correct equipment shall be provided in the Manual.

# SPECIFICATION: AUR 10010

## Pump Station (Multi-Stage, Ring-Section, Centrifugal Pumps)

# 1. INTRODUCTION

Aur 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 baseframes.

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 (Aur 10010).
- Aur 0001: General Mechanical Requirements.
- Aur 0002: Operating and Maintenance Manual.
- Aur 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- Aur 1003: Lifting Equipment.
- Aur 1008: Ventilation for Plant Rooms.
- Aur 7001: Design and Manufacture of Medium-Pressure Steel Pipework Specials.
- Aur 7012: Nozzle Check Valves for Water.
- Aur 7014: Eccentric Axis Butterfly Valves.
- Aur 7015: Metal Seated Wedge Gate Valves.
- Aur 7021: Double Door Check Valve with Vertical Axes.
- Aur 7023: Couplings and Flange Adaptors.
- Aur 7024: Pipe Supports.
- SANS 1123.
- BS EN 1092.
- 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

### 5.2.1 General

Each item of equipment shall comply with the performance requirements of the relevant Aur spec. Each shall be rated for continuous operation at the specified duties unless otherwise specified.

All components shall perform reliably over the specified range.

### 5.2.2 Pumps

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 Aur 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 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.

The following alarms shall cause a system shut-down of the diesel engine (if applicable):

- high engine coolant temperature (unless air cooled).
- low engine coolant flow (unless air cooled).
- low engine oil pressure.
- high ambient temperature in room (if applicable).
- overload.

### 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:

$$T_{shut\text{-}down} = T_{equilibrium} + (40^{o}C - T_{ambient}) + 10^{o}C.$$

The pump shall shut down if $T_{shut\text{-}down}$ is reached.

#### 6.2.2.2 Motors

Bearings of electric motors shall be provided with the same temperature protection as the pump bearings.

### 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 & 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 Aur 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 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.

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 $V_{RMS}$ = 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 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 Aur 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 Aur 0001.

## 8.8 BEARINGS

### 8.8.1 General

Bearings shall be mounted external to the pump casings.

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 Aur 0001.

### 8.8.2 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.

### 8.8.3 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.

### 8.8.4 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 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 Aur 7014. Metal seated wedge gate valves shall be double flanged and shall comply with Aur 7015.

### 9.2 CHECK VALVES

A check valve shall be provided on the discharge leg of each pump.

Check valves shall be of the vertical axis, double door type or shall be of the nozzle check type.

Vertical axis, double door valves shall comply with Aur 7021 and may be of wafer configuration.

Nozzle check valves shall comply with Aur 7012 and shall be double flanged.

### 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 Aur 0001. This, inter alia, specifies that the design and manufacture of pipework shall comply with Aur 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 Aur 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 Aur 7023.

## 10.5 PIPE SUPPORTS

Pipe supports shall comply with Aur 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 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 Aur 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. DIESEL ENGINE DRIVES FOR PUMPS

### 12.1 GENERAL

The engine and pump shall be mounted on anti-vibration mounts within a rigid baseframe.

The installation shall meet the requirements and approval of the engine manufacturer.

### 12.2 SPEED AND POWER

The engine shall operate at no more than 85 % of its rated full speed.

The engine's continuous power output rating at operating speed shall be at least 26 % greater than the shaft input power required by the pump's maximum power draw at any point in its specified operating range. This engine rating shall be the net power, i.e. over and above the

power consumed by all driven accessories. This requirement is expressed algebraically in the table below.

| Factor | Power [kW] |
|---|---|
| Shaft input power required by pump at the maximum power draw | = X |
| Power required by engine accessories | = Q |
| **MINIMUM ALLOWABLE DIESEL ENGINE SHAFT OUTPUT CONTINUOUS POWER RATING AT OPERATING SPEED.** | **= Q + (1,26)(X)** |

The power rating shall be in accordance with an approved British Standard or other approved by the Engineer.

## 12.3 ENGINE ENVIRONMENT

The Contractor shall provide an installed environment which allows the engine to deliver its design output continuously without overheating or other failure.

The installed environment shall provide the combustion air, the ventilation air and the cooling air requirements of the engine, including the radiation and convection heat losses from the pumpset. This air shall be drawn from an area free of the heated discharge(s) and free of the exhaust emission.

The allowable temperature rise to be used for the design of plant room ventilation shall be no higher than 10 ºC.

If the engine cooling fan is not adequate for providing all cooling air and combustion air requirements for internal installations, the Contractor shall provide additional ventilation.

## 12.4 ENGINE COOLANT

Water-cooled engines shall be provided with the engine manufacturer's recommended anti-corrosive coolant.

## 12.5 ENGINE LUBRICATION

Engine oil filters shall be mounted in an accessible position.

An extension pipe shall be provided to facilitate draining oil from the sump if the sump plug is inaccessible. The pipe shall be provided with secure supports at each end. The supports shall accommodate vibration during operation. A threaded plug shall be provided.

## 12.6 COMBUSTION AIR INTAKE

A two stage cyclonic dry type air cleaner shall be fitted and shall have water and dust evacuators. It shall incorporate a condition monitor to indicate servicing. The air cleaner shall be amply rated

for the application. The complete air induction system shall have the approval of the engine manufacturer.

The air filter shall be designed to reduce intake noise breakout.

## 12.7 ENGINE FUEL SYSTEM

A primary and a secondary fuel filter of the replacement element type shall be provided. In addition, a water trap shall be provided.

Piping between the fuel tank and the engine shall be of stainless steel. A flexible section for absorbing vibration shall be provided.

The suction pipe connection shall be positioned at least 50 mm above the tank bottom.

A fuel return line from the engine shall be connected to the tank at the same height as the suction line and its diameter shall be the same or larger than the suction line. The suction line and the return line shall be separated by at least 450 mm.

A heat fusible link shall be mounted above the engine and failure of this shall lead to closure of a fuel isolation valve in the event of fire. A manual shut off valve shall also be installed upstream of this valve.

## 12.8 EXHAUST AND SILENCING SYSTEM

The Contractor shall provide a reactive silencer and an absorptive silencer. The reactive silencer shall be provided for low frequency attenuation and the make and model shall be acceptable to the engine manufacturer. The absorptive silencer shall be provided for high frequency attenuation.

Engines smaller than 100 kW may be provided with a combined reactive/absorptive silencer.

The exhaust system, including pipework, silencers and pipe support brackets shall be of stainless steel.

A flexible connection of the stainless steel bellows type shall be installed close to the exhaust manifold(s) to reduce vibration transfer and to allow expansion under heating.

The exhaust system and silencers shall be thermally insulated with a preformed mineral wool inner layer which is clad with stainless steel or aluminium sheeting.

The exhaust outlet shall be arranged so that it is not possible for wind driven rain to enter.

## 12.9 STARTING SYSTEM

The starting system shall be 24 Volt lead acid battery. Two, 12 Volt batteries in series are acceptable.

A mains supply charging system shall maintain the batteries at full voltage.

A lockable battery box shall be provided. The box shall support the battery above the surface of the floor. It shall be sized to provide at least 50 mm clearance around the battery on all sides and shall be very well ventilated.

### 12.10 ENGINE HEATER

Engines of 100 kW or larger shall be provided with engine heaters which are connected to the mains power. These shall only operate whenever the engine is not operating.

### 12.11 SOUND BREAKOUT

Where the pumpset is installed inside a room, the Contractor shall reduce the noise breakout from the room by providing the air supply and discharge openings with double acoustic louvres.

The Contractor shall also provide the openings with a weather louvre and an internal mesh screen.

## 13. PLINTH & BASEFRAME

### 13.1 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 baseframe and anchor design to the Engineer for acceptance.

Plinths and baseframes shall comply with Aur 0001.

### 13.2 ENGINE DRIVEN PUMPS

The pump and engine shall be mounted on anti-vibration mounts within a skid baseframe. Duplex base arrangements are preferred.

The skid baseframe shall be rigid enough for the assembled unit to be placed on an uneven surface without visible deflection.

The skid baseframe shall be provided with four jacking points and four lifting eyes.

The anti-vibration mounts shall be resistant to diesel fuel and other oils.

Anti-vibration pads shall be provided between the baseframe skids and the concrete floor if the unit is to be permanently mounted on a concrete surface. The pad shall be Tico or equivalent anti-vibration pads.

### 13.3 ELECTRIC MOTOR DRIVEN PUMPS

#### 13.3.1 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.

#### 13.3.2 Baseframes and Soleplates

Baseframes for pumpsets up to 1 000 kW shall have both pump and motor mounted on a single baseframe which is anchored to a concrete plinth. Separate baseframes or stainless steel sole plates may be used for pumpsets above 1 000 kW.

Welding on the baseframe shall be continuous all round and without crevices. The baseframe shall be designed so that liquids do not pool on it.

Baseframes 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 baseframe shall be blasted to bare steel and re-galvanized.

The Contractor shall arrange for the Engineer to inspect the baseframe after fabrication is complete but before galvanising.

The Contractor shall anchor the baseframe to the plinth.

All exposed surfaces of soleplates shall be of a suitable grade of stainless steel.

## 14. INSTRUMENTATION

### 14.1 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 Aur 0001.

### 14.2 PRESSURE MEASUREMENT

#### 14.2.1 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 Aur 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.

#### 14.2.2 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.

## 14.3 FLOW MEASUREMENT

### 14.3.1 Full Bore Magflo

One magnetic flow meter with both local readout and transmission capability shall be provided on the discharge manifold.

### 14.3.2 Insertion Magflo

One insertion magnetic flow meter shall be provided in the pipework for each pump.

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.

## 14.4 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). 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:

$$T_{shut\text{-}down} = T_{equilibrium} + (40^{o}C - T_{ambient}) + 10^{o}C.$$

An alarm shall be provided at a suitable, lower temperature.

Suitable indication shall be provided for each bearing.

# 15. 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 Aur 1008.

# 16. LIFTING EQUIPMENT

The Contractor shall provide an overhead travelling crane in pump stations in which the pumps are 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 Aur 1003.

# 17. MATERIALS AND COATINGS

## 17.1 GENERAL

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Aur 0003.

Materials shall comply with Aur 0001.

## 17.2 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. |
| 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. |

| | | |
|---|---|---|
| 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 (*This requirement does not apply to small bore, auxiliary pipework*). |
| Baseframe | See Baseframe clause. | See Baseframe clause. |
| Pipe Supports | As per Aur 7024. | As per Aur 7024. |
| Isolation Valves | As per Aur specification. | As per Aur specification. |
| Check Valves | As per Aur specification. | As per Aur 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. |
| 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.

## 18. FASTENERS

Fasteners shall comply with Aur 0001.

Anchor fasteners shall have a minimum diameter of M16.

# 19. ELECTRICAL EQUIPMENT

Refer to the electrical specifications.

# 20. SPARES

The spares which are to be provided are specified elsewhere.

# 21. FABRICATION, DELIVERY AND INSTALLATION

## 21.1 FABRICATION

Fabrication and welding shall comply with Aur 0001.

Fabrications will be inspected by the Engineer after fabrication is complete.

## 21.2 DELIVERY

When pumps and motors are transported, care shall be taken to prevent damage to bearings.

## 21.3 INSTALLATION

### 21.3.1 General

Installation work shall comply with Aur 0001.

### 21.3.2 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.

### 21.3.3 Testing

The installation shall provide for the specified Site testing procedures.

### 21.3.4 Small Bore Pipework

Auxiliary small bore pipework, including fittings, shall be of stainless steel. Flexible lengths shall be of stainless steel braided hose.

# 22. 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.

# 23. 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.

# 24. INSPECTIONS

## 24.1 FABRICATIONS

Fabrications such as the baseframe, 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.

## 24.2 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 despatch 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 despatch 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 despatch from the manufacturer's works.

## 24.3 PUMPS

The pumps shall be inspected at the factory. The impellers and diffusers shall be available for inspection.

### 24.4 SITE

The Contractor shall make arrangements for the Engineer to inspect the installation on Site.

## 25. TESTING

### 25.1 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.

### 25.2 PRESSURE TESTING

#### 25.2.1 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.

#### 25.2.2 Valves

The Contractor shall pressure test the valves in compliance with the requirements of the applicable Aur specification.

### 25.3 PUMP PERFORMANCE TESTING AT FACTORY

#### 25.3.1 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.

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.

### 25.3.2 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.

### 25.3.3 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.

## 25.4 PUMP PERFORMANCE TESTING ON SITE

### 25.4.1 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.

### 25.4.2 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.

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.

## 25.5 ENGINE PERFORMANCE TESTING

The Contractor shall perform an engine power output test to a suitable standard and shall submit the test report to the Engineer for acceptance.

### 25.6 MOTOR PERFORMANCE TESTING

The Contractor shall test and shall submit the motors' factory performance testing report to the Engineer for acceptance.

## 26. DOCUMENTATION TO BE PROVIDED

### 26.1 PUMP DESIGN

Large scale curves for the pump offered shall be provided with the tender offer. These shall include pressure, power and NPSHr 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.

### 26.2 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 Aur 0002.

# SPECIFICATION: AUR 10014

## Ventilation for Plant Rooms

# 1. INTRODUCTION

Aur 10014 specifies the requirements for ventilation systems to be provided by the Contractor.

# 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

# 3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

a) Amendments, Additions and Detailed Requirements (Aur 10014).

b) Aur 0001: General Mechanical Requirements.

c) Aur 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

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 acceptable.

Equipment which does not satisfy these requirements is not acceptable unless called for in the specifications or unless the Engineer agrees in writing.

# 5. PERFORMANCE REQUIREMENTS

The installation shall provide the air flow required for each room volume and/or shall limit the temperature rise in each room, whichever is specified.

The specified sound pressure level for each fan shall not be exceeded.

# 6. OPERATION AND CONTROL

At least one fan shall operate continuously in order to provide through flow for minimising corrosion and preventing stagnant volumes. Backflow prevention dampers shall be provided in multi-fan systems in order to prevent short circuit flow.

Multi fan systems shall be arranged so that the second, third, etc. fans switch on as the temperature in the plant room rises (the second fan shall switch on at thirty degrees Centigrade, the third fan at thirty two degree Centigrade, etc.).

A flow switch for each fan shall lead to an alarm if the flow fails.

Differential pressure measurement shall be provided at each fan and at each filter.

An hour meter which cannot be reset shall be provided for each fan motor.

Each fan shall be provided with an emergency stop station in an appropriate position.

Manual start and stop of each fan shall be provided at the MCC.

# 7. DESIGN AND CONSTRUCTION

## 7.1 FLOW

The design of the ventilation system shall deal with the following:

- heat generated by equipment.
- air consumption by equipment (such as compressors, blowers and internal combustion engines).
- provision of cross flow through the room even if the main entrance door is open.
- prevention of short circuit flow in multiple fan installations.
- avoidance of stagnant volumes.
- friction losses (at least 250 Pa shall be allowed for resistance loss at each filter).
- a safety factor shall be incorporated in the calculation of the fan flow and pressure so that reasonable modification to ductwork during installation can be made.

## 7.2 FANS

### 7.2.1 General

Fans and motors shall preferably have a nominal speed of 1 500 rpm or lower and motors shall have a nominal voltage of 400 Volts.

Fans shall be flexibly supported using spring or rubber-in-shear mountings having a minimum static deflection of 20 mm.

Guarding shall totally enclose drives.

Fans shall be dynamically balanced to ISO 1940, grade G6,3.

### 7.2.2 Axial Flow Fans

Direct drive, axial flow fans shall incorporate manually adjustable pitch, cast aluminium, aerofoil section blades, clamped in split, metallic hubs. Fan casings shall cover the full axial length of the fan and motor assembly. Terminal boxes shall be mounted on the fan unit.

Suspended fans shall be restrained to prevent excessive movement during start-up.

Axial flow fans installed in corrosive flows shall have their motors protected by bifurcated airstreams.

### 7.2.3 Centrifugal Fans

Centrifugal fans shall be constructed of sheet metal with inlet cones and with machined shafting supported on rolling bearings mounted in sealed bearing housings provided with stainless steel grease nipples.

Fans shall be mounted on steel channel base frames accommodating the fan and its drive motor.

Belt drives, where applicable, shall be accurately aligned.

## 7.3 MOTORS

Motors shall have a nominal rating of at least 15 % above the maximum power requirement of the fans as installed.

Motors shall comply with Aur 0001.

Motors shall have ingress protection to at least IP 55.

Motors shall comply with the requirements of the hazardous location zone for the area in which they are installed.

## 7.4 DAMPERS

Dampers shall be fabricated from the same material as the ductwork.

Adjustment, position indication and a locking arrangement shall be provided for each regulating damper.

## 7.5 DUCTWORK

Ductwork shall be manufactured in accordance with SANS 1238.

A flexible connection shall be provided on each side of each fan/attenuator assembly in order to isolate the ductwork from the fan vibration. Flexible collars shall have sufficient free movement to take up the deflection of the connected moving equipment. They shall not be used as a means of accommodating misalignment. Collars shall not restrict the free area of the ductwork.

Take off sockets shall be provided where grilles are mounted in distribution ductwork. Sockets shall be long enough to ensure that no part of the grille or its associated control mechanism projects into the duct cross-section. Grilles shall be provided with regulating dampers.

Rectangular ductwork shall be supported on trapeze type hangers with stainless steel hanger rods. Support spacing shall be less than 2 000 mm. Circular ductwork shall be supported in hoops suspended from stainless steel rod with spacing less than 3 000 mm.

Rod diameter shall be not less than 10 mm.

Drain points shall be provided in ductwork where condensed water could pool. Permanently open 8 mm holes are acceptable as drains in positions where noise breakout would not be a problem.

The nominal flow speed in ductwork shall not exceed 7 m/s.

## 7.6 FILTERS

Filters elements shall consist of pleated media in modular frames. The elements shall be individually replaceable and shall be mounted in proprietary frames with zero discernible bypass. Clip-fixed units are acceptable but in-line, slide frame mounted units are preferable.

Each filter bank shall have a differential manometer connected across it. The range shall be selected for the application and the units shall be provided with red gauge oil. The difference level at which filter elements require replacement shall be indicated.

The nominal flow speed through filter elements shall be not greater than 3,2 m/s.

## 7.7 SOUND

### 7.7.1 General

The sound pressure level of each fan, as installed, shall not exceed 80 dBA at 3 metres from the outer surface.

### 7.7.2 Acoustic Attenuators for Axial Flow Fans

Axial flow fans shall be provided with upstream and downstream circular acoustic attenuators. The attenuator internal diameter shall correspond with the fan diameter. Each attenuator's length shall be at least two diameters.

Each attenuator shall be provided with a central pod with aerodynamic end fairings.

Attenuators shall be directly connected to the fan flanges.

### 7.7.3 Acoustic Attenuators for Centrifugal Fans

Centrifugal fans shall be provided with upstream and downstream splitter attenuators and these shall be mounted as close to the fan as feasible. Each attenuator's length shall be at least twice the fan's outlet dimension (if the outlet is not square, the larger dimension shall be used).

### 7.7.4 General Requirements for Attenuators

Attenuators shall be designed by a manufacturer which specialises in acoustic applications and who can provide attenuation graphs for the units.

Acoustic infill material shall be "Eurolon" by Donkin, or equivalent. Where velocities exceed 20 m/s, the infill material shall be supported by perforated stainless steel sheet. Where

  

attenuators are to be used in grease or oil laden atmospheres, a polyester membrane shall also be provided.

External surfaces of the attenuators shall be painted as for the ductwork.

### 7.7.5 Acoustic Louvres

The Contractor shall provide double acoustic louvres at each air inlet and each air outlet.

Acoustic louvres shall be designed by a manufacturer which specialises in acoustic applications and can provide attenuation graphs for the units.

The installation of acoustic louvres in wall inlets and outlets shall be neat and all edges shall be fully sealed in order to prevent acoustic breakthrough.

### 7.7.6 Equipment Bases in Acoustically Sensitive Areas

In acoustically sensitive areas, concrete inertia bases shall be provided for fans and motors. The bases shall be at least 150 mm deep and shall be reinforced with Ø 13 mm reinforcing bars located at 150 mm centres each way.

The mass of bases shall be chosen to avoid operation at critical frequencies and the ratio of the mass of the base to the mass of the equipment shall be higher than 1:1. Bases shall be large enough to accommodate the motors, driven equipment and any required supports and fittings.

The equipment shall be mounted on hot-dip galvanised baseframes anchored to the concrete inertia bases.

A floor plinth shall be provided under each base. It shall be large enough to accommodate the concrete inertia base and its spring isolators.

Spring isolators shall be provided between the inertia bases and the floor plinth. Either free standing stable spring units or caged spring units with snubbers may be used. Isolators shall themselves be mounted on ribbed elastomer acoustic pads. Spring diameters shall be large enough to prevent excessive rocking of equipment during start-up as well as during normal operation.

## 7.8 LOUVRES AND SCREENS

The Contractor shall provide storm resistant weather louvres at each air inlet and air outlet.

The nominal flow speed through inlet louvres shall not exceed 2 m/s. The flow speed through outlet louvres may be higher.

Louvre discharges shall be guarded with wire mesh screen barriers. The screens shall be of approximately 20 mm mesh and 1,6 mm minimum gauge wire.

The screens shall be easily removable for cleaning.

# 8. INSTRUMENTATION

Instrumentation shall comply with Aur 0001.

# 9. FABRICATION

Fabrication and welding shall comply with Aur 0001.

# 10. FASTENERS

Fasteners shall comply with Aur 0001.

# 11. SPARES

The spares which are to be provided are specified elsewhere.

# 12. MATERIALS AND COATINGS

## 12.1 GENERAL

Components for water treatment works shall be suitably designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Components for wastewater treatment works shall be suitably designed for corrosion resistance to the very high - industrial corrosivity category (C5-I) of SANS 12944-2.

Corrosion protection shall comply with Aur 0003.

Materials shall comply with Aur 0001.

## 12.2 EQUIPMENT

Equipment shall comply with the table below.

| ITEM | MATERIAL | COATING |
|---|---|---|
| Axial Flow Fan bodies. | Hot dip galvanised steel | Colour code externally. |

| | | |
|---|---|---|
| Centrifugal fan bodies in dry applications. | Hot dip galvanised steel. | Colour code externally. |
| Centrifugal fan bodies in moist air applications. | EN Grade 1.4401 (316) stainless steel. | Colour code externally. |
| Baseframes | Carbon steel. | Hot dip galvanised and painted. |
| Acoustic attenuators for fans | EN Grade 1.4401 (316) stainless steel. | Colour code externally. |
| Ductwork inside wet wells. | Welded polypropylene. | N/A |
| Internal ductwork conveying moist air. | Welded polypropylene | N/A |
| External ductwork conveying moist air. | EN Grade 1.4401 (316) stainless steel. | Colour code externally. |
| | EN Grade 1.4162 stainless steel (LDX 2101) | Colour code externally. |
| Ductwork in dry areas. | Hot dip galvanised carbon steel. | Colour code externally. |
| Acoustic louvres in dry air applications. | Hot dip galvanised steel. | Nil |
| Weather louvres in dry air applications. | Hot dip galvanised steel. | Nil |
| Acoustic louvres in moist air applications. | EN Grade 1.4401 (316) stainless steel. | N/A |
| Weather louvres in moist air applications. | EN Grade 1.4401 (316) stainless steel. | N/A |

| | | |
|---|---|---|
| Inlet and outlet mesh screens. | EN Grade 1.4401 (316) stainless steel. | N/A |
| Filter frames in dry air applications. | Hot-dip galvanised steel. | N/A |
| Filter frames in moist air applications. | Stainless steel. | N/A |
| Dampers. | As for ductwork. | As for ductwork. |
| Supports for polypropylene ductwork and for stainless steel ductwork. | EN Grade 1.4401 (316) stainless steel. | N/A |
| Supports for hot-dip galvanised ductwork. | Stainless steel hanger rods with hot-dip galvanised steel frames. | N/A |
| Fasteners. | EN Grade 1.4401 (316) stainless steel. | N/A |
| Auxiliary metal components. | EN Grade 1.4401 (316) stainless steel. | N/A |
| Motor casing; water treatment plant. | Manufacturer's standard. | Corrosion resistance to the high corrosivity category (C4) of SANS 12944-2. |
| Motor casing; wastewater treatment plant. | Manufacturer's standard. | Corrosion resistance to the very high - industrial corrosivity category (C5-I) of SANS 12944-2. |
| Bearing housings; water treatment plant. | Manufacturer's standard. | Corrosion resistance to the high corrosivity category (C4) of SANS 12944-2. |

| | | |
|---|---|---|
| Bearing housings; wastewater treatment plant. | Manufacturer's standard. | Corrosion resistance to the very high - industrial corrosivity category (C5-I) of SANS 12944-2. |

NOTES

- 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 for corrosion prevention purposes.
- Hot dip galvanising damaged by welding, cutting, grinding or any other means shall be rejected.

## 13. INSTALLATION

Installation work shall comply with Aur 0001.

The installation shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level and plumb.

Where ductwork penetrates brickwork, a timber frame shall be built in to locate and mount the ductwork. Plaster shall be used for infill to prevent sound breakout.

Where ductwork penetrates concrete slabs or walls, a flange shall be provided on one side to stabilize the duct. Weak grout or fire stopping shall be applied to the spaces between the ductwork and the structure to effectively seal the clearance.

Where ductwork penetrates between areas having differing fire risk or mandatory fire separation, fire dampers to SANS 193 shall be installed.

## 14. 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 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.

## 15. SAFETY

The Contractor shall design and install all equipment installations with due regard to any hazardous areas requirements.

## 16. INSPECTIONS

The Contractor shall make arrangements for the Engineer to inspect the installation for compliance.

The Contractor shall inspect the operation of the installation three months after the start of the Defects Notification Period and shall provide a condition report to the Engineer.

## 17. TESTING

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

a) operation of all equipment.

b) achievement of the specified performance requirements.

c) correct operation of the control system.

The Contractor shall provide site test reports to the Engineer and shall submit copies in the Manual.

# SPECIFICATION DWS 0750

# WATER RETAINING CONCRETE

Revised: November 2017

CLAUSE CONTENTS PAGE NUMBER

THE TOTAL NUMBER OF PAGES IN THIS SPECIFICATION IS 41

1. SCOPE

This work shall consist of procuring and supplying the necessary materials, mixing and placing the concrete to the required proportions, erection and stripping of formwork, preparing hardened and old concrete surfaces to accept fresh concrete, bending and fixing of reinforcement, erection of precast reinforced concrete members, curing of the concrete, repair of damaged concrete, forming of joints, finishing off of concrete surfaces after removal of the formwork, clean-up of the areas after completion of the work and all such other operations as are incidental to the concreting operations. The insertion of water stops and joint fillers shall be in accordance with the requirements of the relevant Specifications. Tests for watertightness shall be in accordance with the requirements of the Specification DWS 1810.

2. GENERAL

2.1 Definitions

Reference shall be made to SANS 1200G, clause 2.3 for project Definitions. The following shall be added:

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

*Extender*: Material which, when placed with Portland Cement, has a cementing property and is used as a portion of the cement in a concrete mix for economic reasons or for the chemical or physical properties (or both) that it gives to the concrete mix.

*Cementitious binder (also referred to as binder)*: Common cement that complies with the requirements of SANS 50197-1, and blends of certain types of common cement and cement extenders that comply with the requirements of SANS 1491-1, SANS 1491-2 or SANS 1491-3.

*Water/cement ratio*: Ratio (by mass) of the water to the cementitious binder in a concrete mix.

*Immediate protection of concrete*: The prevention of moisture loss from the concrete from the time of compaction until full wet-curing is possible.

*Joints:* Notwithstanding SANS 1200G subclause 2.4.3, “designated joints” will only be joints that are shown on the drawings. Any other joints that are required by the Contractor as a result of his construction constraints or for any other reason, whether approved by the Engineer or not, will not be considered to be designated joints as defined in SANS 1200G subclause 2.4.3, i.e. they will be considered to be non-designated joints.

2.2 Supervision

During the entire or at any time that the placing of concrete is being carried out, the concreting operation shall be under the supervision of a suitably qualified Engineer or other experienced person acceptable to the Engineer.

2.3 Records

A complete record shall be kept of all concrete work, which shall cover the quality and quantity of concrete, the placing of reinforcing steel, the removal of formwork, the curing of the concrete and the results of all tests described under subclause 3.8. A daily record shall be kept of the progress of the work. The position of all construction joints not shown on the drawings shall be recorded as ordered by the Engineer.

The maximum and minimum daily temperatures shall be recorded.

All the above records shall be available at all times during the progress of the work for inspection by the Engineer and on completion of the work a copy of the records shall be deposited with him. For the duration of the Contract a copy of all the records shall be submitted weekly to the Engineers Representative on a day to be mutually agreed upon.

3. MATERIALS

3.1 Cement

Only CEM I 52.5 or CEM I 42.5 (Portland Cements), CEM II A 52.5 or CEM II A 42.5 in accordance with SANS 50197-1 may be used. Further blending with a suitable extender shall be as per subclause 8.3.

If the Contractor wishes to use any other type/blend of cement, he shall obtain the Engineer's prior written approval. The tendered rates, however, shall be based on the use of the above-mentioned cements/blends only.

The test results conducted to evaluate the conformity of cement in terms of SANS 50197-1, clause 9, shall be made available to the Engineer at least 28 days before the materials are used for concrete.

All cement on the Works shall be fresh and of the best quality and be supplied by a factory such as will meet with the approval of the Engineer. Preference will be given to cement with a moderate heat of hydration and low alkali content.

The heat of hydration at 28 days shall not exceed 335 Joules per gram when using the heat or solution method.

The Contractor shall always have at his disposal, on the Site, a minimum stock of cement sufficient for 2 weeks normal work and no cement shall be stored for more than 8 weeks. Cementitious binder shall be used in the order in which it is received. The Contractor shall endeavour to obtain all cement supplies from the same factory.

Transport of cement to the Site may be either in bulk or in multiwall paper sacks. When bulk transport or storage of cement is being employed the Contractor shall ensure that no contamination by foreign materials occurs and that all moisture is excluded. Silos for bulk storage shall be so constructed that the cement is protected from the action of atmospheric agents and must be fully waterproof. In addition, the method of charging and discharging from the silos must be such that the oldest cement is always used first. Cement transported in sacks shall be stored in solidly constructed weatherproof sheds of sufficient capacity, provided with damp proof floors at least 450 mm above ground level and covered by tarpaulins. The cement sacks shall be closely stacked to a height not exceeding 12 sacks and shall not be packed against outside walls. The stacking arrangement shall be such that the cement is used in order in which received unless it has been rejected by the Engineer for use in the Works. Under no circumstances shall defective or set cement be used. Cement in sacks transported to the Site in trucks or other vehicles shall be properly covered with tarpaulins or other effective waterproof coverings.

On Site, each different quality of cement shall be stored in a separate section of the storage shed or in a separate silo according to its place of origin.

3.2 Coarse aggregate

3.2.1 General

The term "Coarse aggregate" shall be used to designate aggregate that is well graded from 5,0 mm to 150 mm or any size or range of sizes within such limits.

3.2.2 Quality

Coarse aggregate shall be clean, sound, unweathered stone from an approved source crushed and well graded to the sizes specified for the applicable grades of concrete for which it will be used.

The crushed stone shall be reasonably free from dust, clay, soft, friable or decomposed pieces.

The Engineer shall be entitled to order the Contractor to wash or remove from Site, at the Contractor's expense, coarse aggregate, if the total of dust, clay, fines or other deleterious substance exceeds 2% by mass of any random sample.

Crushed stone particles shall be approximately round or cubical in shape and aggregates containing flats or flaky and elongated particles will not be accepted.

Coarse aggregates for watertight concrete shall be from a commercial source with a known low-alkali content. Additional requirements for aggregates are set out in subclause 3.8.2 and clause 8.

The coarse aggregate shall conform to and be tested in accordance with the requirements of SANS 1083 with the following additions:

(i) The 150 mm nominal size, which is not specified in SANS 1083, shall fall within the following grading limits:

Percentage passing the 150 mm sieve 90 to 100%.

Percentage passing the 75 mm sieve 0 to 25%. Percentage passing the 40 mm sieve 0 to 5%.

No plums may be used in any plain or reinforced concrete.

(ii) The weighted average loss after 5 cycles in the sodium sulphate test as described in ASTM C88-SST shall not be more than 10% by mass.

(iii) The linear shrinkage when tested in accordance with clause 6.11 of SANS 1083 when using the fine aggregate intended for use on the Works shall not exceed 0,05%. In addition, the linear shrinkage of the coarse aggregate when using a fine aggregate known to have no shrinkage characteristics shall not exceed 0,035%.

3.2.3 Separation

The coarse aggregate shall be separated and separately stored into the following nominal size fractions, but alternative size fractions can be used subject to the approval of the Engineer.

| Aggregate Designation (mm) | Nominal Size Range (mm) |
|---|---|
| 10 | +5,0 - 10,0 |
| 20 | +10,0 - 20,0 |
| 40 | +20,0 - 40,0 |
| 75 | +40,0 - 75 |
| 150 | +75 - 150 |

After separation of the different aggregate sizes, the Contractor shall ensure that the percentage material, by mass, passing the upper and lower sieves of the nominal size range does not vary by more than a total of 5% for each of these two sieve sizes, subject however to the grading limits given in SANS 1083 for each of the aggregate sizes. In the event of the grading varying beyond the limits stated above, the Engineer shall be entitled to suspend all concreting operations until time as the results of trial mixes, using the material having the new grading are available. The cost of such trial mixes shall be borne by the Contractor.

3.3 Fine aggregate

3.3.1 General

The term "fine aggregate" shall be used to designate aggregate in which the nominal maximum size of particle is 5,0 mm. All fine aggregate for concrete or mortar shall be from deposits approved by the Engineer, but such approval shall not be construed as constituting approval of all materials taken from deposits and shall in no way relieve the Contractor of his responsibility to ensure that the materials used in the work conform to the specified quality. The use of limited quantities of crusher fines in order to correct the grading shall however be subject to the prior approval of the Engineer.

Satisfactory precautions shall be taken to ensure that the moisture content of the fine aggregate can be maintained at a constant value during any particular concreting shift. The moisture content of the fine aggregate shall however not exceed 8% at the time of delivery to the concrete mixing plant.

3.3.2 Quality

The fine aggregate shall consist of hard, dense, durable, uncoated well shaped particles and shall be free from injurious amounts of dust, lumps, soft or flaky particles, shale, alkali, organic matter, clay, loam, mica or other deleterious matter.

Sand shall be rejected if the total percentage by mass of all deleterious matter in a random sample exceeds 2% or if the percentage by mass of either shale, material with a specific gravity of less than 2, coal or clay exceeds 1%.

The fine aggregate shall conform to and be tested in accordance with the requirements of SANS 1083, with the following additions; all tests except for the grading analysis being conducted and evaluated only on the minus 4,75 mm material:

(i) Not more than 10% by mass of the fine aggregate shall be retained on the 5,0 mm sieve. Of the minus 5,0 mm fraction at least 90% by mass shall pass a 2,36 mm sieve, at least 90% by mass shall be retained on 150 micrometres sieve and not more than 4% by mass shall pass the 75 micrometres sieve. In addition not less than 3% shall pass the 150 micrometres sieve.

(ii) The fineness modulus (F.M.) of the sand provided shall fall within the range 2,0 to 3,2. Throughout the duration of concreting shift the F.M. of the sand shall not vary by more than 0,1 on either side of the value existing at the commencement of the shift, but in no case shall the limits stated previously be exceeded. Furthermore, whenever the F.M. varies by more than 0,2 from the F.M. of the sand used in the trial mixes, the Engineer shall order that new mix proportions based on trial mixes using the sand with the new grading be performed. The cost of such additional trial mixes shall be borne by the Contractor.

(iii) The shape of the particles shall be such that the percentage voids do not exceed 48%.

(iv) The linear shrinkage when tested in accordance with clause 6.11 of SANS 1083, and when using the coarse aggregate approved for use in the Works shall not exceed 0,05%. In addition, the linear shrinkage characteristics of a mortar bar shall not exceed 0,06%.

The Engineer shall have the right, at any time he considers the fine aggregate dirty, to order it to be washed by approved means or to be removed from Site at the expense of the Contractor and no fine aggregate when ordered to be washed shall be used in the works until so washed.

3.4 Stockpiling of aggregate

Aggregates shall be stored in flat stockpiles in such way that segregation of the sizes in any stockpile is avoided as far as possible. Spillage of material from one stockpile into another shall be prevented by the provision of adequate bulkheads. The contamination of stockpiles by dust and foreign matter shall be prevented.

When aggregates of different chloride content are stored on the Site, their use in the various classes of concrete shall be strictly controlled.

In hot weather concreting coarse aggregate dumps exposed to the sun shall be pre-cooled to ambient temperatures by jetting with water or by other approved methods before the aggregate is mixed into concrete.

3.5 Water

The water used for concrete or cement mortar shall be clean and free from such acids, alkalis, organic matter, soluble salts and any impurities which in the opinion of the Engineer would make it unsuitable for use.

If the water from local natural resources should contain at certain times objectionable quantities of impurities, the Contractor will be required to make arrangements to the satisfaction of the Engineer for ensuring its purity before use.

The water shall comply with the requirements of SANS 51008.

3.6 Admixtures

Admixtures such as air entraining or wetting agents may be used only with the written approval of the Engineer covering the type, amount and location of use. Admixtures shall be measured accurately and shall be introduced into the mixer in solution in the mixing water. Use of admixtures in the concrete shall in no way relieve the Contractor of his responsibility for compliance with the requirements of these Specifications governing protection and curing of the concrete.

The cost of using and testing such admixtures if permitted by the Engineer shall be borne by the Contractor.

If the use of air entraining agents is permitted by the Engineer test measurements shall be carried out by the Contractor on the Site as and when required by the Engineer to determine -

(i) the percentage of air entrained in the concrete (after elimination of aggregate larger than 19,0 mm); and
(ii) the density of the concrete.

Air Entraining Agents shall comply to the requirements of ASTM C260 and Water Reducing Additives shall comply to ASTM C494, type A. The additives shall be free of chlorides.

3.7 Reinforcement

These requirements shall be deemed to cover all steel used in concrete construction.

3.7.1 General

Steel reinforcement shall be placed in the concrete wherever shown on the Drawings or where directed by the Engineer. Reinforcement shall consist of plain or deformed steel bars or of cold-drawn steel wire or of fabricated forms of these materials as shown on the Drawings. The materials shall comply with the requirements of the latest editions of the relevant South African and British Standard Specifications as set out hereunder:

SANS 920 Steel bars for concrete reinforcement.

BS 4449 Hot rolled steel bars for the reinforcement of concrete.

BS 4482 Hard drawn mild steel wire for the reinforcement of concrete.

SANS 1024 Welded steel fabric for concrete reinforcement.

Structural steel sections used for steel reinforcement shall comply with the latest editions of the relevant British Standard Specifications as set out hereunder:

BS 4360: Part 2 Weldable structural steels.

On the drawings, the following notation is used to indicate the various types of reinforcement bars:

R - Round mild steel bars with a characteristic strength of 250MPa and minimum elongation on 22%.

Y - High yield stress deformed bars with a characteristic strength of 450MPa and minimum elongation on 14%.

Z - Any type not covered by R and Y, the type must be specified on the drawings and schedules.

3.7.2 Cleaning

Before placing any reinforced bars the surfaces of the bars and the surfaces of any metal supports for the bars shall be cleaned of concrete, dirt, grease or other foreign matter which is objectionable in the opinion of the Engineer.

Heavy flake rust and mill scale that can be removed is also considered objectionable. After placing, all steel shall be maintained in a clean condition until it is completely embedded in the concrete.

3.8 Tests

3.8.1 Cement\

Until the cement is used in the Works the Contractor shall be responsible for the preservation of its qualities. The Engineer may arrange for tests to certify that the cement has not deteriorated and the cost of all such tests shall be borne by the Contractor. Should the tests show that any sample does not comply with the Specification requirements, the whole consignment from which the sample was taken will be rejected by the Engineer, and the Contractor shall forthwith remove the consignment from the Site at his own cost.

Any cement which has been stored on Site for more than two months may be required by the Engineer to be re-tested before use as and where he directs, and the whole cost of retesting shall be borne by the Contractor.

All tests shall be performed in accordance with the relevant SANS specifications specified in subclause 3.1 of this document.

3.8.2 Alkali-aggregate reaction

Reference is made to “Fulton’s Concrete Technology, Chapter 10, Alkali-silica reaction.”

In accordance with this reference, the Contractor shall provide the Engineer with the following (with the concrete mix design submission):

- Type of coarse aggregate
- Source of coarse aggregate
- Recent SANS 6245:2006 test results (accelerated mortar prism method) for the coarse aggregate
- Certificates from cement (and extender) supplier stating the certified active alkali content(s)
- Total active alkali content of the various mix designs, adhering to the maximum values stated below (including calculations)

| **Result of SANS 6245 Coarse aggregate test (@12 days)** | **Description** | **Limit on total active alkali content of mix ($kg/m^3$)** |
|---|---|---|
| Linear Expansion < 0.10% | Aggregate innocuous | N/A |
| 0.10% < Linear Expansion < 0.20% | Slowly reactive/ inconclusive | 2.8 |
| Linear expansion > 0.20% | Deleteriously reactive, rapidly expansive | 2.1 |

Over and above the table above, aggregates from the Witwatersrand Supergroup shall have a limit of 2.0kg/m3 active alkalis in the mix design.

The Engineer may instruct a petrographic analysis of the coarse aggregate for new/unknown coarse aggregates in addition to the tests above.

All costs of the testing described above shall be deemed included in the cost of the rates for concrete.

Note: The equivalent sodium oxide content is measured as Na2O + 0.658K2O. For cement, it is expressed as a percentage by mass, for concrete it is expressed in kg/m3.”

3.8.3 Coarse aggregate

Periodic tests will be done by the Engineer on the coarse aggregate and the Contractor shall provide such facilities as may be necessary for procuring representative test samples. The Contractor shall submit for preliminary tests and approval a representative 100 kilogram sample of each size of coarse aggregate proposed for use in the Works at least 4 weeks before the coarse aggregate is required for use if deposits not already approved by the Engineer are to be used.

Coarse aggregate shall also by subject to tests by sieve analysis before delivery to the batching plant is commenced and at frequent intervals thereafter to ensure the suitability of the grading. No coarse aggregate will be approved for use in the Works until satisfactory tests have been made on concrete cubes.

Samples shall be taken from the batching plant of each category of material and of the dry mixes (before adding cement and water) in order to check the grading and the free moisture present in the coarse aggregate as and when the Engineer may direct. The percentage free moisture present will normally be checked at least once daily.

All tests and the interpretation of tests shall be in accordance with SANS 1083.

3.8.4 Fine aggregate

Periodical tests will be done by the Engineer on the fine aggregate and the Contractor shall provide such facilities as may be necessary for procuring representative samples. The Contractor shall submit for preliminary tests and approval a representative 30 kilogram sample of fine aggregate from each deposit at least 4 weeks before the fine aggregate is required for use, if new deposits not already approved by the Engineer are to be used.

The fine aggregate shall be tested for dust, loam, silt, organic matter or other detrimental constituents as well as for cleanliness, grading, fineness modulus and other necessary qualities before delivery to the batching plant is

commenced and at frequent intervals thereafter, and no sand which fails to comply with the requirements of these tests shall be used for concrete.

The fine aggregate shall also be subjected to moisture content tests in order to maintain a constant water-cement ratio. During concreting operations the sand used at the batching plant shall be sampled hourly. Variations in moisture content shall not exceed 1% from hour to hour nor more than 3% during one 8 to 10 hour concreting shift.

The fine aggregate grading shall be tested by the Contractor at regular intervals by taking 1 sample for every 150 cubic metres of concrete placed. In the event of smaller quantities of concrete being placed in one concreting shift, the sand grading shall be tested at the beginning and at the end of each concreting shift. Copies of the results shall be deposited with the Engineer not later than 1 day after performing the tests.

All tests and the interpretation of tests shall be in accordance with SANS 1083.

3.8.5 Reinforcement

No tests on the reinforcement need be conducted on Site, but it will be required of the Contractor to supply to the Engineer, for each batch or consignment or both of steel other than mild steel delivered on Site, copies of certificates supplied by the manufacturer or by an approved testing laboratory stating the relevant SANS, B.S. or ASTM Specification with which the steel complies and also the guaranteed minimum yield stress in the various size ranges. Certificates can be dispensed with if the steel bears some clear identification marks placed thereon by the manufacturer to certify the quality.

Test certificates for prestressing steel conducted on each size batch and consignment delivered shall include the following information:

(i) Nominal diameter.

(ii) Ultimate strength.

(iii) 0,2 per cent proof stress.

(iv) The modulus of elasticity.

(v) The elongation at rupture over 100 mm gauge length.

(vi) The contraction of area at fracture, in per cent.

(vii) The creep characteristics, both under constant load and constant elongation.

(viii) The unit weight.

(ix) The stress-strain diagram.

3.8.6 Concrete

Tests for concrete shall be as per SANS 1200G clause 7. All costs with respect to clause 7 shall be deemed to be included in the rates for concrete.

In addition to SANS 1200G clause 7 the following shall apply:

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

ii. Site sampling methods and storage shall be in accordance with SANS 5861-3:2006.

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

iv. Test results obtained from the supplier of ready-mixed concrete will not be accepted for evaluation in terms of subclause 7.3 of SANS 1200G, but samples for testing shall be taken of such concrete at the point of placing.

3.9. Roofing felt

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

4. BATCHING

4.1 Minimum plant

The Contractor shall have the following minimum Plant available and in sound working order:

(i) Two concrete mixers (for circular walls, each mixer shall be of sufficient capacity to complete a section of the wall between horizontal construction joints within 4 hours and without interruption).

(ii) Two weigh-batchers to supply the mixers.

(iii) Four concrete vibrators, at least one of which shall be powered by an internal combustion engine.

(iv) One air compressor.

(v) Suitable and adequate Plant to transport and raise concrete and other material and equipment from ground level to the top of the structure at all stages of construction.

(vi) Elevated storage tanks of adequate capacity to ensure that sufficient water will be available before commencement of every major concrete-placing operation.

If the Plant used for placing concrete for the structure is electrically or mechanically powered, the Contractor shall also provide some other approved, non-electrically-powered standby means for placing concrete at an adequate rate in the event of a power or mechanical failure of the main Plant.

When the Contractor elects to place a crane inside the walls of the structure during the construction period, he shall communicate with the Engineer in good time to ensure that the design and layout of the panels that form the roof slab and floor allow for such positioning of the crane. When sections of the roof and floor have to be redesigned to accommodate the crane, the redesign cost shall be borne by the Contractor."

4.2 General

The Contractor shall provide such means and equipment as are required to determine accurately and to control the amount of each separate ingredient entering the concrete in the proportions indicated by the results of trial mixes performed by the Contractor for each class of concrete intended for use in the Works. Such means and equipment shall at all times be subject to the approval of the Engineer.

Provisions shall be made for weighing the various coarse aggregate fractions, the fine aggregate, the cement and the water in a calibrated manually controlled or automatic type of weighing and batching plant.

The arrangements made shall be to the approval of the Engineer and shall be such that all operations can be viewed from a single point and thus be capable of being fully inspected and checked by an approved inspector.

The measuring equipment shall be capable of ready adjustment for affecting changes in concrete mix proportions, and shall be constructed and operated so that the combined inaccuracies in feeding the measuring the materials shall not exceed 1% in the case of cement, water and any additive, which the Engineer might approve, 2% for fine and coarse aggregate up to and including the 37,5 mm fraction and 3% for aggregate larger than the 37,5 mm fraction. In case of an automatic plant the weighing scales shall be interlocked so that a new batch of concrete materials cannot be delivered until the weighing hoppers have been completely emptied of the previous batch and the scales are in balance. Where discharge of materials in the hoppers is manually controlled a method of signalling by means of coloured flags or otherwise shall be employed to ensure that constituents are not omitted or added more than once to a single batch of concrete.

Convenient facilities shall be provided for readily obtaining representative samples of cement, additives and each class of coarse and fine aggregate between the supply bins and the mixers. The facilities shall also include means satisfactory to the Engineer for obtaining representative samples of concrete at the point of discharge of each mixer. All sampling shall comply with SANS 5861.

The Contractor shall provide standard test masses, at least equivalent to the maximum working load on the most heavily loaded scale and other auxiliary equipment required for checking the satisfactory operation of each scale or other measuring device. Tests shall be conducted by the Contractor at intervals to be determined by the Engineer and shall be conducted in the presence of and to the approval of the Engineer.

The Contractor shall furnish the Engineer with copies of the complete results of the tests and shall make adjustments, repairs or replacements as the Engineer may consider necessary to ensure satisfactory performance.

Any box containing the levers or masses or both of the weighing or batching plant shall be kept locked and the keys deposited with the Engineer's Representative.

4.3 Ready-mixed concrete

Ready-mixed concrete may not be used unless approved by the Engineer. If the Contractor elects to use ready-mixed concrete in the Works he shall provide a qualified technical assistant who shall check the quality of materials used, the accuracy and effectiveness of the water gauges and all relevant parts of the batching and mixing equipment, the moisture content of the aggregates, the quantities batched, the time of departure of each batch and all other matters which may affect the quality of timely arrival of the concrete.

The technical assistant shall commence work at the batching plant sufficiently in advance of the batching of the first mix to carry out all the required checks and shall remain at the plant throughout the period in which concrete for the Works is being batched.

The technical assistant shall maintain a continuous record of all the tests and checks carried out by him. The record shall be available for the Engineer's inspection at all times and a copy of the record for each day shall be given to the Engineer the following morning.

5. MIXING

The concrete mixing plant shall be installed in a suitable position on the Site to the approval of the Engineer.

All concrete mixing machines shall be capable of producing a uniform distribution of the constituents throughout the mixture.

The adequacy of mixing shall be determined by the method of "Variability of Constituents in Concrete" in accordance with the provisions of Designation 26 of the seventh Edition of the Concrete Manual of U.S. Bureau of Reclamation. Mixers shall be such that the concrete produced complies with the following requirements:

(a) The variability of the unit mass of air free mortar in samples taken from the first and last portions of the batch as discharged from the mixer shall not exceed 0,8% where the variability is defined as the difference between the two masses expressed as a percentage of the total of the two masses.

(b) For any one concreting operation, the average variability of the unit mass of air free mortar for more than one batch shall not exceed the following limits.

| Number of Tests | Average Variability (%) |
|---|---|
| 3 | 0,6 |
| 6 | 0,5 |
| 20 | 0,4 |
| 90 | 0,3 |

(c) The percentage of coarse aggregate by mass in samples of concrete taken from the first and last portions of a batch as discharged from the mixer shall not differ by more than 10% of the mean.

Each mixer and its operation shall be subject to the approval of the Engineer and any mixer which in his opinion is unsatisfactory shall promptly by repaired or replaced.

The mixing operation shall be under the control of a suitably experienced and approved Supervisor. The sequence of filling a mixer with the concrete constituents shall be subject to the approval of the Engineer and unless otherwise authorised, the same sequence of filling shall be followed throughout the Work. Water shall be added prior to, during and following the mixer charging operations. The quantity of the mixed material per batch shall not exceed the manufacturer's rated capacity of the mixer. No constituents shall be added while the mixer drum is stationary and excessive overmixing requiring the addition of water to preserve the required concrete consistency shall not be permitted. An approved timing device shall be used to measure the duration of mixing and each mixer shall be equipped with an automatic recorder showing the number of batches mixed.

The speed of rotation of the mixers and the mixing time shall conform to the manufacturer's recommendations to ensure adequate mixing of concrete.

After any batch of concrete has been mixed no water shall be added to the mixer until the batch has been completely discharged.

The mixer shall be completely emptied before receiving the materials for a subsequent batch and shall be kept clean and be well washed out after stopping work at the end of each concreting shift.

Telephone or radio-telephone communications, when provided for in the Schedule of Quantities, shall be set up between each concreting point and the concrete mixing plant. Such equipment shall be made available to the Engineer and any members of his staff connected with the concreting operations in order that matters regarding the quality and quantity of the concrete being produced may be settled immediately.

6. FORMWORK

6.1 Construction

All formwork or scaffolding required for any part of the Works shall be designed by the Contractor, and before commencing with the erection of any formwork or scaffolding, the Contractor shall submit the methods he proposes to use to the Engineer for approval. The Engineer has the authority to order alterations to the design or the sizes of any part of the formwork or scaffolding. The Contractor shall check the safety and suitability of all such alterations. Formwork supports and staging shall be of sufficient strength to support the loads exerted by the fresh concrete and to any incidental construction loads that it may be subjected to without deflecting beyond the specified tolerances and finish required for the particular concrete surface. Adequate provision shall be made in the design of formwork for the additional loads imposed by vibration of the concrete. Approval of proposals for formwork shall however in no way relieve the Contractor of his responsibility to ensure that the formwork conform to the specified requirements. All formwork shall be designed according to accepted methods and shall be constructed with close fitting joints so that no leakage of cement mortar will occur during concreting. Where reinforcement, waterstops, pipework etc. pass through formwork care shall be taken to ensure a close-fitting joint to prevent leakage of mortar from the fresh concrete.

Formwork shall be so designed and constructed that it can be easily removed after the requisite time for setting without injury or damage to the concrete. Unless otherwise specified or permitted by the Engineer, joints in formwork shall be either horizontal or vertical and shall be either continuous or form a regular pattern on the concrete surface. No plugs, bolts, ties or clamps of any description used to hold the formwork will be allowed to project into or through the concrete unless expressly approved by the Engineer.

Only approved tie-rods consisting of solid rods (that remain embedded in the concrete) and with removable ends shall be used to hold the formwork of the walls. The removable tie-rod ends shall facilitate removal without damage to the concrete, and no permanently embedded parts of such tie-rods shall have less than 50 mm of cover to the finished concrete surface. The holes or cavities left by ferrule heads in the concrete of water-retaining structures shall be filled with an approved non-shrink grout applied strictly in accordance with the manufacturer's specifications, and shall be neatly finished to a smooth surface uniform with that of the surrounding concrete. The cost of supplying special tie-rods as well as the filling of cavities left by the tie-rod cones shall be included in the rates tendered for formwork under the appropriate pay items. On no account shall formwork be secured to reinforcing bars.

Holes, pipes or other approved means of evacuating the air shall be provided for where the formwork forms overhangs.

Temporary openings shall be provided in the formwork at the bases of columns and walls as required to facilitate cleaning and inspection before the concrete is placed and to facilitate placing of the concrete. Unless otherwise specified or authorised by the Engineer, top formwork shall be provided to surfaces having slopes steeper than 1 vertical to 3 horizontals to enable the concrete to be properly compacted. This requirement shall not apply to the side slopes of canal linings. All formwork shall be provided with angle fillets or splays to internal and external corners where the included angle is less than 135° unless otherwise specified or directed by the Engineer.

Upright formwork supports may be bolted to previously cast concrete provided the type of bolt is approved by the Engineer. After the concrete has been cleaned to the required standard the Contractor shall withdraw the bolts and securely stop up the holes with dry pack and finish them off flush with the concrete surface after inspection by the Engineer. On removal of the formwork all wire ties which pass through the concrete shall be cut off at least 50 mm inside the concrete where the face will be in contact with water and at least 30 mm inside the concrete for faces not directly in contact with water and the resulting cavities stopped up with dry pack. No patching or filling up of holes shall however be permitted before the concrete has been inspected by the Engineer.

For deep members, the height of formwork shall be such as to permit easy placing, working and compacting of the concrete and shall be regulated by the practical heights of lift or, as shown on the Drawings or as may be specified from time to time, and the capacity of the mixing plant available as it is essential that each section of concrete bounded by construction or expansion joints be cast in a single continuous operation. No construction joints shall be allowed in places other than those shown on the Drawings or approved of in writing by the Engineer.

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

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

pipes prior to casting in. The cost of such method will be deemed to be included in the rates tendered for as per subclause 15.10 as applicable.

6.2 Formwork surfaces

The surfaces of formwork that are in contact with the fresh concrete shall depend on the type of finish required on the complete structure. The Contractor shall be at liberty to use timber formwork in lieu of steel formwork, but under no circumstances will steel formwork be allowed if the type of surface finish required in such as can only be obtained by the use of timber formwork. Details of the formwork surfaces required to give the minimum specified finishes are given in subclause 6.4.

The Contractor will not be permitted to alter the type of shutter surface on concrete work that will not be permanently covered up once a particular surface has been in use for a particular structural element or unit unless written authority has been obtained from the Engineer.

6.3 Surface tolerances and irregularities

6.3.1 General concrete surfaces

Permissible deviations appropriate to the degree of accuracy required will be applied to linear dimensions, position, verticality, level, squareness, and bow. The degree of accuracy may be one of the following:

a) Degree of Accuracy III for use where a high degree of accuracy is unnecessary, e.g. mass foundations;

b) Degree of Accuracy II for what is commonly called "good work";

c) Degree of Accuracy I where the use of special, as opposed to normal, methods or materials (or both) is warranted despite the probability of higher costs than are caused by the use of Degree of Accuracy II. This may apply where, for example, prefabricated units (windows, precast panels) are required to fit in position.

The methods for measurement of deviations will be measured as set out below:

a) Any deviation from flatness of a plane surface will be measured as the maximum deviation of the surface from any straight line of length 3 m joining two points on the surface, determined by means of a straight-edge the ends of which are supported on identical blocks of suitable thickness placed over each of the points.

b) Any abrupt change in a continuous surface, including a local depression or peak in a floor or wall and any abrupt change caused by a joint in formwork will be measured as specified in (a) above.

c) Out-of-squareness of a corner or an opening or an element such as a column will be measured by taking the longer of two adjacent sides as the base line, and determining any departure from the perpendicular of the side at either end of the base line.

The Contractor shall construct each of the various parts of the Works within the limits of the applicable permissible deviation set out in the table below appropriate to the degree of accuracy specified on the drawings. If no degree of accuracy is specified, Degree of Accuracy II shall apply.

Any departure from flatness and the height or depth of any irregularity of a finished plane concrete surface shall not exceed the applicable maximum value given by (d) (7) and (8) in the table below. The specified accuracy shall be achieved without any treatment except the rubbing down of hardened surfaces with carborundum blocks.

| | | Permissible deviation | | |
|---|---|---|---|---|
| | | Degree of accuracy | | |
| | | III | II | I |
| **a)** | **Reinforcement** | mm | mm | mm |
| 1) | Spacing between two adjacent bars…… | ±25 | ±20 | ±15 |
| 2) | Longitudinal location of bends and ends of bars…… | ±40 | ±30 | ±20 |
| 3) | Cover to reinforcement (see (e) below)…… | -0+20 | -0+10 | -0+10 |
| **b)** | **Formwork**: Formwork shall be so constructed as to ensure that the position of the finished work will be as specified, subject to the relevant permissible deviation given in (c) or (d) below, as applicable | | | |
| **c)** | **Foundations**: Mass and reinforced concrete. | | | |
| 1) | Position on plan of any edge or surface measured from the nearest grid line or agreed centre line……. | ±50 | ±35 | ±20 |
| 2) | Linear dimension on plan cast against excavation sides…… | ±60 | ±40 | ±20 |
| 3) | Linear dimension on plan cast against formwork……..... | ±30 | ±20 | ±10 |
| 4) | Level of underside of concrete……..... | -40+20 | -30+15 | -20+10 |
| 5) | Surface level (i.e. top of foundation) (excluding floor slabs)…… | -30+15 | -20+10 | -10+5 |
| **d)** | **Elements or components above foundations** (including floor slabs) | | | |
| 1) | Position on plan of any edge or surface measured from the nearest grid line or agreed centre line……..…… | ±25 | ±15 | ±5 |
| 2) | Linear (other than cross-section) dimensions……..…… | ±30 | ±20 | ±10 |
| 3) | Cross-section dimensions……..…… | -10+20 | -5+15 | ±5 |
| 4) | Level (deviation from designed level with reference to the nearest transferred datum (TD) of the upper or lower surface, as may be specified, of any slab or other element or component)..... | -20+10 | -15+5 | -10+0 |
| 5) | Verticality, per metre of height……..…….... | 5 | 3 | 2 |
| | Subject to a maximum deviation of..……..…… | 50 | 30 | 10 |
| 6) | Out-of-squareness of a corner or an opening or an element such as a column for short side of length | | | |
| | i) Up to and including 0, 5 m……..... | ±10 | ±5 | ±3 |
| | ii) Over 0,s m up to and including 2 m…….. | ±20 | ±15 | ±10 |
| | iii) Over 2 m, up to and including 4 m…… | ±25 | ±20 | ±15 |
| 7) | Exposed concrete surface: | | | |
| | i) Flatness of plane surface…… | 10 | 5 | 3 |
| | ii) Abrupt changes in a continuous surface…….. | 10 | 5 | 2 |
| 8) | Exposed concrete surface to be plastered: | | | |
| | i) Flatness of plane surface…… | 15 | 10 | * |
| | ii) Abrupt changes in a continuous surface…… | 10 | 5 | * |
| **e)** | **Cover to reinforcement**. No deviation from the minimum cover of concrete over reinforcement specified in subclause 7.2 will be permitted……. | | | |
| **f)** | **Location of holding-down bolts** | | | |
| 1) | The centre line of a holding-down bolt from its designated location in plan……..…….. | * | ±3 | * |
| 2) | The top of the bolt from its designated elevation…….. | * | -3+5 | * |
| **g)** | **Constituents in concrete mix** (including water) | % | % | % |
| | Permissible deviation of quantities from approved or designated or prescribed mix, as applicable…… | ±5 | ±5 | ±5 |

6.3.2 Special concrete surfaces

This subclause is applicable to special concrete surface tolerances only. Special concrete surfaces will be those listed in the table below, where there is a contradiction between the tolerances indicated in 6.3.1 and 6.3.2, the table below will take precedence.

Surface tolerances shall be the limitations within which structures shall be constructed in space, in relation to their positions as shown on the Drawings.

Surface irregularities may be either abrupt or gradual and shall be measured with respect to a point on the surface, at a prescribed distance from the irregularity. No point on a surface shall lie outside the band of tolerance.

The surface tolerance and irregularities specified shall be achieved without any after treatment of the surfaces, other than removal of irregularities as specified and which will not affect the surface finish. Any concrete work which does not comply with the requirements of this subclause after the specified permissible treatment of the surfaces may be rejected by the Engineer. Such rejection may be by ordering the Contractor to remove such defective work and replacing it together with any acceptable concrete work that may have been cast on top of the defective work with concrete conforming to the specified requirements, all at the expense of the Contractor. The Engineer may however decide to leave the defective work in place but to exclude the whole or such portions as he may deem fit from the measurement for payment purposes. The same powers of rejection of the work will vest in the Engineer with regard to the standard of the surface finishes obtained as described in subclause 6.4.

The attention of the Contractor is furthermore drawn to the particular necessity of achieving the highest standard of concrete and surface tolerance and irregularities for faces that will be subjected to the passage of high velocity water. Such surfaces will be referred to as special hydraulic surfaces and the concrete alignment and evenness will be of paramount importance.

Both formed and unformed surfaces in the various portions of the finished Works shall be subject to the surface tolerance and abrupt surface irregularities indicated in the following table; except that notations on the Drawings relating to specific tolerance or irregularities shall be considered as supplementary to or superseding these values.

| **Type of Surface** | **Surface tolerances** (mm) | **Abrupt irregularities** (mm) |
|---|---|---|
| Special Hydraulic surfaces | 6 | - |
| Hydraulic surfaces in the immediate vicinity of steel linings, built-in gate, and valve parts and sealing faces | 3 | - |
| Pendulum wells, gate chambers and wells, gate and valve and motor houses, intake structures, trashracks, walls of concrete reservoirs, columns, roof and floor slabs, manholes etc. | 6 | 3 |
| Non-hydraulic surfaces of spillway chutes and bridge piers | 12 | 6 |
| Spillway crests, piers and splitters and surge chambers, draft tubes and hydraulic conduits | 6 | 3 |
| Lining of tunnels, galleries, adits, and non-hydraulic conduits | 12 | 6 |
| Upstream and downstream faces of dams or weirs anchor or thrust blocks for pipes, downstream aprons, canal linings | 25 | 12 |
| Construction, contraction and expansion joints | 12 | 6 |
| Precast members, including beams and slabs | 6 | 3 |

The surface tolerances indicated in the above table are permissible on either side of the positions shown on the Drawings provided that no dimension is decreased by more than 5% from that on the Drawings.

Gradual surface irregularities will be tested by comparison with a straight or an appropriately curved template 3 m long. Unless shown otherwise on the Drawings or unless otherwise instructed by the Engineer, the quality of formwork shall be such that gradual irregularities do not cause points on the surface to lie further away from the template, when laid in the appropriate positions on the concrete than the permissible surface tolerance given in the above table.

On special hydraulic surfaces and hydraulic surfaces in the immediate vicinity of steel linings, built-in gate and valve parts and sealing faces abrupt irregularities shall be completely eliminated by grinding on a bevel of 1:20 height to length ratio where the irregularities are parallel to the direction of water flow and a bevel of 1:50 when the irregularity is not parallel to the direction of water flow.

Abrupt surface irregularities shall be measured as the relative displacement normal to the surface of two points on the surface spaced not more than 10 times the permissible irregularity apart.

The summation of all such abrupt irregularities within a distance of 1 m in any direction shall not exceed the maximum value permitted by the above table.

6.4 Surface finishes

The class of finish and the requirements for finishing of concrete surfaces shall be as specified in this subclause. The finish to be given to the various surfaces shall be as shown on the Drawings and in the event that the finishes are not clearly specified for all surfaces the finish to be used shall be to a Degree of Accuracy II. Before final acceptance of the Work the Contractor shall clear all exposed surfaces of unsightly incrustations and stains. Distinction will be made between formed and unformed surfaces.

6.4.1 Formed surfaces

Formwork will be classified in accordance with the surface condition required on the finished concrete. Such surface conditions are classified as either “Rough” or “Smooth” and will be so scheduled:

Rough: No treatment of the surface of the concrete will be required after the striking of the formwork. The finish of the concrete need not be more accurate than Degree of Accuracy III as defined in terms of clause 6.3.1.

Smooth: Imperfections such as small fins, bulges, irregularities, surface honeycombing, and slight surface discolorations shall be made good and repaired by approved methods. The finish of the concrete shall be accurate to Degree of Accuracy II as defined in terms of clause 6.3.1.

6.4.2 Unformed surfaces

Unformed surfaces such as floors, top surfaces of roof slabs, roads, spillway crests, etc. shall be properly and smoothly finished without any plaster or other coating being applied after the work is completed. The classes of finish for unformed concrete are designated by “Woodfloated”, “Steelfloated” and “Powerfloated”. Surfaces shall be sloped for drainage where shown on the Drawings or as directed. Surfaces that will be exposed to the weather and which would normally be level shall be sloped for drainage. Unless the use of other slopes of level surfaces is indicated on the Drawings or directed by the Engineer, narrow surfaces such as the top of walls and curbs shall be cast level across the width; wider surfaces such as walkways, roadways, platforms and decks shall be sloped 2% across the width. The classes of finish are as follows:

Woodfloated: This is a wood floated finish and applies to unformed surfaces not permanently concealed by backfill or concrete. Floating may be performed by hand or power driven equipment and shall be started as soon as the surface has stiffened sufficiently and shall be the minimum necessary to produce a non-skid surface free from screed marks and uniform in texture. Joints and edges shall be tooled appropriately.

Steelfloated: Method statement for achieving this surface finish shall be submitted to the Engineer for approval.

Powerfloated: Method statement for achieving this surface finish shall be submitted to the Engineer for approval.

All unformed surface finishes shall be assumed “woodfloated” unless otherwise stated on the drawings.

6.5 Preparation of formwork

All formwork shall be erected square and true to line and level. Forms shall be erected with joints tight enough to prevent leakage of cement mortar. All sawdust shavings and other foreign matter shall be carefully removed from the faces of the formwork before any concrete is placed. To prevent concrete adhering to the formwork, the surface against which concrete is to be deposited shall receive a thin coat of non-staining mineral oil or other approved material not liable to stain the concrete. Care shall be taken to keep any reinforcement free from such material.

Before re-use, all formwork shall be reconditioned, and all form surfaces that are to be in contact with the concrete shall be thoroughly cleaned.

Where necessary for the proper placing of the concrete, temporary openings for cleaning, inspection, or placing purposes shall be provided and, subsequently, so closed as to provide the finish specified and to conform to the applicable tolerances given in subclause 6.3.1.

6.6 Removal of formwork

When the concrete has hardened sufficiently formwork shall be removed carefully without shock or disturbance and in such a manner as will not injure the concrete. No formwork shall be removed before the concrete has set sufficiently to withstand safely any stresses to which the structure may thereby be subjected. A small portion of formwork shall first be removed to verify that the concrete has set sufficiently hard before the whole area of formwork is removed.

Unless otherwise approved by the Engineer, the minimum periods which shall elapse between the completion of the concreting operations and the removal of the formwork for the various parts of structures are given in the following table, but this shall not relive the Contractor of his responsibility to delay removal of the formwork until the concrete has gained sufficient strength, and the Contractor shall be held responsible for and shall make good at his own cost all injury and damage arising from premature removal of the formwork or loading of the members.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| Formwork to Structural Member | Strength Class of Cement | | | | | | | | |
| | CEM-1 | | | CEM-II-A (or blend of CEM-I with **less** than 20% FA/GGCS /GGBS) | | | CEM-II-B, CEM-III (or blend of CEM-I and **more** than 20% FA/GGCS /GGBS) | | |
| | Minimum time (24 hour periods) before removal of formwork | | | | | | | | |
| | Weather | | | | | | | | |
| | Hot or Normal | Cool | Cold | Hot or Normal | Cool | Cold | Hot or Normal | Cool | Cold |
| Beam sides, walls and unloaded columns | 1 | 1.25 | 1.5 | 1.5 | 2 | 3 | 3 | 4 | 5 |
| Slabs with props left underneath | 2 | 3 | 4 | 4 | 5.5 | 7 | 6 | 8 | 10 |
| Beam soffits with props left underneath and ribs with a ribbed floor construction | 3 | 4 | 5 | 5 | 7 | 10 | 10 | 13.5 | 17 |
| Slab props including cantilevers | 5 | 7 | 9 | 10 | 13.5 | 17 | 10 | 13.5 | 17 |
| Beam props including cantilevers | 7 | 9.5 | 12 | 14 | 17.5 | 21 | 14 | 17.5 | 21 |

*Under cold weather or dry windy conditions, these periods may be extended by the Engineer.

The Contractor shall make provision for the continued support of beams and slabs while the formwork is being removed and/or for back propping of beams and slabs.

Where walls/beams have top slabs attached, the contractor shall keep the wall/beam propped until such a time as the top slab has attained its design strength. Back-propping of such structures shall be discussed and agreed with the Engineer at the time of programme approval.

## 7. FIXING REINFORCING

### 7.1 Bending

Reinforcing bars shall be bent in such a manner that, unless otherwise specified, all hooks and bends shall be in the same plane, unless hot bending is specifically authorised, all bars shall be bent cold. Bending shall be done slowly, using a steady even pressure and avoiding any jerk or impact and all bends shall be to the dimensions shown on the Drawings and in accordance with the requirements of SANS 282. Bars of 40 mm in diameter or greater may be bent hot provided that bars so heated shall not be cooled from this temperature by water or other liquid.

### 7.2 Positioning

Unless otherwise shown on the Drawings or directed by the Engineer, measurements made in positioning the reinforcement shall be to the centre lines of bars, wires or cables. In case the exact position, size and shape of reinforcement is not shown on the Drawings for all bars or cables they shall be in all respects as specified by the Engineer and where necessary the Contractor will be supplied with supplementary detail Drawings or lists which will give the information necessary for cutting, bending and placing of the reinforcing bars.

Reinforcement shall, at the time of placing concrete be free from loose or powdery rust, scale, oil and other coatings that may reduce the bond between the steel and surrounding concrete, affect the durability of the concrete, or initiate corrosion of the reinforcement. If any substance other than water is to be used for lubricating the formwork, every precaution shall be taken to avoid contamination of the reinforcement by such substance.

Reinforcing bars and cable ducts shall be accurately placed and secured in position so that they will not be displaced during concrete placing and special care shall be taken to prevent disturbance of reinforcing bars and cable ducts in freshly placed concrete. Reinforcing bars and cable ducts shall be secured by tying with 1,6 mm or 1,25 mm diameter annealed soft iron wire at intersections, or by the use of suitable clips at intersection, welding of reinforcement bars is not permitted under any circumstances. Reinforcement bars must be aligned and supported against displacement by means of metal hangers and metal, concrete or mortar chairs and spacers provided that no metal chairs or spacers shall be placed in contact with the forms where in the opinion of the Engineer there is any likelihood of corrosion. In addition, steel reinforcing bars or cable ducts shall not be placed closer than 50 mm from any copper waterstops, aluminium inserts or any non-ferrous metal present in the concrete in order to prevent electrolytic corrosion.

The Engineer will inspect the reinforcing after it has been fixed in place, the formwork has been cleaned, cover blocks have been positioned, and before concreting commences.

Cover blocks shall be made of mortar to achieve a strength class (and equivalent durability) of the concrete of the element they are placed in. They shall be placed at a spacing so as to avoid crushing from any applied construction and self-weight loads. Plastic cover blocks will not be permitted in water-retaining/excluding structures.

In slabs and beams, splices in reinforcement shall be made in the position shown on the drawings or approved by the Engineer. Such splices shall provide sufficient lap to transfer the stress between bars by bond and by shear.

Splices in column reinforcement shall be permitted only in regions where lateral support is afforded.

Splices in hoop reinforcement of circular reservoir walls shall be staggered around the perimeter so that not more than one bar in any four adjacent bars splices in the same vertical section.

Where offsets in reinforced concrete columns occur, the longitudinal bars shall be offset in regions where lateral support is afforded, and where offset, the slope of the inclined portion shall be such that the length of the crank is at least 12 times the offset measured from the outside faces of the bar.

Exposed reinforcement intended for bonding with future extensions shall be adequately protected from corrosion.

Unless otherwise indicated on the Drawings, the minimum concrete cover, measured to the outside face of any reinforcing bar or cast in pipe shall be 40mm.

8. CONCRETE

Concrete placed in the Works shall be a homogeneous mixture of coarse aggregate, fine aggregate, water, cement and extenders (as per subclause 8.4). Approved chemical additives may be used to reduce water demand and aid workability.

8.1 Design

The concrete mix design shall be designed by an approved independent laboratory. The proportions of the various sizes of aggregate, cement and water shall be such as to produce a dense concrete of adequate workability for the particular circumstances under which the concrete will be transported, placed and compacted. Approved plasticizing additives may be used to ensure adequate workability in preference to varying the proportions of water and cementitious binder.

All exposed concrete shall be of the same colour. No change in materials or processes shall be made without the Contractor first satisfying the Engineer that no change in colour will result.

8.2 Trial Mixes

Whenever "Designed Mixes" are required by the Schedules of Quantities or drawings, after approval of the aggregates the Contractor shall design for each class of concrete required for the Works, have trial mixes designed within the limits specified herein for 28 day and 7 day strengths and he shall have cubes made and tested by an approved laboratory at his own expense. The test results of cubes made from trial mixes shall be used to determine the proportions for the "Designed Mixes" to be used in the Works.

Details of the mixes as designed shall in all cases be submitted to the Engineer for approval, 30 days before concreting is carried out and no concrete shall be placed in structures before such approval in writing has been obtained. The proportions of cement, aggregates and water for each mix as approved shall not be changed except with approval of the Engineer.

The Engineer must receive for any particular concrete mix:

i. Proportions of each design tested
ii. Strength of each cube tested
iii. Density of each cube tested
iv. The Contractor's nomination of the design he proposes.

8.3 Watertight concrete

The mix designs for watertight concrete must be aimed at ensuring concrete durability and must therefore be guided by the need to:

i. Minimise the permeability of the concrete; and
ii. Maximise the chemical resistance of the concrete to aggressive agents in the environment.
iii. Reduce the heat of hydration and thermal gradient of thick sections (greater than 400mm thick) at early-age.

The following parameters shall be adhered to:

| **Parameter** | **Limit** |
|---|---|
| Maximum shrinkage strain (accelerated shrinkage test): | 350 µm/m |
| Maximum water:binder ratio: | See subclause 8.7 |
| Minimum cementitious binder content: | 300kg/$m^3$ |
| Maximum cementitious binder content: | 400kg/$m^3$ |
| Maximum alkali content: | See subclause 3.8.2 |
| Maximum thermal coefficient of expansion for concrete: | 12x$10^{-6}$/°C |
| Minimum coarse aggregate fraction (as a percentage of total (coarse + fine) aggregates): | 0.55 |
| Type of extender required: | Fly Ash (FA) |
| Minimum and maximum range of extender replacement (as a percentage of total binder content) | 20% - 30% (FA) |
| Maximum water-demand | 190ℓ/$m^3$ |

Where extenders specified may not be locally available, the Contractor should take into account all the costs required to import and batch the specified extender in the rates for concrete.

All structures shall be considered water retaining and shall require watertight concrete:

Where extenders are used/specified, the requirements of subclause 6.6 are highlighted to the Contractor, and the immediate protection during casting and the curing of concrete should be given special attention by the contractor.

8.4 Workability of concrete

The workability of the concrete shall be described in terms of the Compacting Factor which shall be determined in accordance with SANS 5862. The concrete mix proportions used shall in all cases be such that the Compacting factor is higher than 0.85. In addition the concrete shall be of such consistency and composition that it can be readily worked into the corners of forms and around reinforcement without segregation or bleeding, using such compaction methods as specified in clause 10.

Whenever, in the opinion of the Engineer, the consistency of the concrete is such that excessive bleeding or segregation occurs in the concrete, he shall have the power to order the Contractor to perform trial mixes in order to determine the new mix proportions such that excessive bleeding or segregation does not occur. The relative rate of bleeding shall be determined by the "Method of Test for Bleeding of Concrete" in accordance with the provisions of Designation 25 of the Seventh Edition of the Concrete Manual of the U.S. Bureau of Reclamation. The cost of the trial mixes and any change in mix proportions shall be borne by the Contractor. In addition the Contractor shall ensure that whenever a concrete is to receive a screeded finish against a slope, such as for cast-in-situ canal linings the cohesion and stiffness is adequate to allow for ease of placement at the required slope.

8.5 Changes in proportions or materials ordered by the Engineer

The Engineer shall at any time have the right to test concrete made from the material, and according to the mix proportions proposed by the Contractor. If these or the Contractor's own tests on works cubes show that the requirements of this specification are not being met, the Engineer may order such changes in materials or proportions as may be necessary in his opinion in order to meet these requirements. These changes shall be made at the Contractor's expense, and no extra payment will be made for such changes.

These tests may be witnessed by the Contractor should he so desire, and the results of these tests will be made available to the Contractor on application.

8.6 Changes in proportions or materials requested by the Contractor

If at any time the Contractor desires to use other materials or proportions than those originally submitted for approval he shall provide evidence to the satisfaction of the Engineer that such changes will produce concrete meeting the requirements of this specification and will not cause objectionable changes in the appearance or other characteristics of the concrete, before such changes will be approved by the Engineer.

8.7 Durability

The exposure conditions of the water-tight concrete are classified as "severe” in terms of SANS 1200G subclause 5.1.3.

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

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

8.8 Changes in requirements

The Engineer shall at any time have the right to change the specified requirements for any of the classes of concrete, either in materials or in proportions of both. The cost of such variations shall be determined in accordance with the provisions of subclause 15.1 of this Specification.

8.9 Works tests on concrete

The strength of concrete which is being placed in the Works shall be sampled, cured and tested by the Contractor.

The Engineer has the right to witness sampling procedures, making and curing of cubes and any or all tests. Cubes shall be tested to determine the compressive strength of the concrete at 7 days and 28 days and the results shall be made available to the Engineer as soon as results are available.

If the compressive strengths of 7 day old cubes indicate that the 28 day cube strengths may not satisfy the minimum requirements of strength and degree of quality control, the Contractor will be allowed to remove the concrete concerned at his own expense or suspend work on the particular section, subject to the Engineer's approval, or continue concreting at his own risk until actual 28 day strengths of cubes of the same batch are known.

The strength of concrete from every individual concreting operation shall be tested. The Engineer may instruct the strength of any batch of concrete during a concreting operation to be tested regardless of whether cubes of another batch in the same operation have already been made or not. Concrete samples shall be taken at the nearest practicable point prior to final placing. The workability of the concrete will be tested in accordance with B.S 1881 at different intervals during a concreting operation to ensure that the requirements of subclause 8.4 are being complied with.

8.10 Applied loads

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

8.11 Granolithic screeds/benching

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

The contact surface of the base concrete shall comply with the requirements for a degree of accuracy II finish.

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

It shall be brought true to profile as shown on the drawings with a degree of accuracy I finish.

Screeds shall be cured as per clause 11.

## 9. PREPARATION FOR PLACING

### 9.1 General

No concrete shall be placed until all formwork, installation of parts to be embedded and preparation of surfaces involved in the placing have been approved by the Engineer. No concrete shall be placed in water without the written authority of the Engineer and the method of placing shall also be subject to his approval. Concrete shall not be placed in running water or subjected to the action of running water until, in the latter case, such concrete has hardened sufficiently so as not to be damaged in any way.

Where drains are to be provided in or behind concrete for the temporary conveyance of water, they shall afterwards be grouted up and the cost of such pipe laying and grouting shall be borne by the Contractor.

All formwork surfaces and embedded parts that have become encrusted with dried mortar or grout from concrete that has previously been placed, shall be cleaned of all such materials before the surrounding or adjacent concrete is placed.

Blinding layers shall be cast on the same day that earthworks excavation (Restricted as per SABS 1200D, 8.3.3 and Extra excavation as per SABS1200D, 8.3.5) have been completed.

### 9.2 Foundation surfaces

Immediately before placing concrete, all surfaces of foundations upon or against which concrete is to be placed shall be free from standing water, mud, loose rock and other debris.

The surface of rock or rocky foundations shall be thoroughly roughened and cleaned with suitable tools and washed down with the aid of a jet of high pressure water or water and air mixture. The surfaces of absorptive foundations against which concrete is to be placed shall be thoroughly moistened in order that no moisture is drawn from the freshly placed concrete.

Fissures and seams in the rock shall be cleaned out to the satisfaction of the Engineer and shall be stemmed with cement mortar of an approved mix.

### 9.3 Construction and contraction joints

Whenever concrete is to be bonded to other concrete which has taken its initial set the surface of contact between the section shall be considered as being a construction joint. Construction joints shall be such that the concrete cast later shall bond firmly to the concrete previously cast. The construction joints in all structures (designated or non-designated) shall be made strictly in accordance with the details shown on the drawings.

The position and pattern of all joints (designated or non-designated) shall be subject to the Engineer’s approval.

Non-designated joints (refer clause 2.1) shall not be paid for separately and shall be assumed to be included in the various rates for concrete, reinforcing and formwork. This also applies to the preparation of concrete to form construction joints in flume walls as specified on the drawings.

Where alternative joint details are proposed by the Contractor, these are subject to the Engineer’s approval. The joints between screeds and concrete floors shall be regarded as construction joints and the surface of the floor shall be prepared as described for construction joints.

Kickers shall be provided throughout unless noted otherwise on the drawings. Kickers shall be cast monolithically with the floor slab/foundation concrete and the Contractor shall ensure that kickers are thoroughly compacted, immediately protected, and cured using suitable techniques.

For construction joints at kickers, all additional costs for concrete, preparation, etc will be deemed to be included in the rates tendered for concrete in walls and formwork.

The walls shall be cast in lifts of a height that permits each lift to be poured without interruption in one continuous operation during normal working hours.

It is the Contractor's responsibility to ensure that construction joints are watertight. The Contractor's proposed method for ensuring the watertightness of such joints shall be submitted to the Engineer for his approval.

Whenever adjacent concrete sections are to be prevented from adhering to each other during the period of curing and drying out the surface of contact between the sections shall be considered as being a contraction joint. Contraction joints may be required to be coated with a layer such as bitumen to prevent bonding or the joints may be grouted at a later stage of the construction. The locations of all contraction joints and any special surface treatment are shown on the Drawings.

Construction joints shall be arranged so as to reduce to a minimum the effects of shrinkage in the concrete after placing and shall be located in the most advantageous positions with regard to stresses in the structures. Feather edges of concrete at joints shall be avoided.

All vertical construction or contraction joints shall be formed against adequate formwork or bulkheads, slotted if necessary in such a way as to allow continuity of reinforcement across the joint without loss of mortar. Such formwork or bulkheads shall be placed square across the member in which the joint is to be formed.

The intersections of horizontal or near horizontal joints and exposed faces of concrete shall appear as straight lines produced by trowelling or the use of a guide strip fixed to the formwork at the top of the concrete placed up to the joint. Unless otherwise detailed or ordered by the Engineer, the plane of construction joints shall be horizontal or vertical and in no case shall an unformed joint having a slope of more than 1 vertical to 5 horizontal be specified or permitted.

In portions of concrete structures subject to the passage of high velocity water, no construction joints, other than those approximately normal to the concrete/water surface shall be made within 1,5 metres of this surface.

The following procedure shall be adhered to in bonding fresh to older concrete at a construction joint:

(i) Where fresh concrete is to be bonded to concrete which is not more than four hours old:

In the case of a horizontal construction joint, the concrete of the previous lift shall at the time of depositing, be placed to a height slightly above that of the joint and the surplus concrete shall be struck off before the concrete stiffens up. The fresh concrete shall be placed without further preparation. In the case of vertical joints, the surface of the older concrete shall be wire-brushed to roughen the surface. A high pressure jet of water or water and air may be used to remove laitance in order to expose clean sound aggregate on horizontal and vertical faces. Cleaning and roughening shall not be carried out within 20 mm of an exposed face or over the width of the guide strip. Care shall be taken not to undercut the edges of larger particles of aggregate during the above operations.

Immediately before concreting all loose materials and/or pools of water shall be blown from the concrete surfaces.

(ii) Where fresh concrete is to be bonded to concrete which is more than four hours but less than three days old:

In the case of horizontal joints, the surfaces of the older concrete shall be first struck off as described in (i) above.

In the case of both vertical and horizontal joints, the surface of the old concrete shall be thoroughly roughened with a steel wire brush or sand blasted to expose the coarse aggregate and shall be washed with clean water to remove all laitance, dirt, loose particles, etc. The requirements for cleaning is as for (i) above. Immediately before placing the new concrete, a thin layer of plastic mortar shall be applied to the surfaces of the old concrete. The mortar shall consist of cement and sand mixed in the proportion contained in the concrete mix that is, omitting the coarse aggregate. The fresh concrete shall be placed against the layer of mortar while the latter is still plastic.

(iii) Where fresh concrete is to be bonded to concrete which is more than three days but less than eight days old.

The surface of the concrete shall be wire brushed or sand blasted to expose the coarse aggregate. In the case of concrete which has been made with normal cementitious binder, or in the case of concrete which is not less than 14 days old and which has been made with rapid hardening cementitious binder, sharp pointed picks or hammers may be used for this purpose. Roughening shall not be carried out within 20 mm of an exposed face. Approximately 24 hours before the new concrete is to be placed the old concrete shall be washed and cleaned; of any adhering deposits being chipped off.

Thereafter it shall be kept continuously damp and free of foreign materials. Immediately before the placing of the concrete, a neat cement slurry of the consistency of cream, shall be scrubbed into the surface. This shall be followed immediately by a thin coat of plastic mortar and the fresh concrete as described in (ii) above.

(iv) Whenever fresh concrete is being placed on concrete which is more than 8 days old the approval of the Engineer shall first be obtained. In such instances, it will usually become necessary for the heights of the lifts to be reduced temporarily in order to prevent shrinkage cracks from forming in the fresh concrete. The normal height of lift can usually be reverted to after concrete has been cast to a height equal to one normal lift above the old concrete. The Contractor shall however adhere strictly to the programme decided upon by the Engineer before being allowed to resume concreting at the normal lift height. Cleaning and roughening the old concrete and preparations for placing concrete shall be as in (iii) above.

The surfaces of contraction joints shall be cleaned thoroughly of accretions of concrete or other foreign matter by scraping chipping or other means satisfactory to the Engineer before any fresh concrete is placed against such a joint. Where positive separation of the concrete faces is required bitumen painting on approved filler materials are to be incorporated where shown on the Drawings or ordered by the Engineer.

10. PLACING AND COMPACTION OF CONCRETE

10.1 Authority to commence

The Contractor shall give the Engineer notice at least 24 hours beforehand of his intention to place concrete in a particular section of the Works.

Before the cement slurry mortar screed or concrete is placed the Contractor shall apply to the Engineer for written approval of the cleaning of rock or concrete surfaces or both, against which the new concrete is to be placed and of the fixing and cleaning of formwork, reinforcement, cable ducts, waterstops, pipework etc. in order to commence casting concrete in any particular member or portion of the works.

10.2 Transporting

The materials and equipment used for protecting and transporting fresh concrete to its final position shall be such as to prevent segregation, loss of materials, change of consistency or contamination with foreign matter. Where authorised by the Engineer, concrete in tunnel linings and in certain other sections of the Works may be transported and placed by pumping.

10.3 Placing

Where the freshly mixed concrete is not being continually agitated by means of an approved agitator the maximum period between exit of concrete from the mixer and final consolidation shall be 30 minutes. Where approved agitators are used the maximum period of placing may be extended to 1 hour.

Wherever possible, concrete shall be deposited vertically in the final position required but without dropping freely through a height greater than 1,5 m. Bins, drop-chutes, downpipes or baffles shall be provided to prevent segregation of the materials where in the opinion of the Engineer such equipment is necessary.

Concrete in tunnel inverts shall not be placed by pneumatic equipment. Where pumping of the concrete is employed, the equipment used and the method of operation shall be such as will permit introduction of the concrete without high velocity discharge or separation. After the concrete in tunnels has been built up over the arch of steel lining at the start of placing, the end of the discharge line shall be kept well buried in the concrete during placing of the arch and sidewalls to ensure complete filling. The terminal section of the discharge line shall be marked so as to indicate the depth of burial at any time. Special care shall be taken to force concrete into all irregularities in the rock surfaces and to completely fill the tunnel arch. Placing equipment shall be operated by experienced workmen only.

The methods and equipment employed for placing concrete under water shall all be subject to the approval of the Engineer. The concrete shall be placed by bottom discharging watertight containers or through funnel shaped tremies which are kept continuously filled with concrete to above the water level. The discharge end of the tremie shall always be kept immersed in the concrete in order to reduce to a minimum the contact of the concrete with the water. Special care shall be taken to avoid segregation.

Concrete shall not be placed during rain sufficiently heavy or prolonged to wash mortar from coarse aggregate on the exposed sloping faces of fresh concrete nor when the air temperature is below 4 degrees Centrigrade. During hot weather, all surfaces against which the concrete is to be placed shall be kept sufficiently damp to prevent excessive absorption of water from the fresh concrete and the Contractor shall take such measures as may be deemed necessary to ensure that the temperatures of the placed concrete does not rise excessively.

The face from which concreting is to commence shall be subject to the approval of the Engineer in order to allow for the possibility of emergencies that may prevent the completion of a concreting lift.

Once commenced, concreting shall be done in a continuous operation between pre-arranged construction or contraction joints except if an emergency occurs and interruption is unavoidable. The Contractor shall have readily available suitable prefabricated formwork as stop ends to form emergency vertical construction joints and in the event of such an interruption occurring, the concrete already placed shall be properly finished up to stop end and to a horizontal or inclined surface as directed by the Engineer.

Concrete shall be placed in layers not exceeding 750 mm in thickness for mass concrete approximately parallel to the horizontal or inclined unformed construction joint planes. The minimum layer thickness shall be decided by the Engineer for the type of construction and class of concrete being used. These layers shall be deposited, across the full width, from one face to the opposite face until the full height of the lift is reached. Each layer shall be deposited on the previous layer before the latter has taken its initial set and in such a manner as to keep the

exposed area of fresh concrete to a minimum. In order to accomplish this, a new layer may be started before the previous layer is completed.

Concrete shall be carefully placed within the formwork so as not to displace the formwork, reinforcement, waterstops, etc. that may be embedded in the concrete. During placing and compaction, provision shall be made for the removal of water which may collect on the surface of the concrete, and no concrete shall be placed after loss of workability occurs and under no circumstances shall concrete which has partially hardened be deposited in the work, nor shall any concrete be retempered by the addition of water or other materials.

If it is required that more than one class of concrete be used in a particular lift, the mix shall be changed at the appropriate line without interruption of the concreting of the lift as a whole. This type of construction may be required in mass concrete sections where the concrete forming the interior of the mass can have a lower cement content in order to reduce the heat of hydration and also because of the lower durability requirements.

Concreting of circular walls (without vertical joints) between horizontal construction joints shall be carried out in both directions from a point on the wall in order to close the gap with fresh concrete.

Pumping of concrete shall not be permitted unless approved by the Engineer. For such approval, the Engineer may require shrinkage tests of the concrete to meet the criteria in subclause 8.3. The rates for concrete will be deemed to include such testing costs.

Should excessive cracking of pumped-concrete occur, the Engineer may instruct the Contractor to revert to conventionally placed concrete. All costs associated with changes in mix design, site placing equipment, and any remedial repairs to concrete will be at the Contractor's expense.

10.4 Compaction

The Contractor shall thoroughly compact all concrete immediately after it has been placed in position and this shall be accomplished with the aid of either approved immersion vibrations, vibrating formwork for thin sections or vibrating tables for small precast members, together with rods, spatulas, shovels etc. if necessary.

Vibrators shall be of a size and type adequate for the portion of concrete being placed and shall operate at a frequency of between 100 and 160 cycles per second. The length of the vibrating element of immersion vibrators shall be sufficient to penetrate through the layer of concrete being placed and revibrate the upper portion of the underlying layer of concrete. Under special circumstances revibration may be required, but revibration shall not be resorted to if the concrete is no longer sufficiently fluid to flow into the space occupied by the vibrator. Revibration of an underlying layer shall not be resorted to against the formed surface of exposed concrete where appearance is important as this may result in a line of demarcation forming between the two layers.

A sufficient number of vibrators shall be operated to enable the entire quantity of concrete being placed to be vibrated for the necessary period and in addition a standby vibrator shall be available for use at each concreting place.

Only skilled workmen experienced in the use of vibrators shall be employed on this type of work. Vibrators shall be used purely for the purpose of consolidating the concrete. Lateral moving of concrete with the vibrators shall not be permitted. Vibration shall be continued at each point until the concrete ceases to settle, a thin layer of mortar has appeared on the surface and air bubbles have ceased to appear. The necessary period of vibration shall be carefully determined by trails performed in the presence of the Engineer for each class of concrete and the particular vibration equipment being used for that class of concrete to ensure that no grout separates from the mix. Vibration shall then be continued at each point for this period before any additional concrete is placed on top.

Additional vibration may be required near faces in contact with formwork where the concrete will be exposed, or smaller layer thicknesses may be required in order to prevent the formation of air bubbles at the surface of the formwork. In addition, it may be required to place the concrete in each layer slightly higher against faces in contact with formwork and in corners to prevent the accumulation of mortar.

The spacing of formwork vibrators shall be determined by the Engineer and shall be spaced at distances not further apart than the radius through which the vibration is visibly effective. Immersion vibrators shall be inserted vertically to penetrate the concrete at regular intervals which shall not exceed the radius over which the vibration is visibly effective and in any case shall not exceed 600 mm. Immersion vibrators shall be withdrawn slowly to prevent the formation of voids.

10.5 General

Concrete shall generally be placed in lifts of constant height for each separate structure. The lift heights shall be subject to the written approval of the Engineer, which approval shall be obtained prior to commencing concreting on any particular portion of the works. In mass concrete construction the lift height shall usually be between 1,5 m and 2,25 m although lower heights of lift may be ordered when casting fresh concrete on top of rock or old concrete. Concrete placed in other sections of the Works shall generally be placed in lifts not exceeding 2,25 m, but the Engineer may authorise or instruct different heights to be used according to the section of concrete being placed, the type of formwork being used and whether cooling of the concrete is done or not.

The time interval between two consecutive lifts of concrete in the same block of mass concrete shall generally be not less than 24 hours for each 450 mm of height of lift, although the Engineer may authorise a reduced interval of time depending on the geometric proportions of the lifts being cast. The maximum time interval to be allowed between consecutive lifts may vary between 24 and 84 hours for each 450 mm of height of lift for thin and mass concrete sections respectively but not more than 8 days after which a construction joint may have to be treated as a cold joint.

The Contractor shall, however, obtain the Engineer's prior approval for lift heights and time intervals between lifts before commencing with the concrete work on any portion of the Works.

The time interval between concrete lifts at the same heights, but separated by contraction joints will vary depending on the location. In arch or gravity dams where provision is made for joint grouting and where the distance between joints is large the time interval is not critical. In reservoir walls, floor slabs, roof slabs and in concrete linings for canals intermediate sections shall be generally not be cast within 7 days of the adjacent sections being cast, but as this is governed by the distance between contraction joints and the thickness of the lining, the Contractor shall obtain the prior approval of the Engineer as to the time intervals to be allowed between the casting of adjacent sections of concrete separated by contraction joints, if this is not shown on the Drawings.

11. CURING AND PROTECTION OF CONCRETE

As soon as any portion of the concrete being cast has taken on its final set it shall be protected against loss of moisture by adequate curing, which curing shall be continued for a minimum period of 14 days after the removal of formwork. Curing shall be accomplished by one or more of the following methods as approved by the Engineer for each type of structure:

(a) Covering with waterproof black plastic sheets or curing paper firmly held at edges so as to prevent the escape of moisture.

(b) Continuously spraying or sprinkling with water.

(c) Ponding of water on exposed surfaces.

(d) Covering with moisture retaining materials, such as sand, cotton or jute mats, etc. and which are kept continuously wet.

(e) Application methods of liquid curing agents where these are specifically approved by the Engineer. Curing agents shall be a membrane forming compound complying with the requirements of ASTM C309 and ASTM C156 types 1, 2 or 3. The white pigmented type 2 is preferred.

Where accepted, the curing compound shall be applied within 30 minutes of the stripping of formwork or, in the case of unformed surfaces, after a minimum of 48 hours of immediate protection. It shall preferably be applied by spraying and the rate of application shall be strictly in accordance with the manufacturer's recommendations. A method of monitoring the area to which curing compound has been applied and the application rate shall be as approved by the Engineer and rigidly applied by the Contractor.

Surfaces of joint rebates, where elastomeric sealant is to be applied, shall be protected from contamination by curing compound by the use of masking tape.

The standard method of curing shall be as described in (a), (b) or (d) above, unless otherwise indicated on the Drawings or in the Specifications.

Method (a) will usually be required until such time as in the opinion of the Engineer, the concrete has hardened sufficiently for other methods of curing to be applied without damaging the surface. Whatever the method of curing adopted, the concrete shall not be stained, marked, contaminated or damaged.

Where absorptive formwork or formwork which in the opinion of the Engineer, will allow the loss of moisture from the surface of the concrete is being used, this type of formwork shall be kept continuously wet, as soon as the concrete has hardened sufficiently to prevent surface damage.

When at any stage during the curing period air or water temperature drops below 10 degress centigrade the curing period shall be extended at least by the same length of time as that for which the air or water temperature dropped to below 10 degrees centigrade.

The Contractor shall at his own cost, protect all concrete against injury or damage until final written acceptance by the Engineer. Exposed surfaces of all concrete shall be protected from direct sunlight for at least 3 days after placing the concrete and such protection shall be given as soon as practicable after placing of unformed concrete or after removal of the formwork as the case may be.

Concrete will not be paid for unless properly cured and proof of curing is continuously visible on Site. The cost of immediate protection and curing shall be deemed to be included in the rates for concrete. The contractor is to pay special attention to both the immediate protection and long term curing of the concrete for the various elements.

All installations of proprietary products shall be carried out by supplier-approved applicators. The supplier’s technical representative shall carry out regular inspections to ensure that their specifications are adhered to during installation.

- Where specified, Sikagard 720 EpoCem or similar approved epoxy-cement sealing mortar shall be applied in accordance with the manufacturer’s instructions. The concrete surfaces shall be high-pressure water-jetted to provide a laitance and contaminant free surface. A trial panel shall be prepared by the Contractor for Engineer approval.

- Where specified, Sikagard 63N or similar approved chemically resistive lining shall be applied in accordance with the manufacturer's instructions.
- Where specified, concrete shall be lined with a corrosion resistant HDPE as specified in subclause 15.16, anchored into the concrete with anchor knobs. The lining shall be sealed or fusion welded to be watertight at all joints in accordance with the manufacturer's specifications.

12. REPAIR OF CONCRETE

Immediately after the removal of the formwork, the Contractor shall inspect the concrete and shall report any defects to the Engineer. All repairs of such defects shall be performed by skilled workmen only, by approved methods and to the satisfaction of the Engineer and at the expense of the Contractor.

Repairs shall be carried out as soon as practicable after the removal of the formwork, and in any case not longer than 24 hours after exposure. Concrete that is damaged from any cause and concrete that is honeycombed, fractured or otherwise defective, and concrete which, because of excessive surface depressions must be excavated and built up to bring the surface to the prescribed lines, shall be removed and replaced with mortar or concrete as hereinafter specified or as otherwise directed by the Engineer.

Concrete filling generally of the same class as the damaged concrete shall be used for holes extending entirely through concrete sections and of such a size as will accept concrete and for holes in mass concrete greater in area than 0,1 square metres and deeper than 100 mm and for holes in reinforced concrete which are greater in area than 0,15 square metres and which extend beyond the reinforcing.

All filling shall be bonded tightly to the surface of the area being repaired and shall be bound and free from shrinkage, cracks and hollow areas after the filling has been cured and dried. Curing of repaired areas shall be performed in such a manner and for such periods as the Engineer may direct.

Particular care shall be exercised to ensure that the colour of the repair work shall match as nearly as possible to colour of the surrounding concrete. No cement washing or plastering shall be carried out except on the written instruction of the Engineer.

Repair areas shall be saw-cut to the minimum repair depth allowable by the repair product. Saw-cut edges are to be additionally abraded by approved means for bonding. All products shall be approved by the Engineer and shall be used strictly within their window periods and according to exact manufacturer specifications.

13. SPECIAL CONCRETE MIXES

13.1 Solid blinding concrete

Concrete for blinding layers shall be Grade 15/19. The surface of solid blinding shall be screeded and left with rough finish or as specified on the Drawings. The surface shall however be without honeycombing, voids and other blemishes.

13.2 No-fines concrete

No-fines concrete shall consist of coarse aggregate, cement and water only, no fine aggregate being used. The amount of mixing water used is critical. It shall be just enough to produce a cement paste of the consistency of paint, capable of coating each particle of coarse aggregate uniformly without filling the voids between them.

The cement and coarse aggregate shall be mixed in proportions by volume of 1 part cement to 9 parts of 19 mm nominal size coarse aggregate. The 19 mm coarse aggregate shall have four grading's such that not more than 5% by weight shall be retained on a 26,5 mm sieve and not more than 5% by weight shall pass a 9,5 mm sieve. The aggregate shall be free of dust and elongated flaky particles. The amount of mixing water depend upon shape, surface texture and absorption of the aggregate. The typical amount required for Reed quartzite aggregate is 21 litres per 50 kg of cement.

Mixing shall be carried out in a mechanical mixer for not less than 2 minutes after the mixing water has been added. No-fines concrete shall be placed in accordance with the procedure approved by the Engineer. It shall be placed in its final position within 15 minutes of having been mixed.

All no-fines concrete shall be protected from the elements and loss of moisture. Protection against loss of moisture shall be accomplished by one or more of the following methods:

i. Retaining formwork in place,
ii. Covering exposed surfaces with sacking or other approved material kept continuously wet,
iii. Covering exposed surfaces with plastic sheeting

## 14. DEMOLITION OF EXISTING CONCRETE

### 14.1 General

The work shall consist of the removal of defective concrete or concrete in existing structures and the removal of concrete used in temporary structures such as cofferdams, falsework, etc. and the reconstruction of such portions as may be shown on the Drawings or required by the Engineer.

The work shall include the construction of connections to existing structures, which may be required to complete the work as shown on the Drawings or ordered by the Engineer.

### 14.2 Removal of concrete

All fittings such as handrails, cover plates, etc. shall be removed where necessary with the least possible damage and stored to the approval of the Engineer.

The concrete is to be removed by means of either explosives or suitable percussion equipment, care being exercised not to damage any of the old work which is to remain in position. The Engineer shall have the right to prohibit the use of explosives to avoid disturbances of existing work. Where explosives are used the Contractor shall submit details of the proposed methods to the Engineer for approval prior to commencing with the work. All waste material and rubble shall be disposed of as directed by the Engineer. Where the work being demolished contains reinforcement, care shall be exercised to keep the existing reinforcement intact, which shall be cleaned of all coating of mortar, bent to the correct shape and spliced with the reinforcement of the new work where necessary.

Where the old work is to be extended, the existing concrete shall be cut back for a minimum distance of 50 mm.

Extensions shall be anchored to the existing work by means of dowels inserted at the depths and spacing shown on the Drawings and grouted into the existing concrete in accordance with the requirements of the relevant Section of the Specifications. The face of the old work shall be treated in accordance with the requirements of clause 9 prior to placing any fresh concrete against it.

All joints between old and new work shall be chamfered to demarcate the joint and to provide a neat appearance.

15. MEASUREMENT

15.1 Concrete

The unit of measurement shall be the cubic metre of concrete in place unless specified otherwise in the Specifications. Quantities shall be computed net from the dimensions shown on the Drawings or ordered in writing by the Engineer, but shall not include any concrete used in the construction of cofferdams, falsework, etc. unless such work is shown on the Drawings and listed in the Schedule of Quantities or if such work is ordered in writing by the Engineer to be included in the measurement for payment purposes. No allowance will be measured for concrete required to make up overbreak in soft, intermediate or hard rock material. However payment will be made for additional concrete or formwork ordered in writing by the engineer to replace unsuitable material.

No deduction in volume will be made for the volumes of reinforcing steel, drainage holes, weepholes, pipes, conduits, etc. cast in to the concrete having a cross sectional area less 0,04 square metres. Distinction for payment purposes will be made between the different classes of concrete and between precast, prestressed, reinforced and mass concrete only where shown in the Schedule of Quantities.

Variations in the concrete constituents due to a change in subclause 8.8 shall be measured per 1 000 kg (tonne) distinction being made between the various aggregate fractions and types of cement. No measurement for payment purposes will be made for constituents other than those shown in the Schedule of Quantities. The effect on the yield of the concrete as a result of the variation shall be calculated on the assumption on 1,5% entrained air voids and using the absolute volume of all the constituents.

Any increases in the quantities of the concrete constituents as a result of a change in requirements shall be paid to the Contractor at the same rates as such decreases would accrue to the benefit of the Employer.

No measurement for payment purposes will be made for any variation in concrete constituents made by the Contractor or as required by the Engineer in order to meet the Design Strength requirements.

The cost of the trial mixes for determining the Design Strength shall be borne by the Contractor.

15.2 Reinforcement

The unit of measurement shall be for 1 000 kg (tonne) of reinforcement in place, in accordance with the Drawings or as authorised by the Engineer, calculated from the actual lengths placed (including bends and hooks) and the nominal sections thereof, based on 0,785 kg per metre length per 100 square millimetre cross section. Where the use of steel mesh or fabric is indicated no allowance shall be made for the lap lengths. Measurement shall be deemed to include for cutting, bending and fixing of reinforcement.

The unit of measurement for welded steel fabric shall be the kilogram of fabric reinforcement in place, and the quantity, in kilograms, shall be calculated from the net area covered by the mesh, excluding overlaps.

Clips, ties, separators, stools and other steel used for positioning reinforcement will not be measured, unless these are shown on the bending schedules.

The tendered rate shall include full compensation for the supply, delivery, cutting, bending, welding, placing and fixing of the steel reinforcement, including all tying wire, stools, cover-blocks, supports and waste.

Distinction for payment purposes will be made between the different types of reinforcement used. High yield stress deformed reinforcement bars will be denoted by “Y” and Mild round steel reinforcement bars will be denoted by “R”.

15.3 Formwork

The unit of measurement for payment for formwork, inclusive of all fillets, splays, falsework, fixing etc. shall be the square metre. The measurement shall include formwork to each face of concrete construction as shown on the drawings. Contraction and expansion joints shall be based on the neat lines shown on the drawings or as ordered by the Engineer.

The rates tendered for formwork shall be for either a “Smooth" surface finish on concrete which is exposed within the final structure or a “Rough” surface finish on hidden surfaces. These shall conform to the requirements of subclause 6.4

Where special ducts or openings, such as weep holes are required in the concrete and when the forming of these ducts or openings is listed in the Schedule of Quantities as a separate payment item, measurement for payment for these items of work will be done on the basis of the units stated in the Schedule of Quantities and no such measurement shall be included in the measurements for formwork and/or surface finishes.

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

For construction joints at kickers, all additional costs for formwork to edges up to 300 mm high will be deemed to be included in the rates tendered for vertical formwork to sides of walls and will not be measured separately in narrow widths.

Narrow widths of formwork to slab edges will be scheduled in linear meters in the following increments:

i. Up to 100mm,
ii. Over 100mm and up to 200mm,
iii. Over 200mm and up to 300mm.

No formwork will be measured to edges of blinding layers under structures and the cost thereof, (if needed), will be deemed to be included in the rates tendered for concrete in blinding layers.

Back formwork or formwork to top revealed surfaces of sloping - or conical formwork will only be measured to surfaces of over 40° and up to 85° to the horizontal.

Separate items will be scheduled

i. For each class of finish required on the formed concrete;
ii. For the different angles of the inclination of formwork given below:

| Description of formwork | Angle of inclination from the vertical |
|---|---|
| Horizontal | Exceeding 85º and not exceeding 95º |
| Sloping | Exceeding 10º and not exceeding 85º |
| Battered | Not exceeding 10º |
| Vertical | 0º |

iii. For each inclination of each type of structural element, such as walls and beams, and for different prop heights for beams and slabs, and for formwork to curved (single and double curvature), curved in plan only, arched, domical, specially moulded, and other types of work;

Formwork to horizontal surfaces in pump stations, valve chambers, manholes or sumps can either be removed through the manhole cover opening or the Contractor may use permanent formwork at his own cost as no claims in this regard will be considered.

15.4 Box out holes/form voids

Items will be scheduled per unit number. The shape, size and depth will be stated.

15.5 Unformed surface finish

The unit of measurement for payment for surface finishes, inclusive of curing, shall be the square metre, based on the neat lines shown on the Drawings or as ordered by the Engineer. Measurement for payment of unformed surface finishes shall be for only “Wood floated”, “Steel floated” and “Power floated” finishes.

Measurement for payment for unformed surfaces shall be only for surfaces which are not subsequently covered with fresh concrete in direct contact with the underlying unformed surface.

Measurement will only be made for surfaces finished in accordance with the Drawings or as directed by the Engineer. No measurement will be made for vertical or inclined surfaces or construction or expansion joints where

one face of the joint has been formed and is paid for in accordance with the provisions of subclause 15.3. Where unformed surfaces are separated by a jointing material, measurement will be made only for one face of the joints.

15.6 Precast reinforced or prestressed units

The unit of measurement for precast, reinforced or prestressed concrete units when listed as a pay item in the Schedule of Quantities will be the number of units acceptably manufactured and erected in their final position, unless otherwise indicated in the Specifications. Measurement shall include for all materials, such as reinforcement, prestressing wires, ducting, anchorages, bearing pads, falsework, formwork, concrete etc. manufacture, transport and all work incidental to erecting the members in their final position.

15.7 Demolition of existing work

The unit of measurement for payment purposes shall be the cubic metre of concrete acceptably removed in accordance with the Drawings. Measurement shall not include for the removal of defective concrete placed by the Contractor under the Contract or for the removal of concrete in cofferdams, falsework, etc., unless such work is shown on the Drawings and listed in the Schedule of Quantities or if such work is ordered in writing by the Engineer to be included in the measurement for payment purposes.

15.8 Cast in of pipes with or without puddle flanges

i. Up to 300 mm nominal bore: Through (description and thickness of structural elements)
ii. Over 300 mm up to 700 mm nominal bore: Through (description and thickness of structural elements)

Etc for other nominal bores in increments of 300 mm

The unit of measurement shall be the number of each size of pipe installed.

The tendered rates shall include full compensation for installing the pipe where new pipes are used (with or without a puddle flange) in the exact position as shown on the drawings, for splitting or cutting the formwork where required, for ensuring watertightness where required and for all additional costs required to install the pipes specified or shown on the drawings.

15.9 Joints

The unit of measurement will be the linear meter. Separate items will be scheduled for contraction and expansion joins of different types and sizes and involving different types, sizes and qualities of water bars, soft board, sealers, etc. The unit rate shall cover the cost of all materials and labour for the construction of each joint as specified or shown on the drawings, including the cost of formwork, testing, and making good.

15.10 Grouting

The unit of measurement for grouting shall be the cubic meter. Grouting around pipes and other mechanical equipment in box-out or voids in walls will be measured by the volume of grout necessary to fill the voids and pockets between the outside surface of the pipe or mechanical equipment and the surface of the concrete wall. Grouting to be watertight.

15.11 Miscellaneous work

Items such as bearing pads, platforms, handrails, ladders, manhole covers and frames, locking devices, ventilators, rainwater downpipes, etc shall be manufactured, supplied and installed to details and in positions as shown on the Drawings. Ladders, handrails and flooring, when made of steel, shall be manufactured in accordance with SANS 1200 HA and corrosion protection thereof shall comply with the requirements of SANS 1200 HC

Miscellaneous work will be scheduled as separate items as follows:

| | | | |
|---|---|---|---|
| i. | Measured by number: | (Description of item) | Unit: number |
| ii. | Measured by linear metre: | (Description of item) | Unit: m |
| iii. | Measured by area: | (Description of item) | Unit: m² |
| iv. | Measured by volume: | (Description of item) | Unit: m³ |

v. Tendered for in a sum: (Description of item) Unit: sum

The unit of measurement shall be the number, linear metre, square metre, cubic metre or sum as applicable to each item.

The tendered rate (or sum) shall include full compensation for manufacturing or providing and installing each item complete as shown on the Drawings, and shall include all corrosion protection.

15.12 Dowels

Separate items will be scheduled for each reinforcing diameter.

The unit of measurement shall be the number of dowels installed with a suitable epoxy anchor grout designed for reinforcing bars (Fischer FIS EM Injection Mortar, Sika Anchorfix II, Hilti HIT HY200 or similar approved) to exact manufacturer's specifications to a minimum embedment depth as indicated below:

| Size | Minimum Embedment Depth (mm) |
|---|---|
| R/Y10 | 150 |
| R/Y12 | 150 |
| R/Y16 | 200 |
| Y20 | 300 |
| Y25 | 400 |

Where dowels are required, the holes are to be drilled with a masonry/percussion drill-bit not capable of cutting through reinforcing.

The tendered rate shall include full compensation for drilling and installation of the dowels and the epoxy anchor-grout. The reinforcing bars shall be measured under subclause 15.2.

15.13 Application of expansion/movement joint bridging flexible waterstop

The unit of measurement shall be the meter running length of proprietary product applied.

The tendered rates shall include full compensation for:

Application of a 200mm wide Sika CombiFlex SG-10M (or similar approved), including all preparation and epoxy adhesive, joints etc., by a supplier-approved applicator between concrete edges to provide a water-tight seal to the exact manufacturers specifications.

15.14. Application of an expansive watertight seal in a construction joint

The unit of measurement shall be the metre running length of proprietary product applied.

The tendered rates shall include full compensation for:

Application of a SikaSwell-P HM Profile together with SikaSwellS2 adhesive applied to concrete substrates (or similar approved), including all preparation and application etc., by a supplier-approved applicator to construction joints to provide a water-tight seal to the exact manufacturers specifications.

15.15. Blinding layer/Mass concrete/Benching

The unit of measurement for blinding, mass concrete and benching shall be the following:

i. Blinding: (Thickness stated) Unit: $m^2$
ii. Mass concrete: (Description of item) Unit: $m^3$
iii. Benching: (Description of item) Unit: $m^3$

Allowance will only be made for the dimensions indicated on the drawings. The minimum thickness and grade shall be stated.

15.16. No fines concrete

The unit of measurement shall be the cubic meter. The provisions of subclause 8.1.3 of SABS 1200 G shall apply *mutatis mutandi.*

16. PAYMENT

The quantities determined as provided above shall be paid for at the Contract price per unit measurement respectively for each of the particular items listed below that is shown in the Schedule of Quantities which price and payment shall be full compensation for furnishing and placing all materials including all supervision, labour, transport, equipment, plant, tools and incidentals necessary to complete the work prescribed in this Section.

| Item | Unit of measurement |
|---|---|
| (1) Concrete | Cubic metre |
| (2) Reinforcement/Mesh | Tonne/kg |
| (3) Formwork and surface finishes | Meter or Square metre |
| (4) Box out holes/Form voids | Number |
| (5) Unformed surface finishes | Square meter |
| (6) Precast reinforced or prestressed units | Number |
| (7) Demolition of existing work | Cubic metre |
| (8) Cast in of pipes with or without puddle flanges | Number |
| (9) Joints | Metre |
| (10) Grouting | Cubic meter |
| (11) Miscellaneous work | No. / m / $m^2$ / $m^3$ / sum |
| (12) Dowels | Number |
| (13) Application of an expansive watertight seal in a construction joint | Meter |
| (14) Application of an expansive watertight seal in a construction joint | Meter |
| (15) Blinding layer/Mass concrete/Benching | Cubic meter or Square meter |
| (16) No fines concrete | Cubic meter |

# SPECIFICATION DWS 1810

# SPECIALIST SERVICES

Revised: November 2017

Aurecon Revised DWS 1810
The revised document is project specific to only NGQAMAKAWE REGIONAL SUPPLY SCHEME PHASE 5:
BID NO. W11268.

THE TOTAL NUMBER OF PAGES IN THIS SPECIFICATION IS 6

1. SUPPORTING SPECIFICATIONS

Reference is made to the latest issues of the following standards:

| | |
|---|---|
| SABS 110 | Sealing compounds for the building industry, two-component, polysulphide base. |
| SABS 298 | Mastic asphalt for damp-proof courses and tanking. |
| SABS 745 | Bituminous roofing. |
| SABS 952 | Polyolefin film for damp-proofing and waterproofing in buildings. |
| SABS 021 | Waterproofing of buildings. |
| CKS 388 | Rubber waterstops. |
| CKS 389 | Flexible polyvinyl chloride waterstops. |
| BS 903 | Methods of testing vulcanized rubber. |
| BS 1763 | Thin PVC sheeting. |
| BS 2499 | Hot applied joint sealants for concrete pavements. |
| ASTM | Specification C156, C309, C494 and D1752. |

U.S. Federal specification HH-F-341f.

2. WATERSTOPS

2.1 PVC Waterstops

PVC waterstops shall be of the shapes and sizes shown on the drawings with eyelets spaced 300 mm apart on both sides. The waterstops shall be free from porosity or other imperfections and shall comply with requirements of CKS 389 specification.

The PVC waterstops must be easily joined on site by heating the ends to be joined together. The resulting joint must have a minimum strength of 11,2 MPa in tension at 23°C. Full details of recommended jointing procedures and special tools required are to be supplied for approval. Right angles, tee junctions and other intersections must be joined in the manufacturer's workshops in properly constructed jigs to the approval of the Engineer, and shall have a minimum tensile strength of 12,6 MPa at 23°C.

Waterstops are to be packed in as long sections as manufacture will allow.

2.2 Rubber waterstops

Shall be of the shapes and sizes shown on the drawings shall comply with CKS388 specification and shall meet the following requirements:

The waterstop shall contain not less than 70 % natural rubber by volume, shall be precision moulded, and shall have the following properties at 20°C.

| | | |
|---|---|---|
| Minimum tensile strength | : | 20,5 MPa |
| Minimum elongation of break | : | 450 % |
| Hardness (as determined by BS 903) | : | 60-70 BS degrees |
| Maximum water absorption by weight after 2 days at 70°C | : | 5 % |
| Minimum tensile strength after ageing | : | 75 % of initial |
| (48 hours at 70°C and 2,0 MPa of oxygen | : | tensile strength |
| Minimum elongation after ageing (48 hours | : | 75 % of initial |
| at 70°C and 2,0 MPa of oxygen) | : | elongation at break |
| Maximum compression set by constant | : | |
| deflection method - % of original deflection | : | 20 % |

Joints in straight lengths and between straight lengths and intersection pieces shall be properly vulcanised in accordance with manufacturer's instructions and by using the special equipment available from suppliers for this purpose. Jointing other than by vulcanising will not be permitted.

Right angles, tee junctions and other intersections shall generally be moulded as one unit by the manufacturer.

2.3 Installation

Waterstops are to be installed so that they are securely held in their correct position whilst concrete is placed. The concrete must be fully and properly compacted around the waterstops to ensure that no voids or porous areas remain. Where reinforcement is present, adequate clearances are to be left between this and all waterstops. No holes are to be made through any waterstops.

Before any concrete is cast around a waterstop, the waterstop shall be thoroughly cleaned of all dust, grease, dry mortar or other foreign matter.

3. JOINT FILLERS AND SEALERS

Joint sealants to water-retaining/excluding structures shall be (in order of priority):

a. As per the drawing details, or,
b. Sika-flex PRO-3 / ABE Durakol G HM

The success of any sealant depends entirely on correct application. The Contractor shall ensure that he follows all instructions and carries out every phase of the work correctly. He shall be held responsible for any defects in jointing that might apparent either during construction or during the maintenance period.

4. EXPANSION JOINT CONSTRUCTION

Where shown on the drawings expansion joints shall be formed in conjunction with the designated waterstop by the use of filler sheeting strip to create the required gap which unless otherwise stated shall be 12 millimetres in width. The strip shall be fastened to the end formwork in such a way that on removal of the formwork, the strip will adhere to the concrete previously cast. After the adjacent concrete has been cast and cured for the prescribed period the filler sheeting can be raked out to the required depth to provide a cavity for the sealing compound.

As an alternative, the cavity for the sealing compound may be formed by strips of soft board fastened to the end formwork on both sides of the filler sheets. The soft board can be raked out after curing of the concrete as described above.

The formed cavity shall be dry before placing the sealing material and all dust, scale, grit, earth and loose stones shall be removed.

5. CONCRETE ADDITIVES AND CURING COMPOUNDS

The following types of additives and curing compounds shall be acceptable to the Engineer.

5.1 Additives

Water Reducing Admixtures shall comply with ASTM C 494, Type A. The additives shall preferable be free of chlorides.

5.2 Curing agents

Curing agents shall be membrane forming compound complying with the requirements of ASTM C 309 and ASTM C 156 types 1 &2. The white pigmented type 2 is preferred.

6. TEST ON CONCRETE WATER RETAINING STRUCTURES FOR WATERTIGHTNESS

Water for testing shall be provided by the Contractor and he shall be responsible for providing all necessary equipment that may be required for filling the structures. Potable water shall be used for all structures, and tendered rates are to include the supply and use of potable water.

Should earth-backfilling of the structure be required, watertightness testing shall be conducted prior to backfilling to facilitate the detection of leaks.

The structure shall be filled with water at a uniform rate not exceeding 2,0 m in 24 hours until the top water level has been reached. The water level will then be carefully noted and recorded by the Engineer in relation to a fixed

bench-mark, and shall be maintained by the addition of further water for a stabilizing period to permit complete absorption of water by the concrete.

The stabilizing period should be 21 days. After the stabilizing period, the level of the liquid surface shall be recorded at 24 hour intervals for a test period of 7 days. During this 7-day test period the total permissible drop in level, after allowing for evaporation, shall not exceed 1/500 the of the average water depth of the full tank, or 10 mm.

The evaporation shall be measured by the mean drop in level caused by the evaporation of the water in three flat containers floating in the water being recorded.

In the event of appreciable leakage being evident at any stage of the filling or testing or in the event of the Engineer considering the final degree of watertightness to be unsatisfactory, the Contractor when ordered by the Engineer shall discontinue such filling or testing and shall, at his own expense, take approved steps immediately to rectify the leakage, until a satisfactory test is obtained, which shall prove to the Engineer that a sufficient degree of watertightness has been obtained.

The costs of emptying a water-retaining structure which cannot be drained shall be borne by the Contractor. The water shall be discharged in a manner approved by the Engineer and shall be such that the employer can utilize the water if he so desires.

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

The costs of retesting the structure for watertightness shall be borne by the Contractor."

## 7. STERILIZATION

After completion of the test for watertightness, all structures in contact with filtered water shall be sterilized.

The clear water reservoir shall be filled to a depth of 300 mm with water uniformly chlorinated to a chlorine content of 20 mg1-1. The chlorinated water shall then be sprayed over all internal surfaces including pipes, fittings and the ladder. After the last person has left the reservoir, a quantity of the chlorinated water shall be poured over the access ladder.

Should it be necessary after the above procedure has been carried out for any person to enter any of the sterilized structures, the sterilizing process shall be repeated for that structure.

If re-entry is due to any reason for which the Contractor is responsible, the repetition of the process will be carried out at the Contractor's expense.

During all stages the Contractor will be held responsible for safeguarding the health of his employees.

## 8. CRUSHED STONE ON RESERVOIR ROOF

The crushed stone shall be clean and dust free and shall pass through a 25 mm mesh sieve and shall be retained on a 12 mm mesh sieve. The thickness of the stone layer shall be as shown on the Drawings.

The stone shall not be placed without the permission of the Engineer and not until the concrete of the roof slab has reached the design strength. The stone shall be immediately spread into position on the roof and no heaping-up of the stone will be allowed.

## 9. LIGHTNING PROTECTION

Lightning Protection for the pump station and reservoir structures shall be as per C3.1 Project Specification section 9.28 - LIGHTNING PROTECTION.

## 10. MEASUREMENT

### 10.1 General

All waterstops and joint fillers shall be measured and paid for as described in DWS0750 for the various joints (complete).

10.2 Testing for watertightness

The unit of measurement shall be the tendered sum for each structure successfully passing the specified watertightness test to the satisfaction of the Engineer.

The sums tendered shall include full compensation for the provision of all labour, plant, and materials necessary for carrying out the test for watertightness as specified.

10.3 Sterilization

The unit of measurement shall be the tendered sum for each structure successfully sterilised as specified.

The tendered sum shall include full compensation for sterilising the structure as specified.

10.4 Crushed stone on roof

The unit of measurement shall be the cubic meter of crushed stone required.

The tendered rate shall include full compensation for supplying and placing the crushed stone to the thickness as shown on the Drawings and for all labour, Plant and materials to carry out the work as specified

10.5 Lightning Protection

The unit of measurement shall be the tendered sum for each structure fitted with a lightning protection system.

The tendered sum shall include full compensation for obtaining SABS approval of the Drawings, and for installing and testing the lightning protection system on the structure as specified on the approved Drawings

11. PAYMENT

The quantities determined as provided above shall be paid for at the contract price per unit measurement respectively, for each of the particular pay items listed in the Schedule of Quantities, which prices and payments shall be full compensation for furnishing and placing all materials, including all supervision, labour, transport, paint, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

# SPECIFICATION DWS 1110

# CONSTRUCTION OF PIPELINES

Revised: April 2010

# CONTENTS

THE TOTAL NUMBER OF PAGES IN THIS SPECIFICATION IS 57

## 1. SCOPE

This specification covers the construction of pressure pipelines of steel and reinforced concrete for the conveyance of water at ambient temperatures.

## 2. STANDARDS

The following Standard Specifications, Codes of Practice and Regulations are referred to and shall apply as specified hereinafter. The latest issues shall apply:

| | | |
|---|---|---|
| DWS1130 | : | Department of Water Affairs and Forestry, "Standard Specification for the manufacture and supply of steel pipes, specials and fittings for duties up to 4,6 MPa design pressure." |
| DWS9900 | : | Department of Water Affairs and Forestry, "Standard Specification for Corrosion protection of steel pipes and specials for pipelines, Section C1". |
| DWS2510 | : | Department of Water Affairs and Forestry, "Standard Specification for the supply of valves." |
| PCP-N | : | Department of Water Affairs and Forestry, "Standard Specification for the design, manufacture and supply of prestressed concrete non-cylinder pipes and mating fittings." |
| PCP-C | : | Department of Water Affairs and Forestry, "Standard Specification for the design, manufacture and supply of steel cylinder type prestressed concrete pipes and mating fittings". |
| SANS 14 | : | Malleable cast iron fittings |
| SANS 62 | : | Steel pipes and pipe fittings up to 150 mm nominal bore |
| SANS EN 197 | : | Common cements |
| SANS 202 | : | Chloride content of aggregates |
| SANS 226 | : | Water taps |
| SANS 227 | : | Burnt clay masonry units |
| SANS 280 | : | Hole location in fencing posts and droppers |
| SANS 457 | : | Wooden posts and droppers for fences |
| SANS 558 | : | Cast iron surface boxes and manhole and inspection covers and frames |
| SANS 675 | : | Zinc-coated fencing wire (plain and barbed) |
| SANS 676 | : | Reinforced concrete pressure pipes |
| SANS 677 | : | Concrete non-pressure pipes |
| SANS 719 | : | Electric welded low carbon steel pipes for aqueous fluids (large bore) |
| SANS 935 | : | Hot-dip (galvanized) zinc coatings on steel wire |
| SANS 952 | : | Polyolefin film for damp- and waterproofing in buildings |
| SANS 986 | : | Precast reinforced concrete culverts |
| SANS 1083 | : | Aggregates from natural sources – Aggregates for concrete |
| SANS 1090 | : | Sand for plaster and mortar |
| SANS 1117 | : | Plastic wrappings for the protection of steel pipelines |
| SANS 1123 | : | Pipe flanges |
| SANS 1200 | : | Standardized specification for civil engineering construction (as amended in the Project Specification if relevant) |
| SANS 1215 | : | Concrete masonry units |
| SANS 1373 | : | Chain link fencing and its wire accessories |
| SANS 1533 | : | Padlocks |
| SANS 1700 | : | Fasteners |

| | | |
|---|---|---|
| SANS 4427 | : | Polyethylene (PE) pipes for water supply |
| SANS 4633 | : | Rubber seals – Joint rings for water supply, drainage and sewerage pipelines |
| SANS 10102 | : | The selection of pipes for buried pipelines |
| SANS 15589 | : | Cathodic protection of pipeline transportation systems Part 1 |
| SANS 15614 | : | Specification and qualification of welding procedure for metallic materials |
| SANS 5851 | : | Liquid limit of fines in aggregate for base-courses |
| SANS 5852 | : | Plastic limit and plasticity index of fines in aggregate for base-courses |
| SANS 5853 | : | Linear shrinkage of fines in aggregate for base-courses |
| SANS 6152 | : | Available alkali content of Portland cement extenders |
| SANS 6245 | : | Potential reactivity of aggregates with alkalis (accelerated mortar prism method) |
| CKS 146 | : | Gates, steel, with tubular frames |
| BS 143 | : | Threaded pipe fittings in malleable cast iron and cast copper alloy |
| BS EN 1008 | : | Mixing water for concrete |
| BS EN 1092 | : | Flanges and their joints |
| BS CP 2010 | : | Code of practice for pipelines |
| BS 2633 | : | Class I arc welding of ferritic steel pipe work for carrying fluids |
| BS 7531 | : | Rubber bonded fibre jointing for industrial and aerospace purposes |
| BS 8010 | : | Code of practice for pipelines |
| API 1104 | : | Standard for welding pipelines and related facilities (American Petroleum Institute) |
| Act 85/1993 | : | Occupational Health and Safety act and regulations |
| Act 15/2003 | : | Explosives act 15 of 2003 |
| Act 103/1977 | : | National building regulations and building standards |
| | - | Design for unbalanced thrust for buried water conduits" by C.A. Manganaro (Jour. AWWA, June 1968) |
| | - | Harnessed joints for water pipe by C.A. Manganaro (Jour. AWWA, July 1969) |
| ISO 7005 | : | Metallic flanges |
| ISO 8501-1 | : | Preparation of steel substrate before application of paints and related products. Visual assessment of surface cleanliness – Part 1 |

## 3. MATERIALS

### 3.1 Pipes and fittings

3.1.1 Steel pipes, specials and couplings

3.1.1.1 Steel pipes, specials and flexible couplings shall conform to the "Department of Water Affairs and Forestry" Standard Specification DWS 1130 as amended.

3.1.1.2 Corrosion protection of steel pipes and specials for pipelines shall conform to the "Department of Water Affairs and Forestry" Standard Specification DWS 9900, Section C1, and the particular specifications.

3.1.2 Prestressed concrete pipes and specials

3.1.2.1 Non-cylinder type prestressed concrete pipes and specials shall conform to the "Department of Water Affairs and Forestry" Standard Specification "PCP-N".

3.1.2.2 Embedded steel-cylinder type and lined steel-cylinder type prestressed concrete pipes and specials shall conform to the "Department of Water Affairs" Standard Specification "PCP-C".

3.1.3 Reinforced concrete pipes

Reinforced concrete pressure pipes shall conform to SANS 676.

3.1.4 Galvanized steel pipes and fittings

3.1.4.1 Galvanized steel pipes and fittings shall conform to SANS 62 (heavy class pipes).

3.1.4.2 Steel fittings shall be galvanized heavy weight fittings and shall conform to

BS 1740 in applications where pressures exceed 1,4 MPa. For pressures 1,4 MPa or lower, galvanized malleable iron fittings to BS 143 and/or SANS 14 will be acceptable.

3.1.5 Polyethylene pipes

Polyethylene pipes shall conform to SANS 4427.

3.1.6 Flanges

Except where specified to the contrary in the Project Specification or on the drawings, all flanges shall be steel-plate for welding and shall conform to SANS 1123 for pressure ratings from 1 000 kPa to 4 000 kPa and to BS EN 1092 for pressure ratings of 6 400 kPa. Should the required flange size fall beyond the range of SANS 1123 or BS EN 1092 as applicable for the relevant pressure rating, mating dimensions shall be in accordance with ISO 7005 with thicknesses adequate to withstand closed - end test pressures. Flanges with a pressure rating of 1000 kPa and 1600 kPa shall have flat joint faces machined in accordance with the above SANS or ISO specifications. Flanges with pressure ratings that exceed 1 600 kPa shall have raised joint faces machined in accordance with the above SANS, BS EN or ISO specifications. Flanges with pressure ratings of 6 400 kPa and flange sizes of 2500 mm diameter and larger, irrespective of pressure rating, shall incorporate an “O” ring groove. Details of the “O” ring groove shall be furnished at tendering stage for consideration.

3.1.7 Fasteners

3.1.6.1 All fasteners shall comply with SANS 1700 Grade 8.8 minimum. Washers shall be fitted under all bolts, screw heads and nuts. The shortest standard bolt or stud that protrudes beyond the nut by a minimum of two threads when the assemblies are fully tightened shall be used.

3.1.6.2 Isolating flanges shall be supplied with bolts nuts washers, two isolating washers and an isolating sleeve for each bolt.

3.1.8 Gaskets and rubber joint rings

3.1.7.1 Gaskets for flanged joints shall be of aramid and glass fibre with nitrile rubber binder to BS 7531, suitable for the specified pressures with a minimum thickness of 3 mm. Full face gaskets shall be used for flat face flange connections and ring gaskets for raised face flange connections.

3.1.7.2 Rubber joint rings shall comply with SANS 4633.

**3.2 Valves**

3.2.1 Valves shall conform to the "Department of Water Affairs and Forestry" Standard Specification DWS 2510.

3.2.2 Stop cocks shall be brass or gunmetal heavy pattern screw down types conforming to SANS 226.

**3.3 Small bore water meters**

3.3.1 Water meters at off-takes shall be capable of metering flow within an accuracy of 2% of true flow over rated flow ranges. Turndown ratios shall not be less than 1:10 for single meters and 1:20 for compound meters.

3.3.2 Each meter shall be installed complete with strainers or dirt traps on the upstream side.

3.3.3 Meters of 40 mm size and smaller shall be rotary piston type domestic meters with integrators calibrated in cubic metres. Integrators shall have at least seven effective cyclometer digits.

3.3.4 Meters larger than 40 mm shall be "Sparling" or similar type rotary meters with interchangeable mechanisms. Meters shall be supplied complete with one spare mechanism for every five or part of five meters of similar size and rating. Integrators shall be calibrated in cubic metres with at least seven effective cyclometer digits.

**3.4 Lining and coating materials**

Materials, other than concrete, for the lining and/or coating of pipes, specials and fittings shall conform to the "Department of Water Affairs and Forestry" Standard Specification DWS 9900, Section C1, and the particular specifications.

**3.5 Concrete pipe jacking sleeves**

Concrete pipe jacking sleeves shall be concrete non-pressure pipes of the “in the wall joint” type, class 100D, suitable for jacking and shall conform to SANS 677.

**3.6 Precast reinforced concrete culverts**

Precast reinforced concrete culverts shall conform to SANS 986 to the class as indicated in the Project Specification or the drawings.

**3.7 Manhole covers and frames and ventilators**

3.7.1 Manhole covers and frames shall be manufactured from 3CR12 and stainless steel as detailed on the “Department of Water Affairs and Forestry” type drawings. Where cast-iron manhole covers and frames are specifically required as per the drawings or the Project Specification it shall conform to SANS 558.

3.7.2 Inlet and outlet ventilators for the ventilation of structures shall be manufactured from 3CR12, stainless steel and MPVC piping as detailed on the “Department of Water Affairs and Forestry” type drawings.

**3.8 Fencing materials and gates**

3.8.1 Droppers and posts shall conform to SANS 280 and SANS 457.

3.8.2 Galvanized wire shall conform to SANS 675.

3.8.3 Diamond mesh shall be galvanized and shall conform to the requirements of SANS 1373.

3.8.4 Tubular steel gates shall conform to the requirements of CKS 146.

3.8.5 Padlocks shall conform to the requirements of SANS 1533 and shall be supplied with 10 master keys.

**3.9 Portland Cement and Portland Composite Cement**

3.9.1 Cements shall conform to SANS EN 197-1 and shall be a CEM I 42,5 N or CEM II 42,5 N respectively.

3.9.2 The alkali content of Portland Cement when expressed as sodium oxide ($Na_2O$) equivalent shall not be greater than 0,6% by mass of cement determined in accordance with SANS 6152 or any other reduced value as determined by the Engineer, where:

% . $Na_2O$ equivalent = % $Na_2O$ + (0,658 x %$K_2O$)

3.9.3 All cement shall be fresh and shall be used strictly in order of delivery. All cement in storage for longer than 10 weeks and all cement in unsealed pockets shall be removed from storage and be discarded.

3.9.4 Cement shall be stored in weather-proof and damp-proof silos or sheds.

**3.10 Aggregates for concrete and mortar**

3.10.1 Aggregates used in the manufacture of concrete shall conform to SANS 1083.

3.10.2 The aggregates shall be evaluated for potential alkali reactivity using SANS 6245.

3.10.3 The chloride content of the sand determined by SANS 202 shall not exceed 0,01% per mass.

3.10.4 Coarse aggregate shall be suitable for concrete subject to surface abrasion, shall be of grading category 1 and of the largest possible size that would allow placement of concrete without difficulty.

3.10.5 Sand for mortar or plaster shall conform to SANS 1090.

**3.11 Water for concrete and mortar**

3.11.1 Water used for concrete, mortar, plaster or cement slurry shall be clean and free from injurious amounts of oil, acid, alkalis, vegetable and mineral matter.

3.11.2 Water shall generally conform to BS EN 1008.

**3.12 Concrete**

3.12.1 Concrete shall be a homogeneous mixture of cement, water, sand and coarse aggregate and shall be mixed, placed, cured and tested in accordance with section "G" SANS 1200 as amended.

3.12.2 The specified strength of the concrete at 28 days shall be as follows unless otherwise specified:

3.12.2.1 Reinforced concrete - 25,0 MPa

3.12.2.2 Mass concrete - 15,0 MPa

3.12.2.3 Blinding concrete - 15,0 MPa

**3.13 Formwork**

Formwork shall conform to the requirements of section "G" of SANS 1200.

### 3.14 Concrete reinforcement

Bar reinforcement and welded steel fabric reinforcement shall conform to the requirements of section “G” of SANS 1200.

### 3.15 Bricks

Burnt clay masonry units shall conform to SANS 227, whilst concrete masonry units shall conform to SANS 1215.

### 3.16 Backfill material

3.16.1 General

Material for bedding of pipes and for selected backfill around pipes shall be free from vegetable matter and hard, sharp and flaky particles or other materials harmful to the pipes or to the protective coatings of pipes.

3.16.2 Bedding material shall be either of the following type:

3.16.2.1 Type A: Finely graded material with the following properties:

(i) Percentage by mass passing: 4,75 mm screen - 100%
0,425 mm screen - 80 to 100%
0.075 mm screen – 0 to 55%
0,002 mm screen - 0 to 45%

(ii) Liquid limit (LL) as determined in accordance with SANS 5851 shall not be more than 30%.
(iii) Plasticity index (PI) as determined in accordance with SANS 5852 shall not be more than 15.
(iv) Linear shrinkage (LS) as determined in accordance with SANS 5853 shall not exceed 5%.

3.16.2.2 Type B: Medium graded material with the following properties.

(i) Percentage by mass passing: 9.5 mm screen - 100%
4.75 mm screen – 80 to 100%
0,425 mm screen - 60 to 80%
0.075 mm screen – 0 to 50%
0,002 mm screen - 0 to 40%

(ii) Liquid limit (LL) as determined in accordance with SANS 5851 shall not be more than 35%.
(iii) Plasticity Index (PI) as determined in accordance with SANS 5852 shall not be more than 18.
(iv) Linear shrinkage (LS) as determined in accordance with SANS 5853 shall not exceed 7,5%.

3.16.2.3 Type C: Granular material with the following properties:

(i) Percentage by mass passing: 9,5 mm screen - 100%
4,75 mm screen - 70 to 100%
0,425 mm screen - 30 to 60%
0.075 mm screen – 0 to 45%
0,002 mm screen - 0 to 35%

(ii) Liquid limit (LL) as determined in accordance with SANS 5851 shall not be more than 40%.
(iii) Plasticity index (PI) as determined in accordance with SANS 5852 shall not be more than 20.
(iv) Linear shrinkage (LS) as determined in accordance with SANS 5853 shall not exceed 10%.

3.16.3 Clauses 3.16.2.1 to 3.16.2.3 are conveniently summarized in the following table:

| Material/Type | Percentage by Mass Passing Screens | | | | | Atterberg Limits Shall Not Exceed | | |
|---|---|---|---|---|---|---|---|---|
| | 9,5mm | 4,75mm | 0,425 mm | 0.075 mm | 0,002 mm | Liquid Limit (LL)% | Plasticity Index (PI) | Linear Shrinkage (LS)% |
| Finely graded A | 100 | 100 | 80-100 | 0-55 | 0-45 | 30 | 15 | 5 |
| Medium graded B | 100 | 80-100 | 60-80 | 0-50 | 0-40 | 35 | 18 | 7,5 |
| Granular C | 100 | 70-100 | 30-60 | 0-45 | 0-35 | 40 | 20 | 10 |

3.16.4 Selected backfill

3.16.4.1 For pipelines with organic coatings selected backfill shall conform to the requirements of Clauses 3.16.2 to 3.16.3.

3.16.4.2 For pipelines with concrete coatings, material for selected backfill shall be capable of passing a 75 mm screen, provided that at least sixty percent (60%) by mass of any sample of the material shall meet the requirements of Clauses 3.16.2 and 3.16.3.

**3.17 Storage, handling and transport of pipes, specials and fittings**

3.17.1 General

3.17.1.1 Where the supply and delivery of pipes, specials, fittings, valves, other materials and equipment are not included in the pipeline construction contract, the Contractor shall be responsible for:

3.17.1.1.1 The storage care and insurance of pipes, specials, fittings, valves and other materials and equipment supplied under separate contracts as soon as these have been delivered to site.

3.17.1.1.2 The receipt, provision of craneage and labour for the off-loading of valves, materials and equipment (excluding pipes, specials and fittings) at the store or alongside the pipeline trench.

3.17.1.1.3 The provision of suitable access along the pipeline route and within the pipeline servitude for the purpose of off-loading pipes, valves, etc. and including:

(a) Benching along mild side slopes.
(b) Handling and stringing of pipes, specials and fittings at very steep inclines where the pipe supplier will stack the pipes, specials and fittings either at the top or the bottom of these inclines.

The pipe supply contractor will be responsible for the off-loading of pipes, specials and fittings on site.

3.17.1.1.4 Wherever suitable access to the pipeline servitude is not available, the Contractor shall provide and maintain access as instructed by the Engineer.

3.17.1.2 The Engineer shall be afforded every opportunity of inspecting such materials on their arrival at Site prior to them being off-loaded. If their condition is unacceptable to the Engineer on arrival, the Contractor shall remove them forthwith from the Site and replace such materials at his own cost and to the satisfaction of the Engineer.

3.17.1.3 Spare pipes shall be stacked where indicated by the Engineer and the reflective coating, as per Clause 4.7 of the Specification DWS 9900, shall be touched up.

3.17.2 Transport

Pipes and specials shall only be transported on properly constructed or adapted vehicles containing correctly shaped and padded cradles or with strong, sawdust filled bags separating pipes and vehicle body as well as individual pipes from each other. Special care shall be taken with the transport of all coated steel pipes as damaged coatings might be subject to rejection in terms of Clause 3.17.1.2.

3.17.3 Handling

3.17.3.1 Pipes, specials and fittings shall not be subjected to rough handling at any time. Under no circumstances shall same be dropped during loading or off-loading or be allowed to collide with each other.

3.17.3.2 Coated steel pipes shall only be lifted by means of broad band slings with at least 500 mm wide support area for pipes up to 500 mm NB and 1 000 mm wide support area for larger pipes per 12 m length of pipe, or as approved by the Engineer. If more than one pipe is joined, multiple slings shall be used to spread support.

3.17.3.3 Concrete or cement-mortar lined steel pipes shall only be lifted by means of approved lifting beams with at least two slings.

3.17.4 Storage

3.17.4.1 Pipes shall generally be distributed and stored as close as possible to the laying position in order to minimise double handling. Where pipes are strung alongside the trench, they should be placed on the side away from excavated material.

3.17.4.2 Where pipes, specials and fittings are to be stockpiled in bulk storage yards, the Contractor shall make his own arrangements for a suitable area which shall meet with the Engineer's approval. The stockpiling area shall be adequately fenced and protected by a lockable gate and a watchman shall be maintained at all times.

3.17.4.3 Pipes and specials shall be strung or stockpiled on level, well drained ground in a manner such that they will not be in contact with the ground, tree stumps, or other sharp objects and all vegetation and other combustible material shall be completely removed to at least 5 metres from the nearest pipe or special.

3.17.4.4 Coated steel pipes shall always be supported on a sufficient number of approved soft bolsters to prevent damage or permanent deformation of coatings. Coated pipes shall not be stacked more than two pipes high, each layer separated by bolsters.

3.17.4.5 The number of layers of bare steel pipes in a stockpile shall not exceed:

$$N = \frac{1\,730 \times Y \times t}{(D-t)^2}$$

Where N = Permissible number of layers
Y = Minimum yield stress of steel in MPa
t = Wall thickness in mm
D = Outside diameter in mm

3.17.4.6 Concrete pipes shall not be stockpiled more than 2 metres high with the bottom layer supported on timber runners such that no part of the pipe is in contact with the ground. Timber runners shall be spaced at one fourth (1/4) of pipe

length. Pipes having elliptical reinforcement shall be stockpiled or strung with the marks indicating the top and the bottoms of pipes in the correct position. If concrete pipes are to be stockpiled for longer than four weeks, steps shall be taken to prevent the pipes from drying out by daily spraying of water or the application of an approved membrane type curing compound to the external and internal surfaces.

3.17.4.7 Each class and size of pipe shall be stored separately in its own stockpile.

3.17.4.8 All rubber rings or other materials which will deteriorate under the action of sunlight, ozone or inclement weather, shall be stored in permanent shade in lockable weatherproof sheds. Welding and the running of welding machines and electric machinery shall not be permitted in or near places where rubber or plastic products are stored and care shall be taken at all times to prevent contamination of these products by oil or other petroleum derived solvents.

3.17.4.9 Valves shall be stored in orderly groups on prepared floors to prevent damage, distortion or corrosion of flanges or working parts. All metal valves may be stored in the open but full protection shall be afforded to valves with non-metallic seals or working parts. Under no circumstances shall valves be stored in direct contact with the ground.

**3.18 Records of materials on site**

3.18.1 The Contractor shall keep and maintain a complete and comprehensive record of each pipe, special and fitting delivered to Site.

The record shall at least denote the reference number, size, pressure class, location in the pipeline, date and condition of delivery and the location of delivery and the location of storage. Copies of the record shall be submitted to the Engineer at the end of each month or whenever requested by the Engineer.

3.18.2 Where pipes, specials and fittings are delivered without reference numbers, same shall be provided by stencilling, labelling or other methods approved by the Engineer.

**3.19 Repairs**

3.19.1 The Contractor shall be responsible for the repair of all defects in pipes, specials etc, delivered to and accepted on site, provided always that no repairs shall be permitted on reinforced concrete pipes and specials without the Engineer's prior approval.

3.19.2 The Contractor shall inspect the coatings and linings of all factory coated and lined steel pipes and specials as follows:

(i) Liquid, fusion bonded or extruded coatings shall be inspected in accordance with SANS 1217.

(ii) Other organic coatings (bitumen, coal tar, etc): Shall be inspected with an approved holiday detector equipped with rolling spring or copper bristle brush electrode operating at 15 kV at a nominal pulse frequency of 30 Hz.

(iii) Tape wrappings: This shall be the same as for the organic coatings above except that the operating voltage shall not be less than 50% of the stated breakdown voltage of the tape being used and should not be more than 80% thereof.

Areas which cannot be tested whilst pipes are supported on cradles or otherwise, shall be tested whilst pipes are suspended above the trench immediately prior to laying. Defective areas of linings and coatings shall be marked when detected and shall be repaired, to the Engineer's approval, with materials specified respectively for the original lining and/or coating. Repaired linings and coatings shall be inspected and re-tested after repair and shall have the same properties as specified for the original ones.

3.19.3 Repairs to dented steel pipes and specials shall only be attempted if the dimensions between the lowest point of a dent and the original pipe contour is less than 2% of the outside diameter of the pipe or special for pipes and specials up to 558,8 mm OD and 1% of the outside diameter for larger pipes and specials. Repair of these minor dents shall be done as approved by the Engineer and all such repairs shall be tested by the application of a dye penetrant to detect cracks or laminations in the metal.

3.19.4 Dents in steel pipes or specials of which the depth exceed the above limits and any dents which contain scratches or grooves or which affect the curvature of pipe barrels at welds shall be cut out by cutting of a length of pipe barrel long enough to eliminate the defect. Damaged sections shall be replaced in accordance with the Engineer's instructions. The ends of pipes intended for field welding shall be rechamfered to 30° + 5° with width of root face 1,6 mm + 0,8 mm.

3.19.5 Concrete pipes shall be free from structural cracks and there shall be no chips that would be detrimental to the performance of the pipe.

**3.20 Maintenance of cleanliness**

3.20.1 End covers to pipes and specials shall be kept firmly in position until installation of same in the trench.

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

## 4. DESIGN AND SETTING OUT

### 4.1 Design

4.1.1 General

The detailed design of the pipeline shall either be the responsibility of the Engineer, or shall be the responsibility of the Contractor. Only one of the two alternatives shall apply to any one contract as indicated in the Project Specification.

4.1.2 Design by Contractor

4.1.2.1 The Tender drawings show the alignment of the pipeline, an approximate profile, pipe and valve sizes, geological data and pressure classification, approximate locations of valves, fittings and specials and the general topographical features along the pipeline route. Also included are type designs for rail, road and river crossings and miscellaneous pipeline structures. The Contractor shall be responsible for detailed surveys and the preparation of detailed working drawings comprising the following: Detailed profile drawings showing clearly the exact pipeline levels and grades, the exact location of valves, fittings and specials, the location of all railways, roads and/or other service and utility installations crossed by the pipeline, the location of rivers, streams, property boundaries with title description and other topographical features. Fully detailed and dimensioned working drawings showing the structural details and layouts of rail, road and river crossings and all other pipeline structures.

4.1.2.2 Drawings shall be on size A1 standard sheets with 2,5 mm minimum size lettering and shall be to a scale not smaller than that of the Tender drawings. The drawings shall generally conform to the standard and layout of the Tender drawings.

4.1.2.3 Working drawings shall be submitted for the Engineer's approval in quadruplicate and in the following manner:

(a) Rail and road crossings - 50 working days before construction is due to commence.

(b) All other drawings - 25 working days before construction is due to commence.

4.1.2.4 Working drawings for anchor and thrust blocks, cast-in-situ box culverts and major pipeline structures shall be accompanied by calculation sheets setting out in a clear and logical manner the assumptions, design parameters, computations of loadings and structural computations of same.

4.1.2.5 The Engineer shall check all drawings and calculations and may instruct any drawings or calculations to be altered or corrected and the Contractor shall do so at his own expense and re-submit drawings and calculations for approval.

4.1.2.6 On approval of drawings, duplicate copies of drawings and/or calculations with the Engineer's signature of approval shall be returned to the Contractor. No construction work shall commence before the Contractor's site staff is in possession of relevant approved drawings.

4.1.3 General design criteria

4.1.3.1 Pipelines shall be laid in straight lines or grades between changes of direction or grades. The pipe grade shall follow the general configuration of the ground and shall not be flatter than 1:500. The following minimum depths of cover to natural ground level over the crown of the pipe shall be maintained except if indicated differently in the Project Specification or the drawings:

| Location | Minimum Depth of cover over crown of Pipe in mm |
|---|---|
| Cultivated ground | 900 |
| Veld | 750 |
| Through towns and built-up areas | 900 |
| Uncultivated ground with shallow rock | 600* |

* Subject to the Engineer's approval

4.1.3.2 Where trench depths exceed the external load capacity of pipes the bedding shall be selected in accordance with SANS 1200 LB and the external loads calculated in accordance with SANS 10102.

4.1.3.3 Deflections in the pipe axis of greater than 11,25°, shall only be made with manufactured bends. Smaller deflections may be made as specified hereinafter.

4.1.3.4 Computations and design of anchor and thrust blocks shall be in accordance with "Design for Unbalanced Thrust for Buried Water Conduits" by C.A. Manganaro, published in the Journal of the American Water Works Association, June 1968. Numerical values for shear "Φ" (granular soils), for cohesion "C" (clays) and unit weight "Y" of soils shall be obtained by testing samples of soils in an approved laboratory. Where these values cannot be determined experimentally, they shall be taken as the following with units in the metric system to suit the specified design methods.

| Type of Soil | Φ In Degrees | "C" Cohesion in kPa | "Y" Unit Weight in kg/m$^3$ |
|---|---|---|---|
| Very soft and wet clay | 0 | 10 | 1 300 |
| Soft clay and turf | 4 | 15 | 1 350 |
| Dry and very stiff clay | 10 | 30 | 1 400 |
| Dry sand | 34 | 0 | 1 400 |
| Clayey sands | 30 | 10 | 1 450 |
| Dense sand and gravel | 34 | 0 | 1 600 |

4.1.3.5 Computation and design of harnessed joints in an all-welded pipeline shall be in accordance with "Harnessed Joints for Water Pipe" by C.A. Manganaro, published in the Journal of the American Water Works Association, July 1969.

4.1.4 Design by Engineer

4.1.4.1 The Tender drawings show the alignment of the pipeline, the approximate profile of the pipeline, pipe and valve sizes, geological data and pressure classifications, approximate location of valves and fittings.
Also included are type designs for railway, road and river crossings and miscellaneous pipeline structures. The Engineer shall be responsible for detailed surveys and the preparation of detailed working drawings of the pipeline and all appurtenant structures.

4.1.4.2 Before construction of any part or parts of the Works is due to commence in accordance with the Contractor's detailed Works programme, which are to be submitted in terms of the Contract, the Engineer shall submit duplicate working drawings of such part or parts of the Works to the Contractor and no construction work shall commence before the relevant detailed working drawings are in possession of the Contractor's site staff.

4.1.4.3 No deviation from working drawings shall be allowed without the Engineer's approval. Should the Contractor require deviations or alterations to drawings to suit his construction methods or otherwise, such deviations and alterations shall only be considered by the Engineer on the strength of detailed drawings prepared by the Contractor and submitted to the Engineer in quadruplicate at least 15 working days before construction involving such deviations or alterations is due to commence. Clauses 4.1.2.2, 4.1.2.4, 4.1.2.5 and 4.1.2.6 of this specification shall apply where relevant. The cost of surveys, preparation and submission of such drawings and all delays in completion of the Works resulting from such deviations or alterations shall be to the Contractor's account.

**4.2 Setting out**

4.2.1 The Contractor's responsibility for the setting out of the Works is detailed in the Conditions of Contract.

4.2.2 Setting out of the Works shall be performed by an experienced Engineering Surveyor and shall be to the following limits of accuracy:

(a) Pipe centreline

Shall be in straight lines between changes of direction and/or grade and shall in its final laid position be within 100 mm of the plan centreline on the approved drawings.

(b) Pipe invert levels and gradients

In the final laid position, pipe invert levels shall be within + 25 mm of the invert levels on approved drawings but notwithstanding this tolerance, the same direction of grade as per approved drawings shall be maintained and the grade shall not be flatter than 1:500.

(c) Positions of fittings, specials and valves

Fittings, specials and valves shall be installed within 5 m of the plan position indicated on the approved drawings.

(d) Benchmarks and triangulation points

All levels shall be reduced levels above mean sea level and shall be indicated to the nearest 0,005 m. All co-ordinates shall be based on the applicable Lo system and shall be indicated to the nearest 0,1 m. Levelling

shall be carried out to an accuracy such that the closing error between benchmarks does not exceed 0,03 times the square root of the distance traversed in kilometres.

4.2.3 Setting-out of the Works shall also include the following duties which shall be performed and kept up to date as pipe laying progresses:

(a) Accurate determination of as-laid invert levels of the pipeline before backfilling commences.

(b) Accurate fixing by triangulation of all changes in direction before backfilling commences.

(c) Accurate determination of exact as laid chainages of all specials, changes in direction and/or grade, valves, off-takes, structures, etc., taken along the pipeline before backfilling commences.

(d) The establishment of permanent surface bench marks along the pipeline route at intervals not exceeding two kilometres and accurate levelling of same. Bench marks to be sited within the permanent pipeline servitude width as indicated on the drawings.

(e) The establishment of permanent surface triangulation points along the pipeline route at intervals not exceeding 5 kilometres and determination of co-ordinates of same. Triangulation points to be sited within the permanent pipeline servitude width as indicated on the drawings.

4.2.4 Levels and co-ordinates over any section of pipeline backfilled shall be made available to the Engineer on request.

## 5. ENTRY AND WORK UPON LAND

### 5.1 General

5.1.1 The servitudes available for the construction of pipelines provide the Employer with a right of way but not ownership of the ground.

5.1.2 Servitudes shall normally not be permanently fenced off except where indicated to the contrary in the Project Specification to the Contract or the drawings.

5.1.3 The Contractor shall confine his activities to the servitude strip except where otherwise provided for. Trespassing, poaching of game and gathering of fire wood on property outside the servitude strip shall be strictly forbidden.

5.1.4 All damage caused by the Contractor, his staff or agents outside the servitude strip shall be the responsibility of the Contractor who shall be liable for all claims in this respect.

5.1.5 Provision has been made for the Contractor and the Employer to gain access from public roads to the pipeline servitudes via separate servitudes of access. These are shown on the drawings. The use of any other private roads to gain access to the pipeline servitude shall only be with the prior written approval of the Engineer and the landowner(s). The Contractor shall be responsible for all claims from the landowner(s) arising out of any such agreement.

5.1.6 The issue of the Performance or Final Certificate, as applicable, in terms of the Conditions of Contract shall be subject to the Contractor producing to the Engineer a certificate, signed by the landowner or lessee in question that all the Contractor's obligations to him have been completely discharged in terms of any agreements that may have been arranged between the Contractor and the landowner or lessee or in respect of any damage to crops, land or property caused by the Contractor's activities outside the strip of right-of-way. If such certificates are not produced within 12 months after the issue of the Taking-Over or Completion Certificate, as applicable, in respect of the works or any part of the works, the Employer reserves the right to investigate any agreements entered into between the landowner or

lessee in question and the Contractor and any claim made by the landowner or lessee for damage outside the strip of right-of-way. If the Employer is satisfied that the Contractor is in default in terms of the contract and any private agreements which he has made, all justifiable claims shall be paid to the landowner or lessee by the Employer from retention money held and deducted from the amount payable to the Contractor.

5.1.7 Should Tenderers prior to the award of the contract wish to carry out foundation exploration by means of test holes or exploratory drilling where no geological data is available or where additional data is required they shall get the necessary permission from the Engineer and the landowner(s).

In the event of exploration being carried out the following conditions shall apply:

(a) Trial holes or drilling shall be excavated in such a manner as to avoid damage to owner's property or any services and all claims for damage or compensation shall be the sole responsibility of the Tenderer.

(b) Trial holes shall be attended at all times and they shall be backfilled as soon as the required depth has been reached and/or required information extracted/obtained. Unattended holes at night shall be securely fenced to prevent the accidental falling-in of persons or animals. Material excavated from trial holes shall be backfilled in the same layers as the in-situ material and compacted to in-situ density with topsoil backfilled last.

**5.2 Entry upon private land**

5.2.1 Access to land for construction purposes will be restricted as laid out in the Project Specification. At least 7 days written notice shall be given by the Contractor to the Engineer before entering upon any land to commence construction. The Engineer will, as far as possible, arrange a meeting between the Engineer, the Contractor and the landowner or occupier to inform the landowner or occupier of the programme of construction, to make an agreed record of the state of the land and any crops and/or improvements within the required right of way and to consider any special or reasonable requests of the landowner or occupier.

**5.3 Work in towns and on areas under control of authorities**

5.3.1 Where the pipeline crosses through towns or areas controlled by the Government, Provincial or Local Authorities, Public or Semi-Government Corporations or Mine Owners, the work shall be carried out in accordance with the reasonable requirements of the authorities or owners where these do not contradict the provisions of the contract.

5.3.2 Before undertaking any work in these areas, the Contractor shall contact the authority or owner concerned at least 14 days before commencement of construction, inspect the route in detail and familiarise himself with the requirements of the authority or owner in respect of working hours and working conditions. No additional payment or relief from his obligations in terms of the contract will be made on account of restrictions imposed by the authorities or owners.

5.3.3 Construction of the pipeline in any controlled area shall not be started without the written advice to the authorities or owners concerned that work is about to commence. No felling of trees, removal of crops or demolishing of buildings or other structures shall be undertaken without the approval of the authorities or owners.

**5.4 Access through fences**

5.4.1 Where existing fences cross the pipeline route, the fences within the working area shall be replaced with fences and gates using new material throughout as hereinafter specified.

5.4.2 Before any fence is cut, the Contractor shall erect straining posts of either 100 mm nominal bore steel tubing or 10 kg/m iron rail or creosote impregnated hardwood of 150 mm minimum diameter in the line of the fence on both sides of the pipeline to the working width required. The post shall be firmly concreted into the ground and shall be properly strutted or stayed to the satisfaction of the Engineer. The type of posts and stays or struts used shall depend on the

climatic and soil conditions at the site and the Contractor shall be guided in his choice of materials by the type of fencing material generally in use in the area.

5.4.3 As soon as the concrete has hardened sufficiently to take the strain, the wire strands of the existing fence shall be cut one by one and each individually secured to the straining posts before proceeding to cut further strands so that the tension in the existing fences is maintained.

5.4.4 The Contractor shall immediately erect and maintain temporary fences and gates between straining posts to the same general standard as the existing fence and in a manner that will ensure easy access along the pipeline route for the Contractor and the Engineer or his authorised Representatives.

5.4.5 As soon as construction work has been completed in the vicinity of the temporary fence and gate, a permanent fence and a gate to the standards hereinafter specified shall be erected across the pipeline servitude. Permanent gates shall be provided with a heavy chain and padlock of approved quality. All padlocks shall be similar with duplicate sets of master keys provided. The sets of keys shall be handed over to the Engineer prior to the issue of the Taking-Over or Completion Certificate, as applicable, in respect of the Works or parts of the Works.

5.4.6 From the time of occupancy of the site until the issue of the Taking Over or Completion Certificate, as applicable, the Contractor shall take all measures for the protection and control of livestock etc., which are made necessary by his operations. Livestock shall not be allowed to stray through severed fences or gates provided by the Contractor. If the random movement of stock through any such openings is not effectively prevented at all times, the Engineer shall call upon the Contractor to provide a full time guard at the Contractor's expense.

**5.5 Temporary fencing of working areas**

5.5.1 Should the Project Specification or the drawings indicate that the construction servitude must be fenced the Contractor shall fence both sides of the pipeline servitude (one side of the construction servitude in cases where an existing fence of adequate standard is already present along the other edge of the pipeline servitude) as may be required to prevent straying of livestock or people onto the construction area and to prevent the Contractor’s personnel and equipment from straying out of the construction area. No construction activities shall take place in the construction servitude, except as may be required to set out the servitude and erect the temporary fencing, until the temporary fencing has been erected.

5.5.2 Temporary fencing shall be of a standard as hereinafter specified and shall be maintained to the satisfaction of the Engineer. The temporary fencing shall remain in place until all construction and rehabilitation activities within the relevant section of the construction area and the initial pipeline coating integrity survey and hydrostatic testing and final painting for the relevant section of pipeline has been completed. The final pipeline coating integrity survey and Tests on Completion may still be pending along the relevant section of pipeline at the stage when the temporary fencing is removed. Once temporary fencing has been removed, access to the pipeline servitude will be limited and restricted to light construction vehicles to obtain access to valve chambers for testing and inspection purposes. Should the Contractor require access to a section of the pipeline servitude with heavy construction equipment after the temporary fencing has been removed the Contractor shall re-erect temporary fencing and undertake the required environmental protection procedures at his own cost prior to accessing the pipeline servitude.

5.5.3 The Contractor shall supply, install and maintain gates of the standard hereinafter specified at such points as instructed by the Engineer to obtain access to the construction servitude from provincial roads or as may reasonably be required by occupiers or owners of property for access across the working area or to parts of the farm severed by temporary fences. Where required by land owners or instructed by the Engineer, the Contractor shall provide two (double) gates at such points where access with wide farming equipment will be required through temporary fences. The Contractor will be responsible for proper control of access to the construction area at all such gates.

### 5.6 Interference with and reinstatement of existing services and works

5.6.1 The Engineer will supply the Contractor with such information as he has, concerning obstructions and services which cross the pipeline route. Whilst such information is given in good faith, it shall not relieve the Contractor of any of his liabilities, obligations and risks under the contract.

5.6.2 Before commencing any excavation or pipe work, the Contractor shall verify the locations and elevations of all known or suspected service and utility installations such as power transmission lines or cables, telephone lines or cables, water, gas, petroleum products and sewer pipes, access roads, tracks or paths, railway lines, railway sidings, irrigation or stormwater reticulation, agricultural contours, natural drainage channels, fire alarms, lamps or other posts or pylons and any other service or obstacle, whether those be buried, under water or not. Verification shall be by inspection of the site, examination of drawings, consultation with landowners, occupiers and responsible authorities or, where necessary, by the excavation of trial holes.

5.6.3 The Contractor shall be responsible for the cost of immediate repair of any damage caused to services or utility installations and for any loss or damages suffered as a result of the interruption of any service so damaged whether or not such damage is attributable to negligence on his part. Any damage caused shall be reported immediately to the Engineer.

5.6.4 The Contractor shall not interfere with any service or utility installation without written approval of the owner, occupier or responsible authority. The Contractor shall arrange for the temporary continuance of any service or utility installation which must be discontinued, disconnected, deviated or removed for the purpose of construction and for the maintenance of such temporary measures until final restoration of the service or utility installation. The provision of the temporary measures shall be carried out in such a manner as may be required by the authority or owner concerned or as directed by the Engineer.

The Contractor shall ensure that any bonding to foreign services in terms of the requirements of the South African Electrolytic Corrosion Committee is completed prior to reinstatement.

5.6.5 The Contractor shall send all requisite notices to the authorities or persons concerned and shall make the necessary arrangements for the deviation, maintenance, discontinuance, disconnection or removal of the said installations.

5.6.6 In the case of temporary discontinuance of services, the Contractor shall warn owners, occupants or responsible authorities of the impending interference with the service and co-operate with them in order to carry out the work with as little disruption of the owners', occupants' or local authority's operations as possible and whatever temporary arrangements are required to maintain the service in operation during alterations shall be carried out by the Contractor.

5.6.7 As soon as possible, all service and utility installations that have been interfered with shall be restored to the condition they were in before the start of construction under this contract, or better, but to the satisfaction of the Engineer.

## 6. SITE PREPARATION

### 6.1 Site clearing

6.1.1 Existing structures, heritage sites or graves located within the construction servitude that will not be demolished or relocated prior to construction must be clearly identified and protected prior to commencing with site clearance. Grave sites shall be cleared to determine the number off and position of graves and to establish the boundaries of the grave site. Photographic records of the grave site and individual graves shall be prepared to serve as a benchmark for the monitoring and maintenance of a grave site. The grave site perimeter shall be established to the Engineers approval and fencing shall be erected around the site prior to commencing with site clearancing in the relevant area. The Contractor shall ensure that such sites are protected, monitored and maintained during the construction period. The

Contractor shall adopt construction methods to accommodate such structures and sites within the construction servitude during the construction process.

6.1.2 Prior to commencing with excavation the Contractor shall clear the full width of the construction servitude of all bush, trees, scrub, rubble, boulders etc and shall where specifically indicated in the Bill or Schedule of Quantities or on the drawings, demolish permanent structures, huts, houses etc situated within the construction servitude.

6.1.3 All bush, scrub and trees shall be cut down and all stumps and roots completely removed. Grass however shall not be removed indiscriminately as this would render the servitude liable to erosion. Grass shall be removed and stockpiled together with top soil where applicable. Material obtained from site clearing shall be disposed of at suitable spoil sites. The Contractor shall be responsible to make his own arrangements for a suitable spoil site/s. Spoiling in quarries for rehabilitation purposes will be preferred. Trees and stumps shall not be burnt unless authorised by the Engineer.

6.1.3 The Engineer may direct that certain trees not within 3 metres of the pipeline centreline and which would not interfere with construction, be left standing and the Contractor shall therefore obtain the Engineer's instruction before removing trees which could reasonably be left standing. Specific timber as may be indicated in the Project Specification will remain the property of the Employer and the Contractor shall dispose of such timber in a manner as instructed by the Engineer.

**6.2 Top soil and fertile soil**

Top soil shall be carefully stripped over the trench width, or the width of the construction servitude (top soil stockpiling area excluded) as indicated in the Project Specifications or on the drawings, set aside for bringing back after backfilling of trenches and replacing over the top of trenches or the servitude as applicable to restore the ground to its near as possible original condition. The depth of top soil removal shall be agreed with the Engineer on site but is expected to generally vary between approximately 150 mm to 300 mm. Top soil stockpile heights shall be limited to a maximum of 2 m.

Should it be indicated in the Project Specifications or on the drawings, fertile soil shall be stripped to 300 mm depth in agricultural lands over the width of the trench (after removal of top soil) and set aside for use in trench backfilling after common backfill have been placed in the trench and prior to bringing back top soil over the width of the trench or the servitude as applicable.

**6.3 General levelling**

6.3.1 If, owing to excessive cross-falls, the Contractor requires to carry out general levelling within the servitude strip to facilitate use of plant, such levelling may only be carried out after stripping and setting aside of top soil over the full width of the area to be levelled.

6.3.2 After completion of the works, the ground shall, at the discretion of the Engineer be restored to its original contour, top soil replaced to its original depth and the area protected against erosion to the satisfaction of the Engineer.

6.3.3 In areas where the ground surface is irregular due to the presence of drainage trenches, stockpiles or holes, such trenches and holes shall be backfilled as specified in Clause 7.2.5 using stockpiled material that may be present on the construction servitude in the area or excess excavated material from other excavations on site. Should drainage trenches that will be backfilled need replacement to deal with storm water during the construction period or thereafter, the details of such replacement trenches shall be agreed with the Engineer on site.

**7. EARTHWORKS**

## 7.1 Excavations

7.1.1 General requirements

All excavation work shall be subject to the requirements of the Occupational Health and Safety Act (Act 85 of 1993 and regulations). The Contractor shall ensure that working conditions are safe and that excavations are kept free of water at all times.

The transport, storage, handling and use of explosives shall be in accordance with the Explosives Act 15 of 2003 and OHS Act 85 of 93, Explosive Regulations. Blasting shall not be carried out without the approval of the Engineer. Such approval shall not relieve the Contractor of any of his liabilities, obligations or risks under the Act or the Contract. Proper precautions shall be taken to protect persons, the Works, the property and the natural environment. The Contractor shall collect fly rock, if any, immediately after each blast. Blasting may be prohibited where, in the opinion of the Engineer, injury to persons and/or damage to property and/or services and utility installations is likely.

All blasting shall be carried out in strict compliance with Explosive Regulation 11 and the safety distances of Annexure 1. When blasting within 500 metres of any permanent structure, above or below ground, including pipelines, buildings etc. described in the Explosives Act 15 of 2003 the peak particle velocity as defined in a technical bulletin "Explosive Today" no. 27, March 1982 of AE & CI, shall at no stage exceed 25 mm/s adjacent to any of these structures. These peak particle velocities shall be measured by an approved Vibrorecorder and Peak Particle Velocity meter for each blast over the full length of work which falls within the above limits. Should blasting be required adjacent to any TRANSNET pipeline, written approval shall be obtained from them to carry out such blasting.

No blasting will be allowed within TRANSNET pipeline servitudes and the excavation and backfilling within the servitude shall be undertaken by hand without the use of mechanical or power equipment.

7.1.2 Classification of excavated materials

7.1.2.1 General

Materials shall either be classified with sub-classifications of "soft and pickable" and "rock" or shall be unclassified as "all materials". Only one of the two alternatives shall be applicable to any contract as indicated in the applicable Bill or Schedule of Quantities.

7.1.2.2 Classified materials

The Engineer's decision as to in which sub-classification excavated materials fall shall be final.

7.1.2.2.1 "Soft and Pickable". This sub-classification shall include all top soil, fertile soil, sand, loam, clay, gravel, pickable materials, ouklip (laterite), shattered or loose rock, decomposed or partially decomposed rock and all other materials which can be loosened and removed with a back-acting excavator of 35 ton mass which is in mechanically sound condition, equipped with a rock bucket and operated by a skilled operator or by pick and shovel, whether this be by lifting hard layers from underneath or otherwise. Boulders under 0.3 cubic metre in volume are included. The fact that blasting or pneumatic percussion tools or other rock breaking equipment may be a faster or more convenient method of excavating material under this sub-classification shall not entitle the Contractor to claim payment for "rock" excavation.

7.1.2.2.2 "Rock". This sub-classification shall include all solid undecomposed rock, the practical excavation of which necessitates the use of explosives, rock splitting equipment or pneumatic pavement breakers and rock drills. All boulders larger than 0,3 cubic metre in volume are included.

7.1.2.3 Unclassified materials

Excavations shall be indicated as excavations in "all materials" for which one uniform rate shall apply, regardless of the nature or quantities of actual materials excavated. Any data on type or quantity or nature of materials given by the Engineer at the time of tender shall be for information purposes only and the Engineer and the Employer do not assume any responsibility or liability for the accuracy of this information. The Tenderer shall satisfy himself as to the ground condition to be encountered. No extra payment or claim will be allowed on account of any variation in the nature of the ground condition from that which may have been implied in the tender documents or assumed by the Tenderer in preparing his tender.

7.1.3 Trenches

7.1.3.1 Trench widths

7.1.3.1.1 Minimum trench widths shall generally be as follows:

| Pipe Nominal Bore in mm (D) | Width of Trench in mm |
|---|---|
| 700 and smaller | D + 600 |
| larger than 700 up to and including 1000 | D + 800 |
| larger than 1000 | D + 1000 |

Widths of trenches shall be maintained at the base of the trench and the laid pipeline shall be located centrally in the trench to enable backfill to be effectively rammed below the lower half of the pipe on both sides of the pipe.

7.1.3.1.2 At tie-ins on welded pipelines, trenches shall be excavated to a width of not less than 900 mm in excess of the minimum widths, to a depth of not less than 750 mm below pipe invert level and for a length of not less than 900 mm centred on the joint. For pipelines with flexible joints, sufficient space shall be allowed around joints to permit proper making and inspection of joints.

7.1.3.2 Trench depth

7.1.3.2.1 General

Trenches shall be excavated to the grades and levels shown on the approved drawings and depths shall be so controlled that a uniform depth of bedding underneath the pipeline is ensured.

7.1.3.2.2 Trench floors

7.1.3.2.2.1 Trenches shall be excavated and trimmed to a depth of not less than 150 mm below the underside of pipes in the case of welded or coupled steel pipelines and not less than 200 mm below the underside of pipes in the case of flanged steel pipes or prestressed or reinforced concrete pipes with socket-end diameter in excess of pipe barrel outside diameters. These depths shall be maintained for the full width and length of the trench and all stones, rocks or other projections trimmed accordingly.

7.1.3.2.2.2 The Contractor shall advise the Engineer whenever trench floors have been excavated and trimmed and are ready for inspection. No trench floors shall be covered with bedding material or pipes laid until the inspection has been carried out and the trench floors passed. Failure of the Contractor to comply with this clause shall render the Contractor liable to re-open, uncover and reinstate trench floors for inspection at the Contractor's expense.

7.1.3.3 Progress of trenching

Trench excavation shall proceed progressively from each working head and the opening of trenches haphazardly at various points along the route will not be permitted without approval of the Engineer. In particular, the Contractor will

not be allowed to pass over hard sections of excavations to proceed with soft excavation at further points along the trench. Trench excavations shall not be carried out further ahead of pipe laying than is required for efficient working and in no case shall this exceed 1 kilometre ahead of the last laid pipe without prior approval of the Engineer. At the discretion of the Engineer this clause may be relaxed insofar as road, rail and stream crossings are concerned. Where rock excavation is continuous, the Contractor may be permitted at the Engineer's discretion to use special rock excavating gangs further ahead of the main excavating gangs.

7.1.4 Valve chambers and thrust blocks

Trench excavations shall be carried straight through and excavations widened and deepened where necessary to allow for the construction of valve chambers and thrust blocks.

7.1.5 Soil stockpiles

All excavated material shall be stockpiled along the sides of trenches either separately or in successive layers according to the nature of the material removed in such a way that backfilling in accordance with the specification may be facilitated. Soil stockpiles shall not unreasonably obstruct the works, traffic or drainage, and all surplus soil not required for backfilling and restoration shall be removed to spoil dumps during the progress of the work. The maximum gradient of the subsoil and spoil material so shaped, shall not exceed 1:3, the preferred gradient being 1:5. Thereafter these areas shall be covered with topsoil and grassed.

## 7.2 Backfilling

7.2.1 General

7.2.1.1 Borrow pits for bedding or selected backfill material shall only be developed after the required environmental authorization has been obtained and with the approval of the Engineer and the land owner or lessees. All such sites shall be subject to the approval of the Engineer.

The Engineer shall be kept fully informed of all negotiations that are in progress between the Contractor and the landowners or lessees. It is essential that the Contractor shall make prompt payment to landowners or lessees for any royalties for borrow pits and for any agreed amounts to be paid to the landowners or lessees for the use of borrow pits, access roads, use of ground outside servitudes etc.

7.2.1.2 It is desirable that trenches shall be backfilled as soon as possible after pipe laying to curtail thermal movements of the pipeline, damage to coatings and flotation of the pipeline should the trench fill with water. At no time shall completed backfilling lag more than 300 metres behind the last pipe laid. All specified tests on pipe barrels and joints shall therefore be carried out as soon as possible.

7.2.1.3 The Contractor may use his discretion as whether to backfill around joints before the pipeline is hydrostatically tested. The Contractor shall be responsible for the location and repair of any leaks on the pipeline under hydrostatic test and no extra payment will be made for any re-excavation and subsequent reinstatement which may be necessary to locate and remedy leaks or for the installation of cathodic protection equipment. Should the Contractor elect to leave joint holes open until after the hydrostatic test, he shall provide at his own expense effective and approved barricades and fences around each hole for the protection of persons and animals. In built-up areas, barricades shall be clearly marked at night time with red warning lights.

7.2.1.4 Material suitable for bedding, selected backfill or common backfill shall be moved from any part of the works where there is a surplus to any part where there is a deficiency. Material from the trench which contains particles that exceed 9.5 mm but otherwise comply with the specification for bedding and selected backfill material shall be screened along the trench to obtain material suitable for bedding and selected backfill. Alternatively a shortage of bedding and/or selected backfill shall be imported from borrow areas or commercial sources.

7.2.2 Pipe bedding

7.2.2.1 Pipe bedding comprises backfill placed and compacted in trench bottoms up to the level of pipe springing points in a manner such that pipes are uniformly supported over an arc length of $120^0$, centred on the pipe centreline for its full length.

7.2.2.2 Placing and compaction of the pipe bedding shall be regarded as the most critical phase of the backfilling operation. Backfilling beyond this point shall only proceed after inspection and approval of the completed bedding by the Engineer.

7.2.2.3 As soon as possible after trench floors have been passed by the Engineer, the layer of bedding material below the underside of pipes shall be placed and compacted, level over the full width of the trench and to the required level and grade along the trench.
A 20 mm to 30 mm thick raked and uncompacted layer of bedding material shall be placed on top of the compacted bedding layer to bed the pipe. Prior to laying a pipe in the trench, joint and lifting sling holes of adequate dimensions shall be excavated in the compacted bedding layer or trench floor to facilitate proper jointing and repair of pipes and the removal of lifting slings without causing damage to the pipe coating.
This phase of the operation shall be subject to the Engineer's approval and the Contractor shall submit a comprehensive method statement to the Engineer for perusal and approval before pipe laying commences.

7.2.2.4 Bedding material shall be placed and compacted evenly on both sides of the pipe, compaction to be by hand or mechanical tamping. The method adopted shall be subject to the Engineer's approval. Whatever method is adopted and approved, great care shall be exercised at all times to prevent damage to pipe coatings. To avoid damage to the pipe coating, wooden shutter board or a similar barrier shall be placed along the edges of the pipe to avoid tamping or compaction of bedding within 50mm from the edges of the pipe. The top of the completed bedding shall form a level surface completely filling the space between the pipe and trench walls including any cavities that might exist in the trench walls.

7.2.2.5 Compaction shall be in layers not exceeding 100 mm (after compaction), watered to optimum moisture content and compacted to densities as per Clause 7.2.6. The material in the "wedges" formed by the curvature of pipe bottoms shall be compacted by hand punning horizontally and obliquely.

7.2.2.6 For placing fluid beddings (soilcrete, concrete and sand), where indicated in the Project Specifications or on the drawings, the procedure indicated in paragraphs 7.2.2.3 and 7.2.2.4 shall be replaced with that specified in this clause and clause 7.2.2.7. As soon as possible after trench floors have been passed by the Engineer, cross berms of compacted bedding material shall be placed over the full width of the trench and of a size and spacing such that the pipe shall be supported at the required level and grade without causing damage to the pipe coating or interference with the placement and compaction of the balance of the bedding material. This phase of the operation shall be subject to the Engineer's approval and the Contractor shall submit a comprehensive method statement to the Engineer for perusal and approval before pipe laying commences.

7.2.2.7 Bedding material shall be placed and compacted evenly on both sides of the pipe, compaction to be by puddling and compaction by means of poker vibrators. The method adopted shall be subject to the Engineer's approval. Whatever method is adopted and approved, great care shall be exercised at all times to prevent damage to pipe coatings or disturbance of the pipe level and grade by flotation or otherwise. The top of the completed bedding shall form a level surface completely filling the space between the pipe and trench walls including any cavities that might exist in the trench walls. To avoid damage to joint repair coatings at welded steel pipe joints, due to longitudinal movement of the pipe associated with temperature fluctuations, a box out of 1 m in length shall be provided at all pipe joints to avoid fluid bedding material from filling the trench at pipe joints. The voids created with such box outs shall be backfilled as specified in clauses 7.2.2.4 and 7.2.2.5 after the pipeline has been bedded down and backfilled sufficiently to avoid longitudinal movement at the joint.

7.2.3 Soft trench bottoms

7.2.3.1 Where trench bottoms are too soft and waterlogged to permit placement and compaction of bedding material in the normal manner, such trench bottoms shall be excavated to a depth of at least 450 mm below the underside of pipes and specials for the full width and length of the trench affected.

7.2.3.2 The full width and length of the trench bottom and at least 500 mm height of both sides of trench walls shall be covered by "Bidim" or equal approved filter cloth.

7.2.3.3 The full width and length of the trench shall thereupon be covered by a 300 mm thick layer of coarse gravel, coarse sand or 19 mm nominal size crushed stone, fully compacted within the confines of the filter cloth to take the mass of the pipe filled with water and all loads on the pipe without settlement.

7.2.3.4 The free drainage layer shall be covered over the full width of the trench by a single layer of filter cloth with the cloth on trench walls folded over and overlapping to completely seal off the free drainage layer against ingress of sand or fine soil particle.

7.2.3.5 Pipes shall be bedded on the layer prepared as above and pipe bedding and selected backfill completed as specified.

7.2.4 Selected backfill

7.2.4.1 Selected backfill comprises backfill material placed and compacted in trenches from the top level of completed beddings up to a level of 300 mm above the crown of pipes.

7.2.4.2 As soon as possible after completed beddings have been inspected and accepted by the Engineer, selected backfill shall be placed and compacted evenly on both sides of the pipe, compaction to be by pneumatic rammers or vibratory rollers or may be placed as a hydraulic fill and compacted by poker vibrators. The method adopted shall be subject to the Engineer's approval. Whatever method is adopted and approved, great care shall be exercised at all times to prevent damage to pipe coatings or disturbance of the pipe level or grade by flotation or otherwise. To avoid damage to the pipe coating, wooden shutter board or a similar barrier shall be placed along the edges of the pipe to avoid tamping or compaction of bedding within 50mm from the edges of the pipe.

7.2.4.3 If compaction is by pneumatic rammers or vibratory rollers, compaction shall be in layers not exceeding 150 mm (after compaction), watered to optimum moisture content and compacted to densities as per Clause 7.2.6.

7.2.4.4 The top surface of the completed selected backfill shall be level over the full width and length of the trench. The compacted selected backfill shall completely fill all spaces between the pipe and trench walls, including any cavities that might exist in trench walls.

7.2.4.5 If selected backfill of the required properties is not available for coated steel pipelines, approved non-shielding mesh rock shield having a close fit around the pipe shall be used subject to the Engineer’s approval. The rock-shield shall be nominally 6 mm thick with 50 % open area so as to allow fines and cathodic protection current to pass through. Material complying with clause 3.16.4.2 may be used in conjunction with the rock shield, provided the required degree of compaction is maintained.

7.2.4.6 If selected backfill of the required grading is available, but which exceeds the specified requirements in respect of linear shrinkage, coated steel pipes shall with the approval of the Engineer, be protected with a close fitting blanket of geotextile. Note that many of the pipeline coatings are extremely resistant to soil stress, so this requirement will be dependent on the type of coating used.

7.2.5 Common backfill

7.2.5.1 After completion of backfilling with selected backfill material, the remaining trench depth shall be filled with selected "common soil" originally excavated from the trench and with all rocks or boulders exceeding 150 mm nominal size excluded. The backfill shall be placed in the trench in layers not exceeding 200 mm (after compaction) and each layer shall be compacted sufficiently to a density of at least 87% of the Modified AASHTO maximum dry density, to prevent later settlement. The trench shall be filled to the level to which the topsoil and fertile soil, if applicable, was originally separately removed. The top of the trench shall then be backfilled with fertile soil, if applicable, and compacted to the density as for common backfill and the trench or servitude shall then be completely filled with the topsoil and compacted up to the original ground level. If specified in the Project Specifications the top of the trench may be mounded to 150 mm to provide for settlement, provided natural drainage of the ground is not interfered with.

7.2.5.2 Where backfilling is carried out by mechanical plant such as bulldozers, the method of working shall be subject to the Engineer's approval. Heavy plant and equipment shall not be allowed to travel along the top of the trench or across the trench.

Suitable material for backfill shall be moved from any part of the works where there is a surplus to any part where there is deficiency or shall be imported from borrow areas or commercial sources.

7.2.5.3 As soon as trench backfilling has been completed over any portion of the pipeline all surplus materials and rubbish shall be removed from the site to a dumping site, approved by the Engineer.

Where spoil is to be moved outside the free-haul distance, the Engineer's authority in writing must be obtained.

7.2.5.4 Precautions shall be taken to ensure that the natural drainage of the ground is not interfered with, especially where final backfill is left mounded and all necessary cross drains shall be constructed and agricultural drainage berms and contours reinstated as backfilling progresses. Care shall be taken to prevent erosion of backfill by construction of the necessary diversion banks and drains.

7.2.5.5 The Contractor shall be responsible for settlement of backfill and erosion of the site until the end of the Defects Notification or Liability Period, as applicable, and he shall fill and level any settlement and/or erosion from time to time, as required by the Engineer and at the Contractor's expense.

7.2.6 Compaction

7.2.6.1 Where compaction of bedding material or selected backfill is specified, such compaction shall be to a dry density of at least 90% of the Modified AASHTO maximum dry density. The Contractor shall determine the maximum Modified AASHTO dry density for every type of material used by taking representative samples of bedding materials.

7.2.6.2 The Contractor shall control the field compaction densities with a fully registered nuclear surface moisture-density gauge which is in a proper working order or any other method approved by the Engineer.

This density gauge with operator shall be made available to the Engineer for his use if and when required.

7.2.7 Cleaning of pipeline servitude

7.2.7.1 As soon as possible after the common backfilling has been completed, valve chambers has been constructed, pipes and fittings has been installed and the initial pipe coating integrity survey (applicable to steel pipes) has been completed, the Contractor shall clean the construction servitude of all surplus materials and rubbish and the fertile soil and top soil shall be placed to the original levels. The cleaning of the servitude shall not lag behind the last laid pipe by more than 5 000 metres. Should this happen the Engineer reserves the right to stop the pipe laying operation.

## 8. LAYING AND JOINTING OF PIPES AND SPECIALS

### 8.1 General

8.1.1 Pipelines shall be laid to straight grades between vertical bends and shall be, within the specified tolerances, to the routes and levels indicated on the approved working drawings.

8.1.2 Pipes shall be laid free from cold stresses. No deflections shall be taken in curvature of pipes, but shall be taken with approved prefabricated bends with exceptions as hereinafter specified.

8.1.3 All deflections under 6° of the axis of pipelines with flexible joints may be made by spreading the deflection over not less than 5 number of joints, provided always that the deflection in any one joint does not exceed those recommended by the manufacturer of the joint after allowance for pipe settlement, heave or other ground or pipe movements.

8.1.4 All deflection in the axis of butt welded steel pipelines of 11,25° or less shall be made by scarfing equally the ends of the two pipes to be joined so that the maximum scarf in any one pipe will be 5,63°. Where the total deflection is 3° or less, the scarfing may be made in one pipe end only.
Ends to be scarfed shall be carefully and accurately marked and then either machine cut or machine planed. Hand planing shall not be permitted. After scarfing, the pipe ends shall be re-chamfered as described in clause 5.1.5 of SANS 719. The minimum gap between pipe end root faces before welding shall be 1,5 mm and the maximum gap shall be 3,0 mm. After scarfing all pipe ends shall be thoroughly cleaned before the field weld is carried out.

8.1.5 Except where otherwise provided for, the Contractor shall supply all bolts, nuts, washers, gaskets and other jointing materials for complete installation of pipelines including all specials, fittings, valves, meters etc. The Contractor will be responsible to confirm flange thicknesses at all flanged connections prior to ordering bolts of the correct length.

8.1.6 The tolerances allowable for the installation of pipes and specials shall be the same as those laid down for the manufacture thereof.

8.1.7 Lifting eyes (lugs) provided to fittings and specials during manufacturing, to facilitate handling and to minimize damage to the protective coatings, shall be removed on site after installation of the fitting or special and the pipe linings and coatings shall be made good.

**8.2 Specials**

8.2.1 Fabrication

8.2.1.1 All specials shall be fabricated, lined and coated where applicable, in the pipe suppliers' works with all flanges and openings protected as specified.

8.2.1.2 Except where otherwise approved by the Engineer in writing, the following field welding will be permitted; tie-ins to existing pipelines and the attachment of flanges where the exact position and alignment of same are dependent on site conditions e.g. closure pieces.

8.2.2 Installation

8.2.2.1 Bends

Bends shall be installed true to line, level and deflection and shall be anchored in concrete where required to counteract thrust. Bends shall normally be supplied with "centre planes" marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends in laying.

8.2.2.2 Tees

Tees for air valves shall be installed with branch barrels vertical. Tees for scour valves shall be installed with branch barrels horizontal or at the gradients as indicated on the drawings. Tees for off-takes shall be installed as shown on the drawings.

8.2.2.3 Flanges

All flanges shall be installed with bolt holes off-centre and symmetrically off-set from the vertical centre lines of the flange. Flanges shall be installed truly square to the axis of the pipe.

8.2.2.4 Insulated flanged joints

Insulated joints shall be provided and installed by the Contractor where specified or instructed by the Engineer. The Contractor shall supply all materials, labour and equipment and shall complete and prove that each insulated joint after installation in the pipeline has a resistance well in excess of the resistance to earth of the pipeline on both sides of the insulating joint.

8.2.2.5 Dismantling joints

Dismantling joints shall be installed where indicated on the drawings or instructed by the Engineer. These will normally be provided to facilitate the removal of valves or similar fittings from the pipeline. The Contractor shall supply and install dismantling joints with due regard to their pressure rating and mating flanges.
The hydraulic pressure restraining tie-bolts shall be carefully installed to tie the pipework across the dismantling joint. Dismantling joints shall be watertight.

8.2.2.6 Thrust flanges

Where thrust flanges are to be installed on site as for anchoring pipes on steep slopes etc. these flanges shall be supplied by the Contractor split in two equal segments, undrilled with outer perimeter unmachined.

At the point of installation of the thrust flange the pipe coating shall be stripped of the pipe for a distance of 300 mm. The flange segments shall be double fillet welded to the pipe barrel around the full circumference and also along both sides of the split which shall be chamfered for welding. After welding, the coating and lining of the pipe shall be made good.

8.2.2.7 Temporary closure pipes

Temporary closure pieces of the same standard, diameter and wall thickness as the pipeline shall normally be jointed with flanges and/or flexible couplings, except where otherwise specified or instructed by the Engineer.

8.2.2.8 Access tees

Access tees shall be required where butt welded pipelines are to be lined in-situ with cement mortar. These tees shall be spaced throughout the pipeline in accordance with requirements of lining operations.

8.2.2.9 Minor connections and off-takes

8.2.2.9.1 General

A considerable number of small connections for farms and other minor consumers may be installed during the laying of the pipeline but the position of these will only be fixed on site. Connections of up to 40 mm nominal bore shall be permitted to be installed on site without the use of prefabricated branch tees. Typical assemblies of complete minor off-takes are shown on the drawings and these consist of branches fitted in the pipeline, stop cocks, pressure reducing and relief valves, constant discharge orifices, water meters and strainers and manholes around valves and meters, all in accordance with approved drawings. All off-takes shall terminate at pipeline servitude boundaries.

8.2.2.9.2 Steel pipelines

The Contractor shall strip an area of pipe coating of 600 x 600 mm. A hole of the required size shall then be cut through the pipe wall in the crown of the pipe and in the centre of the stripped area. A 300mm nominal bore off-take tee with flange shall be welded onto the pipe barrel. A standard boss shall be provided on a blank flange and the assembly bolted onto the off-take tee. After removal of welding slag, weld spatter and all foreign matter, the coating and lining shall be made good. The connection shall be off-set from any weld in the pipe barrel.

8.2.2.9.3 Concrete pipelines

Minor off-takes shall be installed in accordance with the drawings and as generally specified in clause 8.2.2.9, except that actual tapping of the pipeline shall be by means of saddle pieces on the concrete pipes or by tapping steel specials in accordance with clause 8.2.2.9.2 or by such other method as recommended or provided for by the supplier of the pipes.

**8.3 Installation of valves and meters**

8.3.1 The mass of valves or meters shall at no time be carried by the pipe, the flange or the coupling and valve chamber floors shall preferably be cast complete with valve stools and supports immediately after the installation of valves and meters.
Stools shall not be permitted to carry the mass of a valve until at least 7 days after casting the concrete. Alternatively, prefabrication and welding of pipe and valve supports shall comply with the requirements of SANS 15614 and shall be fabricated to the Engineer's approval. Supports shall be welded to pipe only where specified and linings and coatings of pipes and specials shall be made good after welding.

8.3.2 Valves and meters requiring special adjustment after installation shall be adjusted and commissioned by the respective suppliers or agents after installation.

8.3.3 Butterfly valves shall be installed with the blade seal retaining ring facing upstream.

**8.4 Field welding**

8.4.1 All field welding shall only be done by welders who satisfy the requirements of API 1104 and who have been tested at the Contractor's expense by an independent testing authority.

8.4.2 Before any welding of pipeline materials commences, the qualification of welders shall have been approved, all detailed welding procedure specifications with weld diagrams required for their completion shall have been submitted for approval in a neat form, and the welding procedure qualification tests shall have been successfully concluded all in accordance with the relevant standard specifications.

Sufficient records shall be kept by the Contractor to ensure that all field welds can be subsequently identified with the welder concerned.

8.4.3 No welding shall be carried out during rain or high wind or under dusty conditions unless the welder, the weld area and the weld are adequately protected and sheltered.

8.4.4 Only welding rods which have been kept dry and uncontaminated shall be used.

8.4.5 Welding rods shall be of a grade and quality such that the chemical composition of weld metal and parent metal is similar.

**8.5 Steel pipelines**

8.5.1 <u>General</u>

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

8.5.2 <u>Butt welded pipelines</u>

8.5.2.1 Pipes and specials to be joined by field welding shall be supplied with ends bevelled for welding.

8.5.2.2 Field welding of joints shall conform to API 1104.

8.5.2.3 Before welding of joints proceeds, pipe ends shall be completely circular and properly mated up by means of backing rings.
At least 4 tack welds equally spaced around the pipe perimeter shall be applied to maintain the root gap and position of the pipe for completion of welding. A protective plastic or rubber sheet shall furthermore be placed over the coating adjacent to the joints to protect same from damage caused by welding spatter.

8.5.2.4 Root welds shall thereafter be carried out followed by successive filler passes, and capper passes, all in accordance with the approved welding procedure. Wherever it is possible to have entry into a pipe, inside welds shall be applied first. The inner weld bead shall not extend more than 1 mm into the bore of a pipe or special.

8.5.2.5 Horizontal weld seams or spiral weld seams at pipe ends shall be placed near the horizontal diameter of the pipe or special and shall be staggered so that the circumferential distance between longitudinal or spiral welds intersecting the same circumferential butt weld, is not less than 90 mm nor more than 130 mm apart.

8.5.2.6 Defects caused by stray welding arc flashes, weld spatter etc. shall be removed by grinding provided that pipe wall thicknesses are not reduced to less than the specified minimum thicknesses, otherwise the portion containing the defect shall be cut out and repaired.

8.5.2.7 During welding of pipes with organic linings, mats of thick rubber felt or other suitable material shall be placed along the pipe invert to protect the pipe lining for the full distance from the point of access up to the point of weld or weld inspection. The mats shall be of sufficient width and shall cover a sufficiently wide area of pipe invert to protect the lining against damage due to access by staff, equipment and inspectors or fall out from arc weld. Workmen shall wear soft rubber soled shoes before entering lined pipes.

8.5.2.8 Care shall be taken not to stroke arcs on epoxy lined areas and protective tapes, if any, at ends of epoxy lined pipes shall only be removed immediately prior to welding.

8.5.2.9 Pipes may be welded together alongside the edge of the trench. For factory lined and coated pipes, the maximum length so welded together shall be such that:

(a) The pipe can be subsequently stored, lifted or handled without damage to linings or coatings.

(b) The out of roundness at a plane perpendicular to the pipe axis at any point along the pipe length during storage, lifting or handling does not exceed 4% of the minimum inside diameter. Out of roundness being measured as the difference between the minimum and maximum inside diameter of the plane at the point.

(c) Safe and easy access to internal tie-in welds are assured for staff and inspectorate with equipment.

(d) The maximum length does not exceed 36 metres.

8.5.2.10 Snaking into the trench of butt welded sections of pipe shall be permissible for bare steel pipes, subject to approval by the Engineer of a complete and comprehensive method statement submitted by the Contractor and provided that the out of roundness as defined and measured above during any stage of the snaking operation, does not exceed 4% of minimum internal diameter.

8.5.2.11 The linings and coatings of pre-lined and coated pipes jointed together outside the trench shall be made good at these joints outside the trench.

8.5.3 Pipelines with flexible couplings

8.5.3.1 Joints by flexible couplings shall be made only in their final laid position. Before assembling the joint, care shall be taken to ensure that pipe ends are clean and free from burrs and ridges. Such burrs and ridges shall be removed if present and linings and/or coatings made good where damaged. Pipe ends shall be mated carefully before joints are

made. Pipe ends shall be concentric and perfectly lined up and the coupling shall not be relied upon to line up or to support the pipe.

8.5.3.2 Joints shall be made and couplings assembled to the manufacturer's instructions. Bolts shall be placed with bolt heads alternately pointing in opposite directions.

8.5.3.3 Two-thirds of the number of coupling bolts, equally spaced, shall first be partially tightened up in a regular sequence, using a short spanner. The remaining bolts shall then be similarly tightened. After checking the coupling alignment, the bolts shall then be finally tightened evenly and in a regular sequence by means of a torque wrench.

8.5.3.4 Where couplings without central registers are used, precautions shall be taken to ensure that the pipe ends are apart by the same distance as if a coupling with central register had been used and the couplings shall carefully be centred over the pipe ends.

8.5.4 Flanged joints

8.5.4.1 Flanges shall be truly parallel with all bolts evenly firm before being finally drawn up with torque wrenches to watertightness. Taper gauges shall be used to check that there is a uniform gap before and after final tightening up of bolts. Bolts shall be tightened in an approved sequence with bolts equally spaced and at opposite ends tightened equally first.

8.5.4.2 The Contractor shall ensure that the correct jointing materials, i.e. gaskets, bolts and nuts are available when required. Only correct diameter and lengths of bolts and studs shall be used. Flat washers shall be used under all bolts and nuts. The length of bolts and studs shall be such that at least two threads protrude from the nut when fully tightened. The threads of bolts, studs and nuts shall be thoroughly cleaned and then coated with a graphite/grease compound immediately prior to assembly.

8.5.4.3 Flanged fittings shall be so installed that there are no stresses induced into the pipework, specials or fittings by forcing ill-fitting units into position or by bolting up flanges with faces not uniformly in contact with their gaskets over their whole faces.

## 8.6 Concrete pipelines

8.6.1 Reinforced or prestressed concrete pipes shall be jointed strictly in accordance with the manufacturer's instructions.

8.6.2 Where rubber joint sealing gaskets are used in flexible joints, these gaskets shall be installed free from loops and twist shall be evenly compressed around the joint perimeter. The gaskets shall be in their designed position and the Contractor shall use feeler gauges inserted from the outside of sockets to prove the correct position of gaskets after completion of each and every joint.

8.6.3 Pipes shall be pushed fully "home" at joints with provision of the gap between pipe ends as recommended by the pipe manufacturer. Particular attention shall be paid to obtaining a smooth continuous bore throughout the pipeline, without steps between adjacent pipes.

8.6.4 In the case of weld-jointed cylinder type prestressed concrete pipes, repairs to lining and coatings at welds shall be reinforced by 100 mm x 50 mm mesh of 2,5 mm diameter, steel wire tack welded to bare end rings in such a way that the mesh is not in contact with end rings except at tack welds.

## 8.7 Maintenance of cleanliness during laying

8.7.1 The interior of pipes shall be perfectly clean before being laid and the Engineer may instruct pipe interiors to be cleaned or washed before the pipes are lowered into the trench. All brushes, trowels, welding rod stumps, pieces of mortar, dust and all foreign matter shall be removed from pipes immediately after laying. Once a section of pipeline has been cleaned, it shall be sealed off and shall not be entered again unless permitted by the Engineer in writing.

8.7.2 The Contractor shall at his own expense make good any damage to valves and fitting or clogging of off-takes or mal-functioning of fittings which result from his failure to keep the pipeline in a thoroughly clean condition.

**8.8 Night-caps**

8.8.1 Metal night-caps shall be used to close off all ends of each laid section of pipework when work is stopped at the end of the day or for longer periods and shall be left on the ends of sections of completed pipework until such sections are tied-in with the remainder of the completed pipeline.
The night-caps shall consist of a steel plate welded into a half coupling which must be provided with a sufficient number of lugs to secure the ring and gasket and shall be strong enough to withstand external water and earth pressure in the event of flooding or collapse of earth and the joint shall be watertight.

8.8.2 The Contractor shall also, at his own expense blank-off all air valves, scour valves and off-takes with 6 mm thick blank flanges which shall be bolted with at least four bolts to tee flanges or shall be fixed to plain ended tee branches by half couplings welded to the blank flanges. These shall be watertight and shall not be removed until the valves or other fittings are about to be fitted.

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

**8.9 Prevention of flotation**

8.9.1 Pipes to be encased in concrete shall be prevented from flotation during concreting operations. Apart from this special case during concreting operations, the Contractor shall prevent the flotation of pipework due to stormwater or groundwater entering the trench before backfilling has been completed.

8.9.2 Methods adopted to prevent flotation shall not damage coatings or linings and shall be approved by the Engineer. Notwithstanding this the Contractor shall at his own expense repair all damage to pipework caused by flotation and/or by the methods adopted to prevent it.

**9. REPAIRS TO LININGS, COATINGS AND PROTECTION OF JOINTS**

**9.1 General**

9.1.1 All damaged linings and coatings of pipes, specials and fittings shall be made good in accordance with "Department of Water Affairs and Forestry" Standard Specification DWS 9900, Section C1 and the particular specifications and to the satisfaction of the Engineer before, during and after installation in the trench, provided always that damage, which, in the opinion of the Engineer is extensive, might subject such pipe, special or fitting to rejection.

9.1.2 The materials used for the repairs to linings and coatings shall be in accordance with "Department of Water Affairs and Forestry" Standard Specification DWS 9900, Section C1 and the particular specifications unless otherwise approved by the Engineer in writing.

9.1.3 The linings and coatings of butt welded steel pipes shall be made continuous over joints as soon as possible after approval and acceptance by the Engineer of the welded joint. At no time shall lining and coating repairs/remedial work lag more than 200 metres behind the last pipe laid.

9.1.4 Flexible couplings shall be provided with external protection as soon as the pipeline has been hydrostatically tested and electrically bonded, where applicable.

## 10. CROSSING OF ROADS, RAILWAYS AND STREAMS

### 10.1 General

10.1.1 The Employer shall obtain permission for the crossing of roads and railways from the responsible authorities. All conditions and requirements imposed and/or prescribed by the authorities concerned shall be conveyed to the Contractor who shall be responsible for meeting all such conditions and requirements in carrying out the crossings.

10.1.2 All crossings shall be constructed strictly in accordance with approved drawings.

## 10.2 Road crossings

10.2.1 Crossings of National, Provincial, District, Divisional, Special roads (hereinafter called major roads) or such other roads as authorities might dictate, shall be made in flanged or butt welded steel pipes within a steel or reinforced concrete sleeve or a reinforced concrete culvert. Steel pipes to extend over the full width of the road reserve.

10.2.2 Crossing of farm roads, unnumbered public roads, school roads, minor roads shall, except where otherwise dictated by authorities, be made by maintaining a one thousand (1 000) mm minimum compacted cover over the crown of the pipe at any point along the pipe centreline for the full width of the carriageway plus shoulders. The Engineer might instruct a 150 mm minimum thickness concrete surround to be placed around the pipe along any length of pipeline at such crossings.

10.2.3 Steel sleeve pipes shall have a 12 mm minimum wall thickness, be lined with a bitumen prime coat and shall be armour coated. Wherever possible reinforced concrete sleeve pipes shall be installed by pushboring underneath carriageways unless otherwise specified. Jacking of reinforced concrete sleeve pipes shall conform to the requirements of section “LG” of SANS 1200 as amended.

10.2.4 Steel pipes at major road crossings shall have:

10.2.4.1 Wall thicknesses increased by at least 20% above the required structural thickness or shall be equal to the specified minimum thickness for the size of pipe whichever is the greater. The required structural thickness shall be that pipe wall thickness which shall limit steel stresses to a maximum of 60% of the minimum yield stress of the steel when the pipe is subjected to design pressure. The pipe of increased wall thickness shall extend for the full width of the road reserve.

10.2.4.2 Coatings in accordance with "Department of Water Affairs and Forestry" Standard Specification DWS 9900, Section C1 and the particular specifications for the length of sleeves or culverts plus a distance of 1 m on each side of the sleeve or culvert.

10.2.4.3 All field applied butt welds falling within reserves 100% radiographically inspected.

10.2.4.4 All flanged joints moulded as per specification.

10.2.5 Backfilling and reinstatement of road surfaces shall be to the requirements of the Roads Authority. Should the Roads Authority prefer to carry out reinstatement of surfaces by direct labour or otherwise, the Contractor shall pay all charges in connection therewith.

10.2.6 Where no method of reinstatement is provided on the drawings or specified/requested by the Roads Authority, the following shall apply:

Backfilling around and over sleeves or culverts shall be placed in layers not exceeding 150 mm, measured after compaction, using a selected sandy material. Each layer shall be compacted to a dry density not less than 90% Modified AASHTO before succeeding layers are placed.
For surfaced roads, backfilling shall proceed to the underside of the sub-base level when 150 mm of approved sub-base gravel shall be placed and compacted to a density of at least 95% Modified AASHTO. On top of the sub-base layer, a 200 mm layer of crushed stone base course consisting of material passing a 40 mm square screen and mixed with an approved binder shall be compacted in two, 100 mm layers, each layer to be dampened and thoroughly compacted before placing the succeeding layer. The top layer shall be swept with a hard broom to remove all laitance from stone surfaces but without under pinning the individual crushed stone particles. The upper surface shall then be covered with a light application of primer or emulsion before placing a 32 mm to 40 mm bituminous premix wearing course which should be rolled to a solid layer.

10.2.7 All underground telephone cables or overhead telephone lines within or adjacent to road reserves shall be properly supported and protected against damage during all phases of construction.

**10.3 Rail crossings**

10.3.1 Crossings of railway tracks shall be made by butt welded or flanged steel pipes within a steel or reinforced concrete sleeve or reinforced concrete culvert, all in accordance with approved drawings and the SANS 15589 Part 1. Steel pipes shall extend over the full width of the rail reserve.

10.3.2 Steel sleeve pipes shall have a 12 mm minimum wall thickness, be lined with a bitumen prime coat and shall be armour coated. Wherever possible reinforced concrete sleeve pipes shall be installed by pushboring underneath railway tracks unless otherwise specified. Jacking of reinforced concrete sleeve pipes shall conform to the requirements of section “LG” of SANS 1200 as amended.

10.3.3 Steel pipes at railway crossings shall have:

10.3.3.1 Wall thicknesses increased by at least 20% above the required structural thickness or shall be equal to the specified minimum wall thickness for the size of pipe, whichever is the greater. Required structural thickness shall be that pipe wall thickness which shall limit steel stresses to a maximum of 60% of the minimum yield stress of the steel when the pipe is subjected to design pressure. The pipe of increased wall thickness shall extend for the full width of the rail reserve.

10.3.3.2 Coatings in accordance with "Department of Water Affairs and Forestry" Standard Specification DWS 9900, Section C1 and the particular specifications for the length of sleeves or culverts plus a distance of 1 m on each side of the sleeve or culvert.

10.3.3.3 All field applied butt welds falling within reserves 100% radiographically inspected.

10.3.3.4 All flanged joints moulded as per specification.

10.3.4 Before any work within rail reserves is undertaken the Contractor shall at his own expense arrange with TRANSNET for the provision, installation and removal on completion of temporary support work for the tracks, in the form of birdcaging or otherwise.

10.3.5 All work within rail reserves shall be performed and completed with the least possible delay and with the closest co-operation at all times with TRANSNET and the Engineer.

10.3.6 Backfilling and reinstatement of surfaces shall be to the requirements of TRANSNET. Should TRANSNET prefer to reinstate ballast by direct labour or otherwise the Contractor shall pay all charges in connection therewith.

10.3.7 Where no method of reinstatement of surfaces is specifically specified or requested by TRANSNET, the following shall apply:

Backfilling around and over sleeves or culverts shall be placed in layers not exceeding 150 mm (after compaction), using a selected sandy material. Each layer shall be dampened to optimum moisture content and be compacted to a dry density not less than 90% Modified AASHTO.

10.3.8 All underground, aboveground or overhead cables, telephone lines or signalling cables or wires within or adjacent to rail reserves shall be properly supported and protected against damage during all stages of construction.

**10.4 Stream crossings**

10.4.1 Stream crossings comprise all crossings of defined water courses in which water flows or might flow as a result of surface run-off or otherwise.

10.4.2 Stream crossings shall be constructed in steel pipe encased in reinforced concrete to 3 metres horizontal beyond the water course bank, all in accordance with approved drawings.

10.4.3 Steel pipes at stream crossings shall have:

10.4.3.1 Wall thicknesses increased by at least 20% above the required structural thickness or shall be equal to the specified minimum wall thickness for the size of pipe, whichever is the greater. The structural wall thickness required shall be that pipe wall thickness which shall limit steel stresses to a maximum of 60% of the minimum yield stress of the steel when the pipe is subjected to design pressure. The pipe of increased wall thickness shall extend for the full length of concrete encased zones plus 2 m on both sides.

10.4.3.2 Coatings in accordance with "Department of Water Affairs and Forestry" Standard Specification DWS 9900, Section C1 and the particular specifications or as indicated on the drawings or in the Bill or Schedule of Quantities whenever encased in concrete.

10.4.3.3 All field applied butt welds within concrete encasements 100% radiographically inspected.

10.4.4 The top surfaces of concrete encasements or adjacent pipes shall not protrude above natural bed level of streams, nor shall it in any way interfere with water flow or be the cause of bed erosion.

10.4.5 The Contractor shall be responsible for diversion of flow, if any, over or away from the trench and shall dewater the trench immediately before pipe laying and keep it dewatered until completion of backfilling. He shall be responsible for and shall repair at his own expense, foundations, structures or other parts of the Works caused by flooding due to failure of any part of the diversion or protective works or due to any other cause.

10.4.6 The Contractor shall remove cofferdams, other protective works and surplus spoil immediately after having served its purpose and shall reinstate the site to its original condition. Flooding of adjacent land, bed erosion or changes in location of water courses due to the Contractor's failure to comply with this clause shall be made good at his own expense.

## 11. CATHODIC PROTECTION AND ALTERNATING CURRENT (AC) MITIGATION

### 11.1 General

11.1.1 The cathodic protection of pipelines shall generally be carried out in accordance with the relevant particular specifications.

11.1.2 Steel pipelines should be made electrically continuous by ensuring that bonding cables are installed across all flanged or flexible joints and around isolating valves inside the chambers, all in accordance with the specification and the drawings.

11.1.3 Alternating current (AC) voltage induced into pipelines laid in parallel to overhead high voltage power lines or that intersects high voltage power lines shall be mitigated as laid out in the relevant particular specifications.

### 11.2 Inspection of Insulating Joints

11.2.1 After installation, the insulating joints must be inspected to ensure their compliance with the specifications and drawings and to test their efficiency for satisfactory electrical insulation. The inspection shall be witnessed by the Engineer, Designer of the cathodic protection installation and Contractor.

### 11.3 Current drainage

11.3.1 Pipe coating integrity testing shall be carried out as specified in the Project and Particular specifications and these tests shall commence as soon as possible after installation of sections of the pipeline and after installation of the total pipeline.

The pipeline itself must be electrically continuous and other civil structures electrically insulated from pump stations, off-takes etc. by means of insulating flange kits, etc. The pipeline should not be bonded to Foreign Service pipelines unless designed accordingly.

## 12. HYDROSTATIC TESTING

### 12.1 General

12.1.1 Pipelines shall be hydrostatically tested as pipelaying proceeds and after installation of all valves, specials and fittings.

12.1.2 The Contractor shall be responsible for providing all water required for testing, the source of which shall be subject to approval by the Engineer.

12.1.3 The length of pipeline to be tested in one operation shall be as approved by the Engineer.

12.1.4 Where the method of test is in any way in variance to this specification, the Contractor shall submit a detailed method statement to the Engineer and no test shall proceed before approval of such method statement by the Engineer.

### 12.2 Test pressures

12.2.1 Test pressures shall be as indicated on the drawings. Test pressures shall generally be 1,25 times the pipeline design pressure for design pressures up to and including 3,2 MPa and 1,1 times the design pressure for higher pressures. Design pressure shall be taken as the maximum pressure to which pipelines might be subjected under all conditions of operation and shall include allowance for transient pressures.

12.2.2 Test pressures over any length or section of pipeline under test, taking possible differences in elevation along the pipeline into account, shall be such that the test pressure at any point along the section is not less than 1.1 times nor greater than 1,40 times the design pressure at these points.

### 12.3 Leakage rates

12.3.1 Leakage of a pipeline under test, taken as the aggregate quantity of water added over a 24 hour period to reinstate required test pressure, shall not exceed quantities equivalent to the following:

12.3.1.1 Prestressed and reinforced concrete pipelines - 1/3 000 of the volume of water in the section under test.

12.3.1.2 Steel pipelines with flexible joints - 1/3 500 of the volume of water in the section under test.

12.3.1.3 Steel pipelines with welded joints - 1/4 000 of the volume of water in the section under test.

12.3.2 The leakage rate at any one joint in the section under test shall not exceed the following:

Q = Allowable leakage in 24 h of pipeline under test in litres/20N
Where Q = Leakage rate in litres/hour
N = Number of joints in section under test

**12.4 State of valves during test**

12.4.1 The state of valves during the test shall be as follows:

12.4.1.1 In-line isolating valves open, except where used to isolate a test length.

12.4.1.2 Scour isolating valves closed except as specified in 12.4.1.4.

12.4.1.3 Off-take isolating valves closed.

12.4.1.4 Where two scour valves are provided in series at scour valve chambers the downstream scour valves open.

12.4.1.5 Air valve isolating valves open.

12.4.1.6 By-pass isolating valves to in-line isolating valves and non-return valves closed.

12.4.2 The Contractor shall be permitted to test against a closed in-line isolating valve. He should bear in mind however that valve gates and seals are not expected to close drop tight at differential pressures exceeding the design pressure of the valve. Design pressures of valves shall be equivalent to a pipelines field test pressure. No relaxation of specified leakage rates shall be permitted due to leaks past gates, blades or seals of isolating valves.

**12.5 Method of testing**

12.5.1 The Contractor shall provide an approved test pump, an accurate water meter, sealed pressure gauge and autographic pressure recorder, tested and certified by an independent testing organisation, and all other equipment, materials and labour required for the test.

12.5.2 The section of pipeline to be tested shall be clean and closed off at the ends by isolating valves, end caps or approved end-closure pieces. Free ends shall be firmly strutted against solid supports or thrust blocks designed to withstand safely 2 times the calculated end thrust under maximum test pressure. It shall be incumbent on the Contractor to establish the need for blank flanges or isolating valve flanges in order to limit leakage rates past gates, blades and seals.

12.5.3 Testing water may be introduced at any air valve within the portion of the pipeline under test. A test manifold shall be placed between the selected air valve and its isolating valve. The manifold shall be provided with three branches, each fitted with drop-tight valves. The main branch shall be sized to suit the Contractor's test pump connection. The two smaller branches shall not be less than 12 mm nominal bore fitted with heavy duty needle valves and reducers to suit pressure gauge connections. A pressure gauge and an autographic pressure gauge respectively shall be connected to each of the smaller branches. A water meter carrying a valid calibration certificate shall be installed between the pump and test manifold. The Contractor shall accurately determine the reduced level at the autographic pressure gauges and enter this level on the recorder chart. The Contractor shall also enter the reduced level of the highest and lowest invert of the section under test on the recorder chart.

12.5.4 The section of pipeline to be tested shall be slowly filled with clean water of quality to the Engineer's approval, great care being exercised to remove all air from the pipeline. The section of pipeline under test shall be completely filled with water and kept full for not less than 7 days in the case of prestressed and concrete pipelines, not less than 3 days in the case of steel pipelines with concrete linings and not less than 1 hour in the case of unlined steel pipelines or steel pipelines with linings other than concrete.

12.5.5 During this initial filling stage, the pipeline joints and all specials, fittings and valves shall be visually inspected for visible leaks and same rectified before proceeding with the test.

12.5.6 After the specified absorption period and with the pipeline full of water, the autographic recorder shall be put into operation at least 15 minutes before pressurisation of the pipeline commences. Water shall be added until the required test pressure is reached whereupon the valve on the test manifold shall be closed and sealed. The reading on the water meter shall be recorded.

12.5.7 The pressure shall be maintained for one hour and if a pressure drop occurs, more water shall be added to reinstate the test pressure and the valve closed again. The quantity of water added shall be measured by recording the readings before and after pumping.
This procedure shall be repeated for a period of 24 hours, with water added at hourly intervals where necessary to reinstate pressure and water meter readings recorded. At the end of the 24 hours period, the aggregate quantity of water required to reinstate pressure over 24 hours shall be determined.

12.5.8 The Contractor shall give the Engineer 48 hours written notice of his intention to commence pressure testing and the Engineer may attend and supervise all or any part of tests. All records, recording charts and the attached duly completed hydrostatic test certificate shall be handed to the Engineer as soon as tests over any section have been completed.

12.5.9 All valves, specials, fittings and exposed joints, shall be inspected visually during the 24 hours pipeline test and all visible signs of leaks, sweating and distress shall be reported and attended to without delay.

12.5.10 Immediately after completion of the prescribed 24 hours hydrostatic test, all air valves shall be tested in turn before test pressure in the pipeline is released. Each air valve shall be isolated and the drain plug removed. The air valve balls or floats and any actuating linkage shall work freely without restraint. The isolating valve shall be checked for leakage before replacing the plug. Finally, the automatic resealing of the air valves shall be checked by re-opening the isolating valve.

12.5.11 After completion of tests on air valves, the section of pipeline under test shall be completely refilled with water, if necessary, and pressurised to static head shown on the drawings. Each scour valve shall be checked by opening isolating valves and sleeve valves where applicable for a duration sufficient to check the complete opening and closing cycles. If necessary, the pipeline shall be refilled after each individual test and re-pressurised to static pipeline head in order to test all scours within the section under test.

**12.6 Remedial measures**

12.6.1 Should the maximum leakage limits as specified be exceeded, the Contractor shall determine the position and cause of the leaks and shall take remedial measures at his own expense and to the satisfaction of the Engineer to stop such leaks and ensure the specified degree of water tightness. Under no circumstances shall peening be permitted as a means for stopping leaks, nor shall the pipeline be allowed to remain under extended period of pressure to allow self sealing with or without sealing aids in the test water. Any leakages from valves not supplied under this contract and which cannot be easily stopped by gland adjustment will be the responsibility of the valve supplier. The Contractor shall in the case of latter event occurring provide and install blank flanges to seal off leaks and to allow testing operations to proceed or to be speeded-up. The supply and installation of these blank flanges shall be covered by a variation to the contract at the rates indicated in the Bill or Schedule of Quantities.

12.6.2 If during the Defect Notification or Liability Period, as applicable, the number of leaks and other defects is considered by the Engineer to be more than could reasonably be expected from a well laid pipeline operating under normal conditions, he may order the Contractor to re-test parts or the whole of the pipeline at the Contractor's own expense and no claims for escalation in costs or for whatever other reasons the Contractor might consider to submit claims shall be considered, except where such re-tests are the result from damages caused to the pipeline by the Employer.

## 13. STERILIZATION

13.1 All pipelines for the conveyance of potable water shall be sterilized.

13.2 As soon as the whole pipeline has passed a hydrostatic test, test water shall be scoured to ensure a flushing velocity of not less than 1 m/sec over the entire length of the pipeline.

13.3 Potable water treated with sodium hypochloride or calcium hypochloride or chlorine gas to a chlorine concentration of not less than 5 mg/l free available chlorine, shall be introduced into the pipeline or section of pipeline to be sterilized. On completion of filling with chlorinated water the chlorine concentration in water sampled at any point along the section of pipeline filled, shall not be less than 3 mg/l free available chlorine.

13.4 In determining chlorine concentrations the Contractor shall satisfy the Engineer that the method adopted does measure free available chlorine concentration and not total chlorine residuals, the latter being the easier to determine by means of simple comparators.

13.5 Chlorinated water shall be retained for at least 2 hours during which all air valves, in-line isolating valves, by-pass valves, branch isolating valves and scours shall be operated in order to expose all interior surfaces of these appurtenances to the chlorinated water.

13.6 After 2 hours retention of chlorinated water in the pipeline, samples drawn at any point along the pipeline shall contain not less than 0,5 mg/l free residual chlorine. Where necessary, additional chlorine shall be injected to maintain chlorine residuals, provided always that the 2 hours minimum retention time with water containing an initial free chlorine residual of at least 3 mg/l and a final free residual of not less than 0,5 mg/l is maintained.

13.7 On completion of sterilization of any section of pipeline, the water in that section may be retained or may be passed along the pipeline to other sections to be sterilized.

13.8 Provided cleanliness of pipelines has been maintained during transport, storage and laying and provided furthermore that testing water is of potable quality, the Engineer may allow the introduction of chlorine gas or compounds into water during hydrostatic testing of pipelines. Should in these instances entry into the pipeline be necessary at any stage to repair leaks or shall the interior surfaces of any pipe, fitting, valve or similar appurtenance be touched by humans, equipment etc, portions so affected shall be re-sterilized.

13.9 Provided the pH of water used for the sterilization of pipelines can be proved to be less than 7,5 before introduction of chlorine, the retention period of chlorinated water in the pipeline may be reduced from 2 hours minimum to half hour minimum.

## 14. DRAINAGE OF PIPELINE

14.1 Standing water in a pipeline can lead to anaerobic conditions where sulphate reducing bacteria can cause corrosion. After a pipeline has been hydrostatically tested and sterilized, if required, it shall be completely drained of all water, including pumping out of all low laying areas such as at scours, etc. Sections that will not need refilling for testing or sterilization should be drained sooner. This will generally apply unless otherwise instructed by the Engineer.

## 15. MISCELLANEOUS CONSTRUCTION WORKS AND WORKMANSHIP

### 15.1 Fencing

15.1.1 Temporary fences

15.1.1.1 Temporary fences shall be stockproof.

15.1.1.2 Where used to fence off the construction area across properties or camps protected by vermin-proof fencing, "jackal proof" netting wire shall be provided.

15.1.1.3 The minimum standard shall be seven strands of 2,5 mm thick galvanised wire spaced as per SANS 280 (type B) and the drawings.

15.1.1.4 The Contractor shall supply, install and maintain temporary gates of the standard as specified hereunder at such points as instructed by the Engineer for access across the temporarily fenced off construction area or to parts of properties severed by temporary fences.

15.1.2 Permanent stock-proof fences

15.1.2.1 Plain stock fencing shall be 1,2 metre high and shall have at least 7 strands of double barbed, 2,5 mm thick galvanised wire or single barbed, 2,95 mm thick galvanised wire. Spacing of wire strands shall be in accordance with the general practice for fencing in the particular area.

15.1.2.2 Fencing standards at least 1,8 metre long either of 3 kg/m iron I-section, 2.5 kg/m Y-section or creosote impregnated hardwood of 70 to 100 mm minimum diameter shall be erected vertically and be spaced at 12 metre intervals with at least 2 droppers of length minimum 75 mm more than fence height, between standards.

15.1.2.3 Droppers shall either be ridged T-section iron droppers or creosote impregnated hardwood of 30 mm minimum diameter or twisted galvanised wire droppers of double 4 mm thick wire.

15.1.2.4 At each change of direction and at intervals not exceeding 400 metres on straights, straining or corner posts shall be provided. Straining or corner posts shall be 2,1 metres long, buried to a depth of at least 750 mm into the ground and properly stayed in the direction of direct pull of the wire. Backfilling in all post holes shall be thoroughly consolidated to give adequate support. Where necessary or instructed by the Engineer, straining or corner posts shall be concreted-in. Straining and/or corner posts shall either be rail section of 10 kg/m mass or steel tubing of 100 mm minimum nominal bore or creosote impregnated hardwood of 150 mm minimum diameter. Each steel post shall have a base plate of size at least 230 x 230 x 5 mm and in the case of tubular posts, a pressed steel or cast iron cap at the top.

15.1.2.5 Materials for posts, struts, droppers etc shall suit climatic and soil conditions and the Contractor shall be guided in his choice of materials by existing fencing practices in the area concerned.

15.1.2.6 Steel and iron straining posts and struts shall be given one coat of bitumen based aluminium paint after erection.

15.1.3 Permanent vermin-proof fencing

Vermin-proof fencing shall be constructed as for plain stock fencing with at least 3 supporting strands of 2,8 mm thick high strain steel wire, +1 metre high covered with 75 m x 1,8 mm thick "jackal proof" netting wire. A further single strand of double barbed 2,5 mm thick galvanised wire shall be placed +200 mm above the netted area. Netting wire shall be placed so as to prevent vermin from creeping under.

15.1.4 Gates

15.1.4.1 Gates shall be single leaf approximately 4 300 mm opening and 1 200 mm high. They shall be of welded tubular construction braced diagonally in both directions. The gates shall be of approved design but in any case the frame shall be of medium quality galvanised tubing of 40 mm minimum bore and the braces shall be of galvanised tubing of 20 mm minimum bore. All welds shall be thoroughly cleaned and wire brushed and treated with an approved cold galvanising solution.

15.1.4.2 Frames shall be covered with horizontal galvanised wires at 220 mm centres where gates are to be installed in stockproof fences. Gates for installation in vermin-proof fences shall be covered with galvanised 50 mm diamond wire mesh of 2,50 mm thick wire.

15.1.4.3 All gates shall be hung horizontally in an approved manner on boxed stays consisting of pairs of cross braced and strutted 10 kg/m iron rails or creosote impregnated hardwood of 150 mm minimum diameter, all posts firmly concreted in. Boxed stays shall be provided on both sides of the gate.

15.1.4.4 All gates shall be placed in line with existing fences.

15.1.4.5 Gates, and all posts, stays and struts shall be given one coat of bitumen based aluminium paint after erection.

15.1.4.6 All gates shall be provided with the galvanised locking chain welded to the gate post.

**15.2 Concrete work**

15.2.1 General

15.2.1.1 All concrete work shall be finished to the lines, levels, slopes and outlines shown on the drawings or as otherwise directed.

15.2.1.2 All exposed concrete surfaces shall be finished such that surface irregularities shall not exceed a tolerance of + 8 mm and shall be rubbed down with a carborundum stone to present a surface of even colour and a smooth and pleasing appearance. All exposed edges shall be chamfered by 40 mm chamfers fixed to shuttering. Unless otherwise specified all floors shall have a wood-float finish.

15.2.1.3 Surfaces shall be free from honeycombing and excrescences. Honeycombing to the extent that in the opinion of the Engineer the strength of the structure is impaired or the reinforcement is subject to corrosion or lack of bond, shall be removed and replaced with approved concrete or repair compound at the Contractor's expense within 72 hours of the concrete originally being placed.

15.2.1.4 The minimum concrete cover to reinforcement of concrete surfaces permanently in contact with ground shall be 50 mm and for all other surfaces shall be 40 mm.

15.2.1.5 All precast units shall be steel-trowelled on upper surfaces to present a dense, homogenous surface.

15.2.1.6 Slight spalling of top edges of manholes to be covered by precast or cast-in-situ cover slabs shall be permitted, provided the maximum dimension of the spall measured along any face shall not exceed 25 mm and provided further that no reinforcement is exposed. The maximum permissible difference in any of the two measurements taken to opposite corners diagonally across rectangular or square structures shall not exceed 2½% of that measurement calculated from the drawing. The tolerance in thickness of walls or cover slabs shall be +15 mm.

15.2.2 Thrust blocks

15.2.2.1 Before any thrust block is cast, the pipe special or fitting shall be supported and secured in its correct alignment and shall be jointed to the adjacent pipework.

15.2.2.2 The width of any thrust block shall be limited to 1 500 mm either side of pipe or special centre line to ensure space for future pipelines in the same servitude. Concrete faces of thrust blocks shall be a minimum of 225 mm from flanges and 300 mm from flexible coupling centres. The bearing face of thrust blocks shall be cast against undisturbed soil or rock.

15.2.3 Valve chambers

15.2.3.1 Chambers for isolating valves, air valves, scour valves, meters, access manholes etc shall be constructed in accordance with approved drawings.

15.2.3.2 Care shall be taken that the elevation of air bricks and tops is such that no ingress of surface run-off or ground water into chambers can occur.

15.2.4 Encased pipework

15.2.4.1 Where steel pipes and/or specials are permanently encased in concrete, e.g. in thrust blocks, walls of concrete valve chambers, stream crossings, etc, the coating over the portion to be so encased shall be as specified in "Department of Water Affairs and Forestry" Standard Specification DWS 9900, Section C1 and the particular specifications.

15.2.4.2 Whenever it is necessary to encase concrete pipes in concrete, the flexible joints shall not be encased and the concrete shall terminate 300 mm from the flexible joint.

**15.3 Brickwork**

15.3.1 Brickwork is to be built to the dimensions, thicknesses and heights as shown on the drawings.

15.3.2 All joints shall be completely filled with mortar. Joints to face brickwork shall be neatly rounded with a 10 mm diameter grooving tool while faces of common brickwork which are to be plastered, shall have joints raked out to a depth of 12 mm to ensure good plaster bond.

15.3.3 Mortar shall consist of one part cement to four parts approved sand by volume and shall be used within one hour of mixing.

15.3.4 Brickwork shall be built in stretcher bond and all common bricks shall be well wetted before being laid.

**15.4 Fabricated steelwork**

15.4.1 All fabricated steelwork for covers, locking bars, keep plates, hinge plates, grids, etc, shall be manufactured from the appropriate steel plate, chequer plate and/or bar as detailed on the drawings.

15.4.2 All welding shall be carried out in accordance with SANS 15614.

15.4.3 Mild steel bars, straps etc. shall be hot-dip galvanised after fabrication and site welding, drilling and cutting if unavoidable, shall be chipped to remove slag, wire brushed and painted with at least three coats of approved cold galvanising solution.

**15.5 Servitude road**

15.5.1 Except if indicated to the contrary in the Project Specification or on the drawings the Contractor shall build a servitude road 4 metres wide along as much of the length of the pipeline as is practicable for the use of the Employer's vehicles for patrolling and maintaining the completed pipeline. The road shall be built as shown on the drawings or in the specification unless otherwise instructed by the Engineer in writing. It shall be built to conform closely to the shape of the natural ground to prevent interference with the surface drainage.

15.5.2 After the pipeline servitude has been cleared of all boulders, trees, bush and other vegetation and prior to trenching operations, the Contractor shall mark out the area of the roadway to the Engineer's approval. Thereafter all topsoil and grass shall be removed over the width of the road to an approximate depth of 200 mm by means of a motor grader or scraper, the excavated material being placed in windrows parallel to and clear of the edges of the roadway on one or both sides.

The windrows may be flattened so as not to restrict pipe laying operations. The Engineer may order a greater or lesser depth of topsoil to be thus removed to expose subsoil or to remove unsuitable material depending on site conditions.

15.5.3 When trenching operations commence, material surplus to backfilling requirements and suitable for surfacing the servitude road shall be dumped on the roadway and spread by motor grader or bulldozer as work proceeds. Laterite, shales, decomposed tillite, dolerite gravels and the like in suitable form, and materials containing rock fragments which

will break down under a grid roller to provide well graded material, will be suitable for the road formation. Soils with a high content of clay and similar fine materials shall not be used for road surfacing. Any shortfall of surfacing material shall be imported from approved borrow pits.

15.5.4 The Contractor may construct the servitude road immediately after the trench has been completed or after the pipeline has been backfilled and while the servitude area and working area are being reinstated.
When the four metre width of surfaced servitude road has been completed, the topsoil shall be bladed up to both edges of the roadway and compacted to form a smooth surface free of cuts or banks except where the Engineer may direct otherwise.

15.5.5 A grid roller shall be used and water applied for binding as required. Compaction of the servitude road formation shall be achieved by the careful routing of construction vehicles along the roadway, supplemented by the use of a grid roller. The final operations of grading and the surface of the road and adjoining areas with the servitude shall be performed with a motor grader.

15.5.6 In areas where the topography precludes the building of the servitude road as described above, the Engineer may direct such benching and earthworks as he may consider necessary to establish access for the Employer's supervisory vehicles. However, such works will be of a minor nature and Tenderers shall understand that they are not intended for pipeline construction purposes.

15.5.7 Material excavated from the pipeline trench surplus to pipeline backfilling or road surfacing requirements shall, if considered suitable by the Engineer and without extra cost be used for road formation at swamp crossings and the approaches to stream crossings instead of being spoiled to waste. Concrete aprons at stream crossings shall be constructed as shown on the drawings or instructed by the Engineer.

## 16. FINAL PAINTING

16.1 After successful hydrostatic testing of the pipeline and after completion of all construction work under this contract all external surfaces of uncoated or ungalvanised steelwork and surfaces of all valves, fittings and equipment shall be prepared and painted as specified in "Department of Water Affairs and Forestry" Standard Specification DWS 9900, Section C1 and the particular specifications. The colour code for final painting is included in Annexure C1 of DWS 9900, section C1.

16.2 The following parts and/or surfaces shall not be painted over:

16.2.1 All working parts of valve actuators which will result in the malfunctioning of the valve.

16.2.2 All indicators, makers plates, instruction plates, hard stamping etc.

16.2.3 All stainless steel, chromium plated parts and non-ferrous work.

16.2.4 Grease nipples, grease cups, valve indicators, exposed spindles.

16.2.5 Hot dipped galvanised surfaces. If cutting of galvanised parts cannot be prevented, exposed steel shall be thoroughly cleaned and painted with at least 3 coats of an approved cold galvanising solution.

16.3 All working parts of valves and fitting shall be checked to ensure that they operate freely and correctly and shall be lubricated after all paintwork has dried out.

## 17. MARKER BEACONS, BENCH MARKS, TRIANGULATION BEACONS, MARKING OF VALVE CHAMBERS AND SCHEDULE OF INSTALLATIONS

17.1 Precast concrete marker beacons as detailed on the drawings shall be placed exactly above the centre line of the completed pipeline and concreted-in at all changes of direction, on reserve boundaries, on both sides of road and railway crossings, on both sides of river crossings, at farm boundary crossings and at 500 metre intervals generally on straight sections of the pipeline where there are no air valve or access chambers present. The exact chainage measured along the pipeline at each marker shall be stencilled clearly in indelible paint as per clause 17.3 on two opposing sides of the marker beacon and a serial number to easily identify a marker beacon or to detect loss of a beacon by a break in consecutive numbers, on a third side.

17.2 Combined triangulation -benchmark beacons as detailed on the drawings shall be placed at approx. 5 km intervals along the pipeline. Wherever possible and approved by the Engineer these triangulation pins with benchmark and marking plates with data shall be incorporated on the outside of chambers founded on undisturbed ground i.e. scour valves, non-return valves, isolating valves, one of the road and railway crossing access chambers, etc.

The beacons shall all be accurately numbered, levelled and triangulated with the following data to the specified accuracy hard stamped on it:

(i) Beacon number.
(ii) Measured chainage.
(iii) Reduced level above MSL to an accuracy of ± (0,01+0,005 $\sqrt{lengthof\ pipelinein km}$
(iv) "X" and "Y" co-ordinates in metres to the applicable "L0" system used on the construction drawings to 100 mm accuracy.

The free standing combined beacons shall be sited next to manholes and firmly concreted-in in undisturbed ground in a position such that excavations for the repair of the pipeline will not disturb or damage the beacons.

On completion of triangulation the threaded portion of the triangulation pins shall be covered with a graphite/grease compound and the end covers firmly screwed back by hand.

17.3 All chambers constructed on the pipeline shall be clearly marked on the outside to denote the appurtenances housed in each and the chainages thereof. Marking shall be by stencilling in yellow road marking paint in letters not smaller than seventy five (75) mm. All markings shall face the upstream direction. Abbreviations to be used shall be as follows:

| | | |
|---|---|---|
| Air valves | - | AV (number off) |
| Isolating valves | - | IV |
| Scour valves | - | Sc V |
| Access only | - | AX |
| Air valve in conjunction with access | - | AV (T or D or SL)/AX |
| Non-return valves | - | RV |
| Insulating flanges | - | IF |
| Water meters | - | M |
| All farm off-takes | - | FO |
| All bulk off-takes | - | BO |
| Surge tank | - | ST |

17.4 All chambers shall also be marked with the appurtenance abbreviations as per Clause 17.3 and chainages clearly legible either hard stamped or engraved (10 mm minimum lettering size) on 100x40x2 mm thick stainless steel 304 L plate fitted to the inside concrete wall closest to the ladder with two M6 stainless steel non-removable anchors. Alternatively, the details may be hard stamped on the manhole covers' frame.

17.5 The Contractor shall provide completed schedules as per attached "pro forma" (page 57) after installation of all mechanical/electrical "correct-functioning" equipment to the Engineer four weeks before the Taking Over or handing-over inspection as applicable. A schematic lay-out drawing(s) shall accompany the schedules.

## 18. COMPLETION DRAWINGS

The Contractor shall submit acceptable complete "As built" drawings before commissioning of the pipeline/s. Failing this the Defects Notification or Liability Period shall be extended with the period by which the submission of the drawings is delayed. The "As built" drawings shall conform to the requirements described below:

### 18.1 Design by contractor

18.1.1 A strip survey of the pipeline route plotted on a co-ordinated grid with all topographical features and the route of the pipeline "As built" shown in plan. On the same sheet, a profile of the pipeline represented by the plan and indicating in detail:

(a) Measured chainages along the pipeline.

(b) Measured pipe invert levels, gradients and ground levels.

(c) The location and chainages of all valves, specials, scours, off-takes, accesses, meters and all other pipeline appurtenances.

(d) All pipe and special sizes and classes and the sizes and pressure ratings of all valves, meters and similar appurtenances.

(e) Location and description of all systems provided for cathodic protection, including location of test posts and groundbeds.

(f) Details of field test pressures applied over every section of pipeline.

(g) Location, elevations and other applicable details of service and utility installations being crossed by the pipeline.

(h) On the plan view, the location, serial numbers and reduced levels of permanent benchmarks.

(i) On the plan view, the location, serial numbers and co-ordinates of permanent triangulation points.

(j) On the profile, the exact measured location and chainage of property boundaries crossed by the pipeline.

(k) On the drawings, a list of serial numbers and co-ordinates of all changes in direction on the pipeline.

18.1.2 Structural details of all chambers, thrust blocks, road, railway and stream crossings and all other structures erected along the pipeline.

18.1.3 Detailed assemblies of valves, cross connections, off-takes etc.

18.1.4 "As built" drawings shall generally conform to the layout of the tender drawings, shall be on size A1 sheets with two and a half (2,5) mm minimum size lettering.

18.1.5 Prints of "As built" drawings shall be submitted to the Engineer for his perusal and comment before final transparencies are submitted.

### 18.2 Design by Engineer

18.2.1 One complete set of paper prints of the drawings supplied to the Contractor shall be marked "As built" with all changes shown in red.

18.2.2 Whenever the Contractor will be required to do design work Clause 18.1 shall apply.

## 19. SUPERVISION AND INSPECTION

### 19.1 General

19.1.1 The Works will be supervised and inspected by the Engineer and/or his authorised Representatives. However, such supervision and inspection shall in no way relieve the Contractor of his obligation and responsibility for performing the Works in accordance with the contract.

19.1.2 The Contractor shall institute his own inspection of the Works and shall conduct tests to ensure that the materials supplied and quality of workmanship complies with the requirements of the contract.

19.1.3 The Employer may appoint an independent Inspectorate who shall act on behalf of the Engineer to conduct any tests to ensure that materials and workmanship comply with the requirements of the contract.

19.1.4 The Contractor shall provide access at all times and shall be responsible for the opening and closing of access covers for inspection purposes and for providing sufficient labour and equipment such as ladders, rubber-tyred trolleys, rubber mats or other suitable protection for linings, lighting etc, all to the approval of the Engineer, to enable the Engineer, his authorised Representatives or the Inspectorate to inspect the works efficiently. The Engineer and the Inspectorate shall be afforded every facility to enable inspection to be carried out effectively.

### 19.2 Weld inspection

19.2.1 Radiographic examination

19.2.1.1 Butt welds shall be examined radiographically by the Contractor who shall process and adjudicate radiographs on Site. The standard of acceptability shall be in accordance with API 1104.

19.2.1.2 10% of the total length of all manual field welds, 2½% of the total length of field welds done by an approved automatic process and 100% of the length of all welds at mitres shall be examined radiographically with particular reference to weld intersections, using equipment supplied and staffed by the Contractor. The first 100 butt welds at each pipe laying head shall however be examined radiographically to establish a basis to decide on the frequency of further radiographic examination.

19.2.1.3 The Engineer reserves the right to decrease the length of welds radiographed to a minimum of 4% of manual welds and 1% of automatic welds if the standard of welding is consistently high and justifies the reduction.

19.2.1.4 The Engineer however also reserves the right to increase the length of welds to be radiographed to 100% of length of weld on the following basis and any increase above 10% of length of manual welds or 2½% of length of automatic welds.

19.2.1.4.1 If in 10% of length of manual welds or 2½% of length of automatic welds radiographed, more than 1 out of every 5 butt welded joints successively examined shows defects, length of weld to be radiographed shall be increased to 20% of manual welds and 5% of automatic welds.

19.2.1.4.2 If in 20% of length of manual, welds or 5% of length of automatic welds radiographed, more than 3 butt welded joints in any 10 joints successively examined shows defects, the length of weld to be examined shall be increased to 50% of manual welds and 10% of automatic welds.

19.2.1.4.3 If in the length of welds so radiographed, more than 5 in any 20 joints successively radiographed shows defects, the Engineer may increase the length of weld to be examined at his own discretion up to 100% of manual and automatic welds.

19.2.1.4.4 All defects shall be repaired and re-radiographed at the Contractor's cost and such radiography of repairs shall not be deemed to be included in the required percentage of radiography.

19.2.1.4.5 Claims arising from delays in construction caused by justifiable additional radiography which may be ordered by the Engineer or necessitated by weld repairs shall not be considered.

19.2.2 Visual examination

19.2.2.1 All field welds shall be examined visually.

19.2.3 Fillet welds

19.2.3.1 Apart from visual examination, fillet welds shall be subject to dye penetrant or magnetic particle tests at the Inspectorate's discretion.

19.2.4 Repair of welds

19.2.4.1 Rectification of defective welds shall be in accordance with API 1104 and to the satisfaction of the Engineer.

19.2.4.2 All costs related to the repair of defective welds shall be borne by the Contractor.

19.2.4.3 Defective welds shall be repaired immediately they are found to be so. The Engineer has the right to stop the Contractor proceeding with further pipe laying in the event of the Contractor delaying the rectification of defective welds. Furthermore, no consideration will be given to any claims arising from delays in construction resulting from such action.

**19.3 Inspection of linings and coatings**

19.3.1 All linings and coatings, whether having passed a factory inspection or not, shall be inspected on site and shall be subject to rejection.

19.3.2 All repairs to linings and coatings shall be subject to inspection. Field joint linings and coatings are an inspection witness and hold point.

19.3.3 All materials used on site for lining and coating or for repairs to linings and coatings shall be subjected to tests. The number of samples tested and the sampling points shall be at the Engineer's or the Inspectorate's discretion. The Contractor shall provide all samples free of charge.

19.3.4 Materials rejected shall be removed from site without delay, whether such materials have already been applied to pipes, specials and appurtenances, or not.

19.3.5 The Contractor shall perform a closed circuit television (CCTV) camera lining inspection survey of constructed pipeline of 600mm diameter or smaller, and repair all faults/damages indicated by the survey at his cost to the satisfaction of the Engineer before filling of the pipeline with water. An acceptable recording shall be handed to the Engineer as soon as surveys over any section have been completed.

19.3.6 Pipe coating integrity testing shall be carried out as specified and these tests shall commence as soon as possible after installation of sections of the pipeline and with testing of the total pipeline to be done after the first general rain. The Contractor shall repair all coating faults/damages indicated by the survey at his own cost to the satisfaction of the Engineer.

19.3.7 Refer to the Project, Particular and Standard Specifications for further details regarding quality management requirements and hold points for inspection by the Engineer and/or his authorized representatives.

## 20. MEASUREMENT AND PAYMENT

### 20.1 General

20.1.1 All rates, lump sums and prices shall be held to include for all labour, plant, equipment, materials, supervision, overheads, profits and maintenance as per contract.

### 20.2 Design, surveys, setting out, drawings (including "as built")

20.2.1 Shall be priced as lump sums in the section for "Fixed Charge and Value Related Items" under the relevant Preliminary and General items in the Bill or Schedule of Quantities.

20.2.2 Payment shall be in equal monthly instalments over the approved contract period.

20.2.3 Sums shall be held to include for re-design and re-drawing and/or correction of drawings not approved by or acceptable to the Engineer.

### 20.3 Site clearing

20.3.1 Shall be measured per hectare of pipeline construction servitude cleared.

20.3.2 Rates shall be held to include for clearing of wider areas where required by the Contractor, for removal of bush, trees, scrub, rubble, surface boulders, destumping, de-rooting, for disposal of vegetable matter, timber, stumps, rubble debris etc to approved dumping sites within 5 km radius from point of loading. Accommodation of existing structures and sites within the construction servitude and the identification, protection, monitoring and maintenance of heritage sites and graves within the construction servitude shall be included in the rate for clearing.

In case of the pipes being supplied by others the Contractor's rates shall include for the provision of suitable access as described in clause 3.17.1.1.

20.3.3 Wherever deemed necessary in the opinion of the Engineer, extra over rates will be provided in the Bill or Schedule of Quantities for clearance of trees and stumps not covered by rates in clause 20.3.1.

20.3.4 No payment will be made against this item for clearing in areas occupied temporarily by the Contractor for offices, storage and working facilities etc.

### 20.4 Demolishing

20.4.1 Demolishing of huts, houses and similar structures falling within the width of the permanent servitude and identified in the Project Specifications to be demolished shall be priced as a lump sum payable on completion of the item.

20.4.2 The sum shall be held to include for demolishing the entire structure and foundations and all services and facilities related thereto and for disposal of all materials, rubble and debris to approved dumping sites within 5 km radius from point of loading.

### 20.5 Fencing and gates

20.5.1 Shall be measured per metre of temporary or permanent fencing erected along the boundaries of the construction servitude, borrow pit sites and grave or heritage sites within the construction servitude. Gates shall be measured per number installed.

20.5.2 The rate for fencing and gates shall be held to include for clearing the fence line from all obstructions, supplying all materials, erection, closing of ditches along the fence line, maintaining the fences during the construction period and, in the case of temporary fencing, removal after completion of construction.

20.5.3 In the case of temporary fencing, 80 percent of the tendered rate will be certified after erection of fencing and gates and the balance of the tendered rate shall be certified after removal of fencing from site.

20.5.4 No payment will be made against this item for the erection of temporary fencing and gates around areas occupied temporarily by the Contractor for offices, storage and working facilities etc. The removal and erection of fences and gates that cross the construction area to obtain access through existing fences and the reinstatement of same as specified in clause 5.4 is include for in clause 20.7.

**20.6 Top soil removal, stockpiling and reinstatement**

20.6.1 Shall be measured per cubic metre of top soil removed and will be measured in cut. The volume will be calculated using the trench width as defined in clause 7.1.3.1 or the construction servitude width as defined on the drawings, as applicable, and the depth of top soil removal as determined during construction.

20.6.2 The rate shall be held to include for removal of top soil, temporary stockpiling within the construction servitude, hauling to temporary stockpiles, protection of stockpiles against erosion, maintenance of stockpiles and reinstating top soil after completion of pipe laying operations.

20.6.3 30 percent of the tendered rate will be certified after completion of top soil removal and stockpiling and the balance of the tendered rate shall be certified after successful protection, maintenance and reinstatement of top soil.

20.6.4 No payment will be made against this item for the removal, stockpiling and reinstatement of top soil in areas occupied temporarily by the Contractor for offices, storage and working facilities etc.

**20.7 Fertile soil removal, stockpiling and reinstatement**

20.7.1 Shall be measured per cubic metre of fertile soil over the width of the trench and will be measured in cut. The volume will be calculated using the trench width as defined in clause 7.1.3.1 to a fertile soil depth of 300 mm. Locations where the removal of fertile soil will be required, typically within cultivated lands, will be indicated in the project specification or the bill or schedule of quantities.

20.7.2 The rate shall be held to include for removal of fertile soil over the actual width of the trench, temporary stockpiling within the construction servitude, hauling to temporary stockpiles, protection of stockpiles against erosion, maintenance of stockpiles and reinstating fertile soil after completion of pipe laying operations.

20.7.3 30 percent of the tendered rate will be certified after completion of fertile soil removal and stockpiling and the balance of the tendered rate shall be certified after successful protection, maintenance and reinstatement of fertile soil.

20.7.4 No payment will be made against this item for the removal, stockpiling and reinstatement of fertile soil in areas occupied temporarily by the Contractor for offices, storage and working facilities etc.

**20.8 Trench excavations**

20.8.1 Shall be measured per cubic metre of excavation and will be measured in cut. The length used for computation will be the total through-length of the pipeline from end to end and no deduction will be made for valve chambers, pipe jack sections or the like. Depth will be measured from the surface of the ground after top soil and, if applicable, fertile soil removal along the centre line of the trench to the bottom of the specified bedding layer.

The trench or base width shall be as defined in clause 7.1.3.1 and vertical side trench walls, as indicated on the drawings, will be applicable for the calculation of quantities. Items will be provided for various depths in increments of 1.0m.

20.8.2 Rates shall be held to include for general levelling to facilitate use of plant, all work in connection with access through existing fences and reinstatement of same with new materials and gates as specified, all expenses in entry upon properties, the crossing, deviation, maintenance and reinstatement of services and utility installations, shoring, battering, widening at joints, overbreak, dewatering, trimming of trench bottoms, repairs and/or reinstatement of trenches after flooding or any other reasons, protection of stockpiles against erosion, maintaining of stockpiles and all additional work and limitations to work due to blasting or other restrictions imposed by statutory authorities, other than the Engineer, for provision and maintenance of access at required points across the trench.

20.8.3 Extra over rates for road crossings shall be held to include for traffic control, deviations, warning signs, safeguarding and all precautions demanded or works dictated or required by roads authorities.

20.8.4 Extra over rates for rail crossings shall be held to include for cost of bird-caging and supervision by TRANSNET and for all precautions demanded and works dictated or required by TRANSNET.

20.8.5 Extra over rates for stream crossings shall be held to include for flow diversion, repair of flood damage to work, dewatering of trenches.

20.8.6 Extra over rates for restriction in use of explosives shall be held to include only for limitations in progress of work due to blasting restrictions to comply with legal requirements.

20.8.7 Should an extra over item for excavation in rock be included in the Bill or Schedule of Quantities the rate shall be held to include for the additional cost of excavating, handling and disposal of rock and the replacement of rock required for backfilling.

**20.9 Excavations for valve chambers, thrust blocks, culverts, concrete encasements and similar structures**

20.9.1 Shall be measured in cubic metres (m3) net to the outside dimensions of the structure for all excavations outside trench payment lines. The cross sectional area of trench payment lines shall as defined in clause 20.8.1.

20.9.2 Rates shall be held to include for widening to allow working room around structure, shoring, battering, overbreak, trimming, dewatering and all additional work and limitations to work due to blasting or other restrictions imposed by statutory authorities other than the Engineer.

20.9.3 Extra over rates for excavations at road, railway and river crossings shall be held to include for all the aspects as per sub-clauses 20.8.3 up to and including 20.8.5.

**20.10 Pipe bedding**

20.10.1 Shall be measured in cubic metres (m3) of bedding placed. Trench dimensions for the calculation of quantities will be as specified in clause 20.8.1.

20.10.2 Rates shall be held to include for bringing in approved bedding material within a 5 km radius from point of application for all costs of opening up borrow areas where required, royalties to owners, reinstatement of borrow areas and access roads on completion, bulking, placing into trench, spreading, levelling, compaction and testing of materials.

20.10.3 Extra over rates for use of "Bidim" or similar approved filter cloth in waterlogged ground shall be held to include for all materials, placing, compaction, deepening of trench bottoms and everything additionally required to complete the bedding in terms of the specification.

20.10.4 Extra over rates for providing a special bedding conforming to SANS 1200 LB shall be held to include for everything additionally required to complete the bedding.

**20.11 Selected backfill**

20.11.1 Shall be measured per cubic metre ($m^3$) of selected backfilling completed. Trench dimensions for the calculation of quantities will be as specified in clause 20.8.1.

20.11.2 Rates shall be held to include for bringing in selected backfill within 5 km radius from point of application, for all costs and royalties in opening up borrow areas, reinstatement of borrow areas and access roads on completion, bulking, placing into trench, spreading, levelling, compaction and testing of materials.

20.11.3 Extra over rates for the use of polyethylene sheets or blankets in conjunction with selected backfill of required fineness of high clay content, shall be indicated as either a plus (+) or minus (-) value. Rates shall be held to include for everything necessary to complete selected backfill up to 300 mm above crown of pipe as per specification.

20.11.4 Extra over rates for the use of approved rock shield in conjunction with backfill which do not meet specified requirements in respect of fineness and clay content shall be indicated as either a plus (+) or minus (-) value. Rates shall be held to include for all expenses in getting rockshield materials approved, its application to approval of the Engineer and everything necessary to complete selected backfill up to 300 mm above crown of pipe as per specification.

**20.12 Common backfill**

20.12.1 Shall be measured per cubic metre ($m^3$) of common backfilling completed. Trench dimensions for the calculation of quantities will be as specified in clause 20.8.1.

20.12.2 Rates shall be held to include for moving of suitable trench spoil from areas where there is a surplus to areas where there is a shortage over a free-haul distance of 10 km, for placing, spreading, levelling and compaction, for reinstatement of agricultural drains and contours across servitude for all works required in safeguarding against and prevention of erosion along the servitude, for backfilling around all chambers and other pipeline structures excavated outside the trench payment line.

20.12.3 Extra over rates for common backfill at road crossings shall be held to include for complete reinstatement of road formations and road surfaces in conformity to the specification or the requirements of the roads authority.

20.12.4 Extra over rates for common backfill at rail crossings shall be held to include for complete reinstatement of rail embankments, ballast and rails in conformity to the specification or the requirements of TRANSNET.

20.12.5 Extra over rates for common backfill at stream crossings shall be held to include for complete reinstatement of the natural stream bed and removal of all obstructions created by pipeline construction and which may obstruct or interfere with the natural flow regime of the stream.

**20.13 Cleaning of servitude**

20.13.1 Shall be measured per hectare (ha) of pipeline construction servitude cleaned on completion of backfilling and reinstatement of top soil and, if applicable, fertile soil.

20.13.2 Rates shall be held to include for clearing of the permanent and temporary servitude widths of surplus spoil i.e. excavated materials including rock, debris, rubble, rejected or surplus piping, specials and fittings and transport of

same to approved dumping sites or acquired servitudes, within 5 km radius from point where loaded, for reinstatement of ground surface in temporary servitude strip by ripping or otherwise to facilitate re-establishment of vegetation. The spoil dumps should be neatly trimmed and, if required, covered with top soil 100 mm thick, and grassed.

**20.14 Laying and jointing of piping and specials**

20.14.1 Shall be measured per lineal metre (m) of pipeline laid and jointed.

20.14.2 Rates shall be held to include for site storage, transport and handling of pipes and specials, for the installation of bends and tees in the run of the pipe, for all jointing materials, for Contractor's inspection services, for radiography, for repairs to piping and specials, repairs to linings and coatings, for moulding of flanges and couplings, for prevention of flotation and provision, installation and maintenance of night caps to all open ends of pipes in trenches, for installation of thrust and puddle flanges where required, for maintaining the pipeline, piping and specials, clean and free from contamination, for final painting as specified and for the provision of suitable plant, labour and supervision to transport pipes, specials and fittings up or down very steep inclines along the pipeline route.

20.14.3 Scarfing, welding and repairing of pipe ends for deflection angles less than 11,25° complete as specified in Clause 20.14.2 shall be measured per unit of complete assembly.

20.14.4 Extra over rates for pipe laying and jointing at road, railway and stream crossings shall be held to include for all additional labour, materials, plant, supervision and inspection required for installation of the piping and specials as per specification and approved drawings and for all limitations imposed on operations and methods of work due to restricted working space and required pipe installation though sleeve pipes or due to restrictions imposed by authorities, high water level etc.

20.14.5 Extra over rates for pipe laying and jointing on steep slopes shall be held to include for all restrictions and limitations imposed by the site for the provision and installation of all anchors and holding down straps, flexible supports.

20.14.6 Extra over rates for marking 500 metre chainages on cement mortar lining and CCTV survey of the lining shall be priced as a lump sum or per lineal metre (m) for pipelines of 600 mm nominal diameter and smaller.

**20.15 Installation of in-line valves, scour valves, air valves, non-return valves, flow meters and fittings**

20.15.1 Shall be measured per unit of complete assembly.

20.15.2 Rates shall be held to include for site storage, handling and transport, for all jointing materials and installation as specified or as per drawings, for oiling and greasing of moving parts, tightening up of leaking glands and final painting after installation, and for everything necessary to complete installation as per specification or drawings except for construction of chambers which is measured separately.

**20.16 Pipeline off-takes and fittings**

20.16.1 Shall be measured per unit of complete assembly.

20.16.2 Rates shall be held to include for site storage, handling and transport, for all jointing materials, for installation of all valves, meters and fittings as per Clause 20.15 and for everything necessary to complete the off-take as per specification or drawing, except for construction of chambers which is measured separately.

**20.17 Chambers, culverts and pipeline structures**

20.17.1 Concrete, formwork, reinforcement, finishing, grouting etc. shall be measured in accordance with Clause 8 of SANS 1200 Section "G".

20.17.2 Miscellaneous built-in steel and iron work like chequer plate covers, cast iron manhole covers and frames, eggcrate grating, tread irons, locking bars and padlocks, holding down bolts and anchorages bearing finger and pin joints, louvres, ventilators, bar and mesh screens, steel valve supports, ladders etc, shall be measured per unit of complete assembly. Rates shall be held to include for fabrication, corrosion proofing, supply and delivery to site and complete installation.

20.17.3 Manhole covers shall be measured per unit of complete assembly and rates shall be held to include for fabrication, supply, delivery and complete installation.

20.17.4 Precast concrete paving blocks or slabs shall be measured per square metre area covered and rates shall be held to include for manufacture, supply, laying, finishing off, all foundation preparation and work, concrete or mortar or soil surround or fills and all cut-off walls for erosion protection.

**20.18 Pipe jacking**

20.18.1 Pipe jacking shall be measured in accordance with Clause 8 of SANS 1200 Section "LG".

**20.19 Hydrostatic testing and draining**

20.19.1 Shall be priced per lineal meter of pipeline tested.

20.19.2 Prices shall be held to include for the supply of water, all gauges, recorders, water meters, detection and repair of leaks, supply, installation and removal of bulkheads, blank flanges, thrust blocks and anchors and everything necessary to conduct and complete the tests, test results and reports as well as the draining of the pipeline as specified.

**20.20 Sterilization**

20.20.1 Shall be priced per lineal meter of pipeline sterilized.

20.20.2 Prices shall be held to include for the supply of water, chemicals, free residual chlorine indicators, instruments, equipment, re-sterilisation after entry and everything necessary to conduct and complete sterilization as specified.

**20.21 Cathodic protection, AC mitigation and coating integrity surveys**

20.21.1 Bonding of pipeline joints, the installation of sacrificial anodes, transformer rectifiers, groundbeds, AC gradient control wire, AC gradient control mats, pipeline coating integrity surveys etc. shall be measured in accordance with particular specifications.

**20.22 Marker beacons, bench marks, triangulation points, stainless steel markers and marking and schedules of installations.**

20.22.1 Shall be priced per number payable on completion of services required in terms of the specification.

20.22.2 Price shall be held to include for hard stamping or engraving of stainless steel 304 L plates, coding, numbering, lettering and everything necessary to complete as specified.

**20.23 Lightning Protection**

20.23.1 Shall be priced as a lump sum payable in proportion to length or pipeline protected.

20.23.2 Prices shall be held to include everything necessary to fully protect the pipeline against lightning strikes or surges as specified.

**CONTRACT W_____**

**HYDROSTATIC TEST CERTIFICATE**

SCHEME: .....

PIPELINE: .....

| PIPE TEST CONTRACT | METHOD REFER CLAUSE 12 | DATE | TEST SECTION: .....<br>BEGIN (m): .....<br>END (m): ..... |
|---|---|---|---|
| PIPE DIAMETER .....(OD)(mm)<br>PIPE GRADE AND t (mm)<br>..... | LENGTH OF TEST SECTION<br>.....(km) | TEST PRESSURE<br>..... MPa) | ALLOWABLE LEAKAGE RATES<br>1. DWS 1110 - Clause 12<br>1/4000 x volume water in test section<br>= ..... litre |

| TEST PUMP | PRESSURE GAUGE(S) | MEASURING DEVICES: |
|---|---|---|
| TYPE: .....<br>MANUFACTURER: ..... | TYPE: .....<br>DIAMETER: .....<br>DIVISIONS: .....<br>CALIBRATION: ..... | METER RECORDER<br>VOLUME: ..... .....<br>DIVISIONS: ..... .....<br>CALIBRATION: ..... ..... |

| TIME: 30 min | | TIME: 60 min | | TIME: 12 hours | | TIME: 24 hours | |
|---|---|---|---|---|---|---|---|
| VOLUME | CUMULATIVE | VOLUME | CUMULATIVE | VOLUME | CUMULATIVE | VOLUME | TOTAL |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

| COMMENTS | LEAKAGES | CH (m) |
|---|---|---|
| .....<br>..... | .....<br>..... | .....<br>..... |

| | NAME | SIGNATURE |
|---|---|---|
| CONTRACTOR | ..... | ..... |
| ENGINEER | ..... | ..... |
| INSPECTION AUTHORITY | ..... | ..... |

DETAILED SCHEDULE OF INSTALLATIONS: _____ PAGE: _____ OF _____

(CLAUSE 17.5)

| Str. No | Chainage | Installation | Plant Description | No. Off | Size | Pressure Rating | Make | Id Mark | Cp Test | Contr. No. | Remarks |
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REMARKS PERTAINING TO: .....

BY (NAME): ..... RANK: ..... ORGANISATION: ..... DATE: .....

# SPECIFICATION DWS 1130

# DESIGN, MANUFACTURE AND SUPPLY OF STEEL PIPES, SPECIALS AND FITTINGS FOR DUTIES UP TO 4,6 Mpa DESIGN PRESSURE

Revised: May 2010

THE TOTAL NUMBER OF PAGES IN THIS SPECIFICATION IS 12

## 1. SCOPE

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

## 2. INTERPRETATIONS

### 2.1 Supporting Specifications

2.1.1 Where this specification is required for a project, the following specifications shall form part of the contract document:

(a) Project specifications;
(b) SANS 1200A and SANS 1200AA, as applicable;

2.1.2 Reference is made to the latest issues of the following standards:

| | | |
|---|---|---|
| DWS | 9900 corrosion | Department of Water Affairs and Forestry, “Standard Specification for protection of steel pipes and specials for pipelines, Section C1”. |
| DWS | 2510 | Department of Water Affairs and Forestry, “Standard Specification for the supply of valves” |
| SANS | 1200 | Standardized specification for civil engineering construction |
| SANS | 62-1&62-2 | Steel pipes and pipe fittings up to 150 mm nominal bore, Part 1 and Part 2 |
| SANS | 719 | Electric welded low carbon steel pipes for aqueous fluids (large bore) |
| SANS | 1123 | Pipe flanges |
| SANS | 1431 | Weldable structural steels |
| SANS | 1476 | Fabricated flanged steel pipework |
| SANS | 1700 | Fasteners |
| SANS | 4633 | Rubber seals – Joint rings for water supply, drainage and sewerage pipelines |
| SANS | 15589-1 | Cathodic protection of pipeline transportation systems – Part 1 |
| SANS | 15614 | Specification and qualification of welding procedure for metallic materials |
| BS | 534 | Steel pipes and specials for water and sewage |
| BS | 970 | Wrought steel for mechanical and allied engineering purposes |
| BS EN | 1092 | Flanges and their joints |
| BS | 2633 | Class 1 arc welding of ferritic steel pipework for carrying fluids |
| BS | 7531 | Rubber bonded fibre jointing for industrial and aerospace purposes |
| API | 5L | Line pipe |
| API | 1104 | Welding of pipelines and related facilities |
| AWWA | M11 | Steel pipe - a guide for design and installation (Fourth edition) |
| AWWA | C208 | Dimensions for fabricated steel water pipe fittings |
| ISO | 7005 | Metallic flanges |
| ISO | 8501-1 | Preparation of steel substrate before application of paints and related products. Visual assessment of surface cleanliness – Part 1 |
| ASME | IX | Boiler and pressure vessel code |

### 2.2 Application

This specification contains clauses that are generally applicable to the design, manufacture and supply of steel pipes, specials and fittings for duties up to 4,6 MPa. Should no other specification for pipes of outside diameter larger than 2 220 mm be included in a contract, then the requirements of this document shall apply.

## 2.3 Definitions

For the purposes of this specification the definitions and abbreviations given in the applicable specifications listed in 2.1 and the following definitions shall apply:

2.3.1 Skelp

The jointing edges of steel coils used to manufacture spiral welded pipes.

2.3.2 H

The cross-sectional shape of a weld at skelp.

2.3.3 Cut and shut bend

See definition with sketches in BS 2633.

2.3.4 Nominal size (DN)

Nominal size (DN) is a numerical designation of size that is common to all components in a piping system other than components designated by outside diameters.

It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions in millimetres.

Nominal size is designated by DN followed by the size in millimetres. This definition is in accordance with ISO 6708.

All equipment of the same size DN, designated by the same PN number, shall have compatible mating dimensions.

2.3.5 Nominal pressure (PN)

Nominal pressure (PN) is a numerical designation, which is a convenient round number for reference purposes.

It is designated by PN followed by the maximum allowable working pressure, of which the flange is intended to be a component, will be subjected to under normal working conditions. This definition is in accordance with ISO 7268.

All pressure units throughout this specification will be recorded in kilopascals (kPa).

2.3.6 Pressure rating

Pressure rating is the maximum allowable working pressure of an installation of which the flange is intended to be a component.

# 3. MATERIALS

## 3.1 Pipes and Specials

Materials used for the manufacture of pipes and specials of nominal bore up to 150 mm shall conform to SANS 62 (heavy class pipes) and API 5L: steel grades up to X52, whilst that for pipes and specials of nominal bore over 150 mm shall conform to SANS 719: steel grades A, B and C,

steel grade 300 WA to SANS 1431 as well as API 5L: steel grades X42, X46, X52, X56, X60 and X65.
Applications for which grade 316 stainless steel in accordance with BS 970 or 3CR12 steel in accordance with EN 10028-7 is required are indicated on the drawings or supplementary schedules.

Weld on flanges shall be manufactured from steel plate in accordance with SANS 1431 grade 300WA with material certification. Specials and fittings shall be manufactured to SANS 62 (heavy class pipes) for nominal bores up to 150 mm, and to BS 534 for nominal bores over 150 mm.

### 3.2 Rubber Joint Rings

Rubber rings shall comply with SANS 4633.

### 3.3 Fasteners and Jointing Materials

All fasteners shall comply with SANS 1700 Grade 8.8 minimum. Washers shall be provided for all bolts, screw heads and nuts. The shortest standard bolt or stud that protrudes beyond the nut by a minimum of two threads when the assemblies are fully tightened shall be provided.

Gaskets for flanged joints shall be of aramid and glass fibre with nitrile rubber binder to BS 7531, suitable for the specified pressures with a minimum thickness of 3 mm. Full face gaskets shall be used for flat face flange connections and ring gaskets for raised face flange connections.

### 3.4 Insulating joints

Where called for insulating joints and materials shall be arranged as set out in Code of Practice No. SAECC/1 or SANS 15589-1. Insulating joints shall be provided as detailed on the drawings and at locations as indicated on the drawings.

Insulating joints shall be supplied with insulating gasket, bolts, nuts, washers, two insulating washers and an insulating sleeve for each bolt.

## 4. PLANT

The Contractor shall supply and maintain suitable tools, plant and equipment to manufacture and supply steel pipes, specials and fittings to the required standard. All specials and fittings shall be manufactured exclusively at the works of an approved manufacturer and at one works only. No site fabrication of specials other than mitre-bends of less than 11.25° will be allowed.

## 5. GENERAL REQUIREMENTS

### 5.1 Design of Pipes

The design stress for pipes subjected to the specified design pressures shall be 60% of the minimum yield stress of the steel. Unless otherwise specified in the Bill or Schedule of Quantities or on the drawings, the minimum pipe wall thickness to prevent buckling of straight piping due to internal sub-atmospheric pressures shall not be less than the larger of 4 mm or the following:

1/150 x pipe outside diameter for backfilled pipes
1/130 x pipe outside diameter for exposed pipes

Pipe outside diameters and wall thicknesses will be as shown on the drawings.

Wall thicknesses for bends exceeding 150mm nominal bore will be as for straight pipe unless

indicated differently in the Project Specification or in the Bill or Schedule of Quantities.

Wall thicknesses for pipes of nominal bore up to 150 mm shall be as specified in SANS 62 (heavy class pipes)

## 5.2 Dimensional requirements

Unless otherwise specified in the Bill or Schedule of Quantities or on the drawings, all line pipes shall be of fixed standard length between 9 metres and 19,5 metres except where shorter lengths are specified. Standard pipes from which samples for destructive testing have been cut may be jointed together by butt-welding to form single pipe lengths of the required standard length.

The tolerances on all dimensions shall be in accordance with SANS 719 clause 5.1, except that for pipe outside diameters bigger than 1 250 mm the tolerances on outside diameter of pipes (excluding pipe ends) shall be +6 mm and -6 mm. For pipe outside diameters bigger than 1250 mm, the tolerances on the outside diameters of pipe ends shall be as specified for pipe diameters of 250 mm to 1 250 mm.

For pipes of nominal bore up to 150 mm the provisions of SANS 62 for plain ended, heavy class pipe shall apply.

## 5.3 Fabrication

### 5.3.1 Welding

Welds shall comply with BS 2633 as modified below as well as SANS 719 and SANS 15614

a. Section 2 is excluded

b. Section 8

In addition to clause 8.1 the following shall also apply:

All butt-welds and branch fillet welds on specials shall where considered possible (refer clause 29.4.2, Section 3) have an internal weld. The height of the internal weld reinforcement shall not exceed 1 mm. Internal reinforcement in the form of backing rings at weld seams shall not be permitted.

c. Section 10

Procedure qualification and qualifying tests shall be restricted to branch connections only.

The internal weld bead/upset metal and flash on the inner surface shall not exceed 1 mm. For pipes and specials to be joined by butt welding, the internal weld bead shall not protrude more than 1 mm into the bore of the pipe or special. For electric resistance welded pipes, the height of upset metal and flash on the inner surface shall not exceed 1 mm. For pipes and specials to be joined by butt welding, the internal weld bead shall be ground flush with the pipe body for a length of 200 mm from the ends to be jointed. For pipes and specials to be coupled by flexible couplings, external weld reinforcement or upset metal and flash shall be ground flush with the pipe body for a length of 200 mm from the end to be coupled.

Where automatic submerged-arc welding is employed, at least one pass shall be made on the inside and at least one pass on the outside. This shall apply for double jointing of pipes in the factory as well. The number of longitudinal weld seams shall not exceed:

(a) 1 for pipes up to 1 000 mm nominal diameter;

(b) 2 for pipes larger than 1 000 mm and up to 2 220 mm nominal diameter.

For pipes to be joined by flexible couplings the pipe manufacturer is required to weld steel plates not less than 50 mm x 50 mm x 16 mm thick to each end of all pipes during the pipe manufacturing process, (i.e. before priming, lining and coating). Steel plates shall be located far enough from each pipe end so as not to interfere with the installation of the flexible coupling.

All manual or semi-automatic welds and repair welds shall only be undertaken by welders qualified under the tests laid down in the latest issue of the ASME "Boiler and Pressure Vessel Code", Section IX.

5.3.2 Pipes

Pipes shall be manufactured in conformity with SANS 719.

5.3.3 Specials and fittings

5.3.3.1 General

All specials and fittings shall be designed and manufactured by the Contractor in accordance with the general arrangement shown on the drawings and/or described in the Bill or Schedule of Quantities, in conformity with SANS 62 or SANS 1476 and sections 3 and 4 of BS534. In the latter case specials shall be manipulated or fabricated by welding from pipes which have been tested to SANS 719. Detailed drawings shall be approved by the Engineer.

Lifting eyes (lugs) shall be welded to all unwieldy specials and to specials of DN 600 and larger to facilitate handling and minimize damage to the protective coating.

5.3.3.2 Bends

Bends shall either be smooth formed or segmented. Dimensions for bends shall be in accordance with AWWA C208 unless otherwise specified or indicated on the drawings. The maximum angle between oblique butt-ends of segments for gusseted bends, including bends on sweep-T items, shall not exceed 22.5°. Cut-and-shut bends shall not be permitted. Bend radii shall be two pipe diameters unless otherwise indicated on the drawings or specified in the Bill or Schedule of Quantities.

Wall thickness for bends exceeding 150 mm nominal bore will be as for straight pipe unless indicated differently in the Project Specification or in the Bill or Schedule of Quantities.

All deflections in the axis of butt welded steel pipelines of 11.25° or less shall be prepared in the field as part of the pipe laying operation.

5.3.3.3 Branches and nozzles for bypasses, drains, air valves, pressure gauges, etc

Branch connections shall have barrel and branch plate thicknesses such that the maximum stress shall not be greater than that for an uncut pipe of the theoretically required minimum thickness. However, where it is more economical to provide external reinforcement in the form of collar plates, wrapper plates or crotch plates, these forms of reinforcement shall be used to achieve the same results.

The attachment of reinforcement to the pipe branches shall be by full penetration welding. Branch connections shall be as remote as possible from the seam or spiral weld on the barrel, and except

where specifically indicated to the contrary on the drawings, the positioning and extent of external reinforcement is to be determined in accordance with AWWA Manual M11.

Branches to pipes or pipe specials shall be of minimum 50 mm nominal diameter and shall be flanged and of “stub in” type in accordance with ANSI B31.3, welded internally and externally. Nozzles of 25 mm nominal diameter or less shall be “stub in” in accordance with ANSI B31.3 and threaded to BSPT.

(i) Centre lines of nozzles and branches shall be at right angles to the barrel of the pipe unless indicated otherwise on the Drawings.

Scour valve tees are to be at right angles to the barrel of the pipe, but tangential to the circumference at the invert of the pipe. The flanges are to be aligned to suit the gradient of the pipeline as indicated on the drawings.

Unless otherwise specified, air valve and scour tees with flanged branches shall be factory prepared with main barrel ends suitable for butt welding to the pipeline.

5.3.3.4 Reducers

Taper pieces shall be manufactured from the same type and quality of steel plate as would the relevant straight pipe for the same duty and with a diameter equal to the larger diameter of the taper. Taper pieces shall not have more than two longitudinal weld seams and the length of the tapered portion shall be at least five times the tapering difference unless indicated otherwise on the drawings.

Tapers along pipelines shall be eccentric with the invert following the invert of the pipeline to allow for draining of the pipeline, unless indicated otherwise on the drawings.

5.3.3.5 Flexible couplings

Flexible couplings shall be of the Viking-Johnson type with centre register, except where specified to the contrary in the Bill or Schedule of Quantities or on the drawings. Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings.

5.3.3.6 Insulated joints

Insulated joints shall have their insulation material arranged as given in SANS 15589-1 and indicated on the drawings, unless otherwise specified.

5.3.3.7 Flanges

Except where specified to the contrary in the Project Specification or on the drawings, all flanges shall be steel-plate for welding and shall conform to SANS 1123 for pressure ratings from 1 000 kPa to 4 000 kPa and to BS EN 1092 for pressure ratings of 6 400 kPa. Should the required flange size fall beyond the range of SANS 1123 or BS EN 1092 as applicable for the relevant pressure rating, mating dimensions shall be in accordance with ISO 7005 with thicknesses adequate to withstand closed-end test pressures. Flanges with a pressure rating of 1000 kPa and 1600 kPa shall have flat joint faces machined in accordance with the above SANS or ISO specifications. Flanges with pressure ratings that exceed 1 600 kPa shall have raised joint faces machined in accordance with the above SANS, BS EN or ISO specifications. Flanges with pressure ratings of 6400 kPa and flange sizes of 2500mm diameter and larger, irrespective of pressure rating, shall incorporate an “O” ring groove. Details of the proposed “O” ring groove shall be furnished at tendering stage for consideration.

Flanges shall be machined to the correct outside diameter as specified in the flange specifications. All flange sealing faces shall be gramophone machined to a toolmark N11. The back surfaces of flanges manufactured from steel plate may be left unmachined. The mill scale shall however be removed by abrasive blasting before flanges are fitted and welded to pipes and fittings.
The back surfaces of cast flanges shall either be machined or be spot faced on the bolt head/nut bearing faces. All bolt holes shall be drilled perpendicular to the flange face. Bolt holes shall be positioned off-centre and symmetrically off-set from the vertical centre lines of the flange and flanges shall be installed truly square to the axis of the pipe.

## 6. MARKING OF PIPES AND SPECIALS

All pipes and specials shall be clearly hard stamped alongside a longitudinal or spiral weld on one end of the pipe with the following:
(a) grade and thickness of steel;
(b) serial number of the pipe or special;
(c) nominal diameter (mm);
(d) factory hydraulic test pressure (kPa).

The applicable drilling table shall be stamped on the periphery of all flanges. Bends shall have their centre plane marked with two small punch marks close to both ends to facilitate correct positioning in laying.

## 7. STORAGE, HANDLING AND TRANSPORT

Pipes and specials shall be protected against damage at all stages from manufacture to delivery. The ends of all pipes and specials shall be protected against denting. Pipes shall be transported, handled and stacked in a manner such as to prevent deformation of the pipe body in excess of 2 % of the diameter or any other such limitations to prevent damage to pipe linings and coatings. Pipes and specials shall at all times be handled with appropriate equipment to avoid damage to linings and coatings. Dents causing a protrusion in excess of 3 mm into the interior of the pipe shall be repaired by cutting out. Temporary end covers shall be provided for the protection of the ends of all pipes and specials to protect pipe linings from damage during transport and during storage and handling on site. Suitable access along the pipeline route must be provided by the pipe-laying contractor.

Access for delivery on site might be restricted by poor weather conditions and the Contractor shall make due allowance for such disruption. Unless otherwise specified the pipes shall be off-loaded adjacent to the laying position, and placed on sandbags or other approved protective supports with adequate bearing area so that they are not subjected to concentrated pressure from stones or other objects. Pipes and storage on site.damaged in any way shall be removed from the Site at no cost to the Employer.

The Contractor shall be responsible for dispatching and transporting of the pipes to site, off-loading

## 8. INSPECTION AND METHODS OF TEST

### 8.1 General

The Contractor is responsible for all inspections, tests and other quality assurance work required to ensure compliance with the specifications. An Independent Inspectorate appointed by the Employer will be responsible to review and verify the Contractor’s quality assurance work and do additional inspections and tests as required by the Engineer and the Employer.

All equipment / instruments used for testing purposes by the Contractor shall be approved by the Independent Inspectorate and if in the opinion of the Inspectorate any equipment / instrument should

require calibration, such equipment / instrument shall be calibrated at the expense of the Contractor by such body as may be approved by the Inspectorate.

Tests and inspections shall be carried out at the manufacturer's works and / or in the field at the expense of the Contractor who shall provide all necessary testing facilities, labour, instruments, equipment and samples that might be required.
The Inspectorate shall be afforded every facility during the course of manufacture and testing to enable the inspection to be carried out effectively.

**8.2 Non-Destructive Inspection**

8.2.1 Visual Inspection

All finished pipes and specials shall be visually examined and shall be free of injurious defects as defined in API 5L section 10.7. In addition welds on specials shall be inspected by the application of a penetrant-dye on the inside of the welds.

8.2.2 Ultrasonic Inspection to API 5L

Pipes shall be made by an approved welding process and 100 percent of all longitudinal or spiral welds on straight pipes shall be checked with an approved ultrasonic method capable of continuous and uninterrupted inspection of the weld seam in accordance with API 5L, sections 9.7.4.1, 9.7.4.2, 9.7.4.3, and 9.7.4.4, except that the equipment shall be checked with an applicable reference standard at least twice every working turn.

As an alternative to ultrasonic inspection specified above, radiological methods in accordance with API 5L, sections 9.7.3.1 trough 9.7.3.12, may be used.

8.2.3 Radiographic Inspection to API 1104

(a) Longitudinal welds: All electric fusion welded pipes shall be inspected by radiological methods for a distance of 200 mm from each pipe end.

(b) Spiral welds: All electric fusion welded pipes shall be inspected by radiological methods for a distance of 100 mm from each end of each length of pipe and of the complete "H" at all skelp end welds, including 150 mm of the spiral welds in both directions away from the intersection points of the skelp end welds.

(c) Circumferential butt welds and welds on specials: 100 percent of the weld length shall be examined. When consistently acceptable results are obtained, the number of welds to be so tested may be reduced by mutual agreement between the Engineer, Inspectorate and Contractor.

(d) Repairs

(i) Straight piping - 100 percent of the total length of all repairs shall be examined radiographically. Where repairs are made before ultrasonic inspection, and such repairs pass ultrasonic inspection, no further radiographic inspection of same is required.

(ii) Specials - 100 percent of all repairs shall be examined radiographically.

(e) Pipes for rail, road and river crossings: 100 percent of the total length of all welds shall be examined radiographically.

8.2.4 Hydrostatic Testing

All pipes shall be hydrostatically tested to a pressure such as to produce a circumferential tensile stress in the steel not less than 90 percent of the minimum yield stress of the steel, or 9 MPa, whichever is the lesser. Each individual straight pipe shall be subjected to a hydrostatic test in accordance with the methods described in API 5L. Leaks or sweats shall be considered injurious defects. Should it not be possible to hydrostatically test straight piping and/or specials, a liquid penetrant test shall be done on all welds over and above the non-destructive tests specified above. This will only be applicable with the prior written approval of the Engineer.

8.2.5 Liquid Penetrant Testing

Where requested by the Inspectorate, liquid penetrant testing shall be done in accordance with Sub clause 7.2.1 of SANS 1200 L.

8.2.6 Magnetic Particle Testing

Where requested by the Inspectorate, magnetic particle testing shall be done in accordance with ASME Boiler and Pressure Vessel Code, Section V, Article 7.

**8.3 Repair of Injurious Defects**

Injurious defects found by non-destructive testing of welds, visual examination, hydrostatic testing or determined by any other means to exceed the limitations in API 5L shall be repaired in accordance with API 5L, but subject always to the requirements of this specification.

**8.4 Destructive Testing**

Destructive tests shall be performed in accordance with SABS 719 clause 6.2 on the first pipe and thereafter on one of every 500 subsequent pipes.

## 9. CORROSION PROTECTION

Corrosion protection of pipes, specials and fasteners shall conform to the “Department of Water Affairs and Forestry” Standard Specification DWS 9900, Section C1, and the particular specifications.

## 10. MEASUREMENT AND PAYMENT

Measurement and payment shall be per linear metre of straight pipe fabricated, supplied and delivered to site. Measurement and payment of specials and fittings shall be per the number of each special and fitting fabricated, supplied and delivered to site. Where pipe linings and coatings are applied prior to delivery, the rates for pipes, specials and fittings shall include for all such linings and coatings as required under Specification DWS 9900 Section C1 and the particular specifications, unless otherwise specified in the Bill or Schedule of Quantities.

Bolts, nuts, washers, gaskets and other jointing material for the installation of pipes, specials and fittings will be supplied by the Pipe Laying Contractor and is therefore excluded except if the supply of connecting material together with pipes, specials and fittings is specifically called for in the project specifications or in the bill or schedule of quantities.

# STANDARD SPECIFICATION

# DWS 2510/02
# SUPPLY OF VALVES

## AUXILIARY DRIVES

**TO BE INCLUDED IN THE SPECIFICATIONS IF AUXILIARY DRIVES ARE TO BE USED**

# INDEX

PAGE

# 1 GENERAL REQUIREMENTS

## 1.1 GENERAL

This section comprises the specifications for hydraulic and electric actuators to be fitted to valves of various types. Preference shall be given to hydraulically operated valves unless otherwise specified in the Project Specification.

All actuators shall be complete with manual operation.

## 1.2 COMPLIANCE

Actuators for the motorised operation of valves shall comply with this Specification in all respects.

Should it be for reasons necessary to deviate from the Specification, such non-compliance shall be fully described and motivated in writing at tendering stage.

The Engineer's written acceptance of such motivation shall be obtained before proceeding. All such documentation shall form part of the Contract and be retained for record purposes.

## 1.3 DESIGN LIFE

The actuators shall be designed for a minimum maintenance free life of 10 000 operating cycles, assuming maximum seating torque at the end of each stroke and an average of 33% of maximum seating torque during each stroke.

The actuators shall be designed to withstand frequent power failures of unspecified duration.

## 1.4 ACTUATOR SELECTION

The available torque transmitted to a valve shaft through an electric or manual actuator shall be rated to include a 50% safety factor in addition to the maximum torque required to fully open or close the valve under the maximum working pressures and prevailing flow conditions.

The Contractor shall submit drawings and/or calculations used for specifying the valve torque at tendering stage.

## 1.5 SOUTH AFRICAN REPRESENTATION

Actuators shall have substantial South African representation with comprehensive technical "know-how", in-house service capability and spares availability.

## 1.6 DUTY CYCLE

The Contractor shall specify the maximum duration of an open/close cycle at tendering stage.

## 1.7 OPERATION

Actuators shall keep the valve opening in any fixed position for an extended period.

All valves shall be capable of being opened or closed under an unbalanced pressure equal to the nominal pressure.

## 1.8 POWER SUPPLY

The actuator shall be designed to operate from a 400V three-phase or 230V single phase, 50Hz A.C. power supply. The actuator shall be capable of operating at the rated duty with a ± 15% variation of the applied voltage measured at the actuator.

The actuator shall be provided complete and equipped with the necessary auxiliary equipment to provide the low voltage power required by its control circuits.

The actuators shall have the correct phase rotation of the power supply after the Site wiring and connections have been made.

## 1.9 ELECTRIC MOTORS

### 1.9.1 Purpose Design

The motor shall have a minimum duty rating of four consecutive complete cycles or a continuous duty of 30 minutes, whichever is the more onerous.

### 1.9.2 Gear driven actuators

The actuator shall be fitted with a low inertia, high torque electric motor.

### 1.9.3 Construction

All motor shall be of the enclosed fan cooled squirrel cage or wound rotor (Slip ring) type. The motor characteristics and construction shall be suitable for the intended application

### 1.9.4 Motor Winding and Over-Temperature Protection

Insulation Class F shall be used on the motor windings and the winding temperature rise shall be designed for Class B.

Two temperature thermostat switches shall be embedded in the stator winding for rapid, accurate over-temperature protection of the motor windings.

### 1.9.5 Motor Enclosure Anti-Condensation Heater

Where specified, an anti-condensation heater shall be provided in the motor enclosure. This heater shall be automatically switched off while the motor is in operation.

### 1.9.6 Locked Rotor Current

The locked rotor current of motors shall be specified to permit adequate sizing of the power supply cable. The voltage at the motor during starting shall not drop below 85% of the nominal supply voltage.

### 1.9.7 Phase Protection

Single phasing and phase rotation protection shall be provided to ensure that the motor is only operated in the correct direction and with all three phases of the power supply present.

### 1.9.8 Phase Rotation

Phase rotation protection shall be provided to ensure that the motor can not be operated should phase rotation occur.

### 1.10 ACTUATOR MOUNTINGS

The actuator shall be mounted directly onto the valve body or gearbox. Should a particular application require an adaptation device, any such device shall be a specific proprietary design for a particular type of valve. A comprehensive design of any such adaptation shall be submitted to the Engineer for approval.

Provision shall be made for a weep hole to release any seepage water from the valve in order to protect the gearbox/actuator from contamination.

The attachment of the actuator to the valve body shall be such that the actuator may be detached without disturbing the valve position.

The valve manufacturer shall ensure that there is no visible movement of the actuator on the mounting adapter or valve body when the actuator is in operation.

### 1.11 INDICATORS

Actuator indicator shall be in accordance with the requirements of paragraph 3.15 of DWS 2510/01

### 1.12 POSITION AND TORQUE SETTINGS

The setting shall be stored in permanent memory and not drift after extended operation. Battery backup memory systems are not acceptable.

# 2 HYDRAULIC OPERATION AND POWER PACKS

### 2.1 GENERAL

A hydraulic actuator shall consist of a control panel, hydraulic cylinders, and electro-hydraulic power pack consisting of an electrically powered hydraulic pump, a hydraulic fluid reservoir, a manual backup operating system, control-, check- and relief valves, electrical distribution box and all hydraulic piping, fittings and anchoring.

### 2.2 CONTROL PANEL

The control panel, designed as part of the support frame, shall comprise the following:

a) 100-mm diameter pressure gauges shall be supplied for
   - One gauge for pump pressure,
   - One gauge for each delivery line pressure,
   - One gauge for each return line pressure

   in accordance with DWS 2510/01 paragraph 3.13, with a range of 0 to 25 MPa. The normal working pressure of 17,5 MPa shall be indicated with a red line.

b) A stainless steel epoxy powder coated electrical distribution box protected in accordance with IP 65 of SANS 60529. The box shall include,
   - A suitably rated isolator, lockable in its off position and a circuit breaker for over current protection
   - A set of On/Off push buttons interlocked to prevent dual activation.

- Three red 230V LED multi-cluster type indicating lamps marked L1, L2, L3 (one per phase) shall be fitted. These lamps shall illuminate when on.

c) The cable from the distribution box to the motor shall be fixed to brackets provided for this purpose. All Cabling shall be secured at intervals of no more than 250mm.

d) All cable glands shall be rated to comply with IP68 standards and fitted with a watertight neoprene shroud.

e) An ammeter.

f) Lever operated directional control valves with a maximum pressure rating of 18 MPa and rated for 1,6 times the design flow rate shall include the following:
- Spring return to neutral
- Open centre
- A and B working ports shall be closed in neutral position
- Built-in adjustable pressure relief valve
- Power beyond

g) A label (white trafolite with black lettering) showing the open and closed directions as well as the valve number shall be fixed with stainless steel screws next to each directional control valve.

h) Directional control valves shall be positioned to allow manual operation to be indented for execution by one person.

i) Double pilot operated check valves to arrest the hydraulic cylinders in the required position. For tubing lengths less than five (5) metre the check valve(s) shall be fitted to the control panel and for tubing exceeding five (5) metre as well as tubing exposed to direct sunlight the check valve(s) shall be fitted at the cylinders.

j) Check valves exposed to weather conditions shall be sealed in a silicone filled stainless steel box with a removable lid. The connections shall be pressure tested before sealing.

## 2.3 MANUAL OPERATION

### 2.3.1 General

All valves shall have a manual backup operation in order to open/close the valve during emergency conditions.

The position indicator shall remain synchronised with the actual valve position during manual operation. Synchronisation of the indicator system shall be done by a simple procedure.

### 2.3.2 Manual operation for hydraulically operated valves

A manual changeover from normal/automatic operation to manual hydraulic operation to open/close the valve(s) shall be supplied. A chart, clearly indicating the changeover procedure to manual hydraulic operation shall be supplied and mounted above the hand pump. All information contained on the charts shall be engraved and painted red on 2 mm thick aluminium plates (minimum size A2).

When the hydraulic power pack is energised, the unit shall not impart any motion to the pump lever, thereby ensuring the safety of personnel.

A check valve shall be fitted to the hand pump outlet.

## 2.4 PUMPS

### 2.4.1 Gear pump

A hydraulic gear pump with efficiency in excess of 75 percent and a pressure rating of 20 MPa is required.

The working pressure shall not exceed 17,5 MPa.

The gear pump shall be mounted separately from the reservoir with the suction pipe lower than the reservoir level. The suction pipe, protruding 30mm minimum inside the reservoir from the bottom, shall be fitted with a lockable stainless steel ball valve for maintenance of the filter system.

A check valve shall be fitted after the gear pump.

A suction filter system comprising a 10 µm filter, of the replaceable cartridge element type, with a minimum capacity of four (4) times the delivery rate and a vacuum gauge shall be installed upstream of the gear pump.

If so specified in the Specific Specification pumps mounted in the tank may be supplied. A filter system comprising a 10 µm filter, of the replaceable cartridge element type, with a minimum capacity of four (4) times the delivery rate and a gauge indicating the state of the filter shall be installed in the pump delivery line.

### 2.4.2 Hand pump

#### 2.4.2.1 Rotary Pump

A high efficiency hydraulic, low speed and high torque motor, operating as a pump, with a high efficiency under low hand-speed operating conditions, delivering 12,9 cc/revolution shall be supplied as a hand pump.

The crank handle shall have a radius of 320 mm be mounted at a height of between 1000 to 1200 mm above the floor. The system shall be designed so that the force required on the lever at Nominal Pressure does not exceed 200 N. The manual hydraulic operation shall be capable of opening or closing the valve under an unbalanced pressure equal to the Nominal Operating Pressure of the system.

#### 2.4.2.2 Plunger Reciprocating Pump

Where specifically requested in the Project Specification a 40-cc/stroke double action hand pump shall be supplied. It shall be mounted on the right hand side of the reservoir with the operating lever in the vertical position for horizontal stroke. The lever shall be designed that the force required on the lever at Nominal Pressure does not exceed 120 N. The manual hydraulic operation shall be capable of opening or closing the valve under an unbalanced pressure equal to the Nominal Pressure. The handle of the lever shall be 1 000 to 1200 mm from floor level.

#### 2.4.2.3 General Arrangement

High quality check valves shall be installed downstream of both the hand pump and the main electrical operated pump to improve efficiency and the safety of the operation of the hand pump.

The oil feed to the hand pump shall be taken through a 10µm filter as specified above.

(For details on the manual operation of the hydraulic system refer to Section 2.3.)

## 2.5 ELECTRIC MOTOR

For details on the electric motor refer to Section 1.9.

## 2.6 HYDRAULIC FLUID RESERVOIR

The hydraulic fluid reservoir, with a capacity of two (2) times the maximum combined displacement volume, shall be manufactured from 304L or coated 3CR12 as specified in the detail specification.

A removable lid, incorporating a watertight filler cap, shall be fitted to the reservoir and sealed with a gasket.

A hydraulic fluid level indicator shall be mounted on the reservoir in such a way that it is clearly visible whilst working on the control panel. Fluctuation of the hydraulic fluid level shall not exceed eighty (80) percent of the scale and the maximum and minimum level, with all cylinders extended, shall be indicated with a red line. The fluid level indicator shall contain an integrated temperature gauge marked in $^{o}$C.

The reservoir shall be mounted on an angle iron support frame, 150-mm minimum from the wall, with stainless steel 304L legs fixed to the floor with M16 stainless steel wedge anchors.

The reservoir bottom shall slope 1% minimum with a drainpipe and transparent glass water trap at the lower end. The water trap shall be fitted with a stainless steel ball valve, 250 mm minimum from floor level for draining purposes and sealed with a taper plug.

The reservoir shall be fitted with a breather filled with silica gel.

A purpose built drip tray shall be supplied below the power pack and reservoir.

Corrosion protection of the reservoir and auxiliary equipment shall be in accordance with Standard Specification DWS 9900: Corrosion Protection.

## 2.7 HYDRAULIC CYLINDERS

### 2.7.1 General

The hydraulic cylinders shall be entirely fabricated from stainless steel 316L unless otherwise specified and shall be designed for a pressure rating of 20 MPa and sized for a working pressure of 17,5 MPa.

Where specifically required, the exposed parts of the hydraulic cylinders (rams) shall be covered with UV stabilised rubber/material bellows. The bellows shall be sized to show discernible retention of the bellows shape at the full operating range of the hydraulic cylinder.

All the stainless steel components shall be pickled and passivated in accordance with Standard Specification DWS 9900: Corrosion Protection.

### 2.7.2 Cylinders

Cylinders shall comprise the following:

- 35 mm diameter ports drilled and tapped 1/2 " BSP minimum.
- The ports shall be positioned to exhaust all air during stroking of the cylinder.
- A phosphor bronze guide bearing.
- An adjustable screw ring to compensate for manufacturing tolerances of the rod sealing set and metal parts.
- Chevron type rod sealing set capable of operating in submerged conditions to 10 metre.
- A wiper seal fitted to the cylinder cover.
- The surface finish of the cylinder inner surface shall not exceed a Ra (Relative amplitude) of 0,2 µm.

### 2.7.3 Rod and Piston

The rod and piston shall comprise the following:

- A hard chromed stainless steel rod with a surface finish not exceeding a Ra (Relative amplitude) of 0,2 µm.
- A double acting piston manufactured from phosphor bronze or cast iron.
- Guide bearings of PTFE or phosphor bronze.
- A piston fitted with metal or PTFE seals consisting of a seal and rubber 'O'- ring combination.
- Piston screwed to the rod and locked with a grub screw.
- An adjustable male clevis with stainless steel swivel bearing and lock nut.

### 2.8 PIPES AND FITTINGS

All hydraulic tubing, fittings, couplings, supports and anchorage shall be of stainless steel 316L. Tubing shall be of the seamless type. Fittings shall be double ferrel type or conical with an o-ring seal.

# 3 ELECTRIC ACTUATOR

### 3.1 ELECTRIC MOTOR

For details on the electric motor see Section 1.9.

## 3.2 ACTUATOR CONTROLS

### 3.2.1 Integral Motor Starters

Integral actuator control, whereby the entire actuator, motor and stop/start control, forward/reverse control and starter are integrally mounted in the actuator enclosure, are preferred.

Where the actuator motor is of such a size that a separately mounted starter is necessary, this shall be specifically stated.

In both cases, the reversing contactor starter shall be electrically and mechanically interlocked.

### 3.2.2 Integral Pushbutton Stations

The actuator shall be provided with an integral pushbutton station with the following features:

- Local/Off/Remote selector switch. This switch shall be pad lockable in each position.
- Open/Stop/Close pushbutton station. The Open and Close pushbuttons shall only operate when a local selection is made on the selector switch. The Stop pushbutton shall be of the emergency latching type and shall operate in all positions of the Local/Off/Remote selector switch.
- Digital or mechanical local indication of the valve percentage open or fully open/closed status as specified in the detail specification.

## 3.3 MANUAL OPERATION

### 3.3.1 General

All valves shall have a manual backup operation in order to open/close the valve during emergency conditions.

The position indicator shall remain synchronised with the actual valve position during manual operation.

### 3.3.2 Manual operation for electrically operated valves

Closure of valves shall be through the clock-wise rotation of hand wheels. All valves shall be capable of being opened or closed under an unbalanced pressure equal to the Nominal Pressure. The effort required on hand wheels to open or close valves under these conditions shall be in accordance with DWS 2510/01 paragraph 3.16.6.

A manual de-clutch lever shall be provided which, when operated, shall disengage the electric mechanism.

When the motor is energised, the unit shall automatically return to motorised operation without imparting any motion to the hand wheel, thereby ensuring the safety of personnel.

## 3.4 MONITORING AND PROTECTION

The following monitoring and protection systems shall be provided:

### 3.4.1 Position Indicators

See General Technical Specification paragraph 3.16

### 3.4.2 Torque Limit Switches

Torque limit switches shall be provided to sense an overload condition in either clockwise or counter-clockwise operation to protect the valve and actuator. These torque switches shall be adjustable over the entire torque range specified for the actuator. A back-up “system fault” warning light shall be provided to indicate trips on torque overload.

### 3.4.3 Travel Limit Switches

Travel limit switches shall be provided to stop the actuator at the required extremes of travel and shall be set to trip the actuator operation before the actuator torque limit switches are activated.

The positions of these travel limit switches shall be adjustable, permitting adjustment to the valve shaft travel. These limit switches shall remain synchronised with the valve shaft travel for both motor and hand powered actuator operation. Provision shall be made for protection against unauthorised tampering with these limit switches.

### 3.4.4 Battery Back-up

No battery back-up shall be allowed to maintain any of the actuator settings during power failure.

### 3.4.5 PLC Interface

PLC I/O interface shall be provided where specified in the Project Specification and shall include position indication and remote control.

### 3.4.6 Motor Protection

Refer to paragraph 1.9. - ELECTRIC MOTORS

### 3.4.7 Potential Free Switch Contacts

Potential free switch contacts for remote and local indication of:

- Travel limit - valve open/closed
- Intermediate position or % open/closed via a 4-20 mA loop
- Torque limit exceeded

These switches shall have both normally open and normally closed contacts rated at 2 ampere, 400 volt.

Indicator lights shall be installed to indicate whether the actuator has tripped on either limited travel or excessive torque.

### 3.5 ENCLOSURES

The enclosure(s) housing the mechanical, electrical and electronic components of the actuator shall be rated to IP68 of SANS 1222. The Contractor shall provide documentary proof that this requirement is met.

A corrosion resistant plate with red lettering, reading as follows, shall be affixed to the actuator terminal cover.

**WARNING**
THIS ACTUATOR IS TESTED FOR WEATHER PROTECTION DUTY I.P. 68
WATERTIGHT SEALS MUST BE MAINTAINED INTACT
REFER TO INSTRUCTION MANUAL

Cable entry into the termination compartments of the actuators and control panels shall not impair the IP rating of the enclosure.

All cable glands shall be fitted with watertight UV stabilised plastic boots and shall be supplied with the actuator. All glands shall be rated to comply with IP 68 of SANS 1222 double seal compression type.

All cable ports into the enclosure shall be sealed to protect the actuator prior to connecting the final cabling at the same rating of IP 68.

Anti-condensation heaters shall be provided in all compartments of the enclosure housing the components of the actuator.

Lead seals shall be affixed via wire through the body and cover on all electric compartment housings after final setting and wiring of the actuators by a qualified actuator service Engineer.

## 4 GEARBOX DRIVE UNITS

### 4.1 GENERAL

Gearboxes for 90 degree action shall be of the self locking worm/quadrant type with minimal backlash. Operation shall be by means of a pinion shaft driving the quadrant.

Worm shafts, gears and other rotating components shall be supported on heavy-duty roller thrust bearings to provide the highest possible efficiency for minimal operating effort.

The effort required on hand wheels to open or close valves shall be in accordance with DWS 2510/01 paragraph 3.16.6.

Gears shall be machine cut and totally enclosed in weatherproof enclosures in accordance with IP67 of SANS 60529 to prevent the ingress of water and debris. A seal shall also be provided on the input shaft of the gearbox.

The open/closed positions of valves shall be set with adjustable mechanical end stops of the travelling nut type.

Gearboxes shall be sized for future fitment of actuators to an integrally cast actuator mounting flange conforming to ISO 5211 when required on site without any additional modification. Additional fully enclosed spur gearing shall be fitted if required.

Gearboxes shall be provided with accurate mechanical position indicators in accordance with DWS 2510/01 paragraph 3.16.

The gearbox shall be coated internally to 125 µm and externally in accordance with the Project Specification and the Standard Specification DWS 9900: Corrosion Protection

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.

## 4.2 LUBRICATION

Gearboxes shall be packed with water repellent grease approved by the Engineer.

Gears shall be fully covered with the lubricant in order to prevent corrosion.

The gearbox configuration and lubricants shall be such that the gearbox can be mounted at any angle without any lubricant leaking from the gearbox enclosure.

If a gearbox is 100% filled with lubricant, the gearbox shall be provided with a maintenance free membrane breather with sufficient capacity to accommodate the expansion of the lubricant over the full temperature range.

## 4.3 SHEAR PINS

Easily replaceable shear pins shall be provided on gearboxes to prevent damage to the valve if excessive force is applied on the handwheel in the fully open or closed positions. A spare pin shall be securely attached (tape plus a cable tie) to each valve. The shear pins shall be detailed on the manufacturer's drawing and specified in the operating and maintenance manual.

# STANDARD SPECIFICATION

# DWS 2510
# SUPPLY OF VALVES

## PARTICULAR VALVE SPECIFICATION

# GATE VALVES

**TO BE READ IN CONJUNCTION WITH THE PROJECT SPECIFICATION**
**AND**
**SECTION DWS 2510/01 –** GENERAL TECHNICAL SPECIFICATION

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# 1 GENERAL

## 1.1 TYPE

Gate valves shall be doubled flanged and be of the resilient seal or wedge-gate type, the gates of which shall be completely clear of the waterway in the fully open position. Unless otherwise specified, the gate valves shall be of the non-rising spindle type. The valves shall be capable of withstanding the nominal pressure (PN) and specified test pressures from both sides. The gate shall operate satisfactorily under the specified conditions.

Where the specification calls for the supply of 1 000 kPa rated gate valves and the manufacturer manufactures these valves identical to the 1 600 kPa rated valves, these valves can be supplied with the casted pressure rating stating 1 600 kPa and drilled to the 1 600 kPa specification, thus supplying a 1 600 kPa valve. The contractor shall, however, confirm this in writing at the tendering stage.

In specific circumstances the valves have to be drilled to suit existing equipment and details thereof will be supplied in the Project Specification.

## 1.2 SPECIFICATIONS

The valves shall generally be manufactured in accordance to SABS 664 and SABS 191.

## 1.3 BODY

The body shall be of rugged design with substantial ribs to minimise distortion under pressure. Bodies shall be designed and manufactured to withstand any additional gearing related stresses.

## 1.4 GEARBOX

The valve gearbox, were applicable, shall not be mounted directly onto the stuffing box but shall be mounted on suitable supporting brackets.

## 1.5 OPERATION

The valve shall be able to open and close satisfactorily under the specified flow rate and pressures.

## 1.6 POSITION INDICATOR

Preference shall be given to mechanical linear indicator system mounted on the valve stem.

## 1.7 STEM AND THRUST BEARING

The stem thrust collar shall bear against a ball thrust bearing of approved design, details of which shall be furnished by the Contractor with his offer.

All gate valves shall be fitted with a back seal to permit the replacement of the stem seals under pressure.

# 2 CONSTRUCTION AND OPERATIONAL REQUIREMENTS

## 2.1 RESILIENT SEAL GATE VALVES

### 2.1.1 Body and guides

The valve body shall incorporate a straight unobstructed body passage without pockets and shall have inclined seats and prominent gate guides to eliminate deposits in the valve body. The guides shall be as deep and as long as possible, but not protruding into the flow path to offer support in all gate positions.

The rubber coated gate shoes shall accurately fit the body guide profile to allow smooth operation of the gate with minimal shudder.

### 2.1.2 Gate

The gate shall be accurately moulded and completely encapsulated in rubber to ensure drop tightness over the valve pressure range. The rubber coated gate shall be designed to offer an equal distribution of sealing pressure in all directions with a capacity to accept foreign matter up to 1mm in particle size.

### 2.1.3 Stem

A corrosion resistant stem seal arrangement shall include a scraper ring to prevent the ingress of foreign matter. A stem thrust collar shall be installed between anti-friction materials to ensure low operating forces.

### 2.1.4 Corrosion protection

RSV gate valves shall comply with the Standard Specification DWS 9900 Section C3 . Damage to the corrosion protection or the rubber-coated gate during testing or normal operation will not be acceptable.

## 2.2 WEDGE GATE VALVES

### 2.2.1 Body and guides

Channel guides on the body and the shoes on the gate shall be as deep and as long as necessary to support and minimise shudder of the gate in any position during its travel.

Shoes shall be accurately fitted in the guides so as to ensure that sealing rings do not make contact before the gate is seated and that the gate is centralised when seated.

The sliding surfaces between the shoe and the channel shall be constructed from acceptable dissimilar materials.

With the valve fully open, at least half of the shoe shall be supported by the guides.

Jacking screws shall be provided to prevent over travel of the gate when closed.

### 2.2.2 Stems

The stem thrust collar shall bear against a ball thrust bearing of approved design, details of which shall be furnished at tendering stage.

### 2.2.3 Sealing faces

Body and gate seals shall be of such design and construction that will prevent seals becoming loose and prevent water passing behind seals under all conditions of operation and test. This feature must be proven at tendering stage by suitable drawings and documentation.

The leading edges of the sealing rings shall be slightly chamfered.

### 2.2.4 Position indicators

All valves of DN 300 and larger shall, except where otherwise specified, be fitted with mechanical indicators to show the position of the gate.

### 2.2.5 Gate and body marks

One face of the gate shall be marked, corresponding to a similar mark on the body, to ensure correct replacement after dismantling. The marks shall be visible and clear after coating.

# 3 MATERIAL

Valve components shall be constructed of the material specified in the following tables unless otherwise specified in the Project specification.

## 3.1 RESILIENT SEAL GATE VALVE (DN 50-300)

| SIZE DN | PRESSURE RATING Kpa | HYDRAULIC TEST PRESSURE IN kPa | |
|---|---|---|---|
| | | STRUCTURAL | SEAT |
| 50 – 300 | 1000/1600/2500 | 1500/2400/3750 | 1000/1600/2500 |

| COMPONENT | MATERIAL TYPE | MATERIAL SPECIFICATION |
|---|---|---|
| BODY | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| GATE | SG IRON, COATED | BS 2789 Gr 420/12, SABS 936 SG 42, Vulcanized EPDM |
| BONNET AND STUFFING BOX | SG IRON, COATED | BS 2789 Gr 420/12, SABS 936 SG 42, Vulcanized EPDM |
| STEM | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| STEM NUT | BRONZE (GUNMETAL) | BS 1400 LG2 |
| STEM BUSH | PLASTIC | |
| BUSH / STEM/ STUFFING BOX SEAL S | O RING | NITRILE / VITON |
| PROFILE / SCRAPER RING | O RING | NITRILE / VITON |
| FRICTION RING | PLASTIC | |
| HAND WHEEL | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| EXTERNAL FASTENERS | STEEL (HOT DIP GALVANISED) | SABS 163 Gr 8.8 |
| INTERNAL FASTENERS | STAINLESS STEEL | ASTM A193 Gr B8M, ASTM A439 Gr D2 |

## 3.2 WEDGE GATE VALVE (DN 350-1200)

| SIZE DN | PRESSURE RATING Kpa | HYDRAULIC TEST PRESSURE IN kPa | |
|---|---|---|---|
| | | STRUCTURAL | SEAT |
| 350-1200 | 1000 | 1500 | |
| 350-1000 | 1600 | 2400 | |

| COMPONENT | MATERIAL TYPE | MATERIAL SPECIFICATION |
|---|---|---|
| BODY | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| GATE | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| SEAT AND GATE RING | BRONZE (GUNMETAL) | BS 1400 LG2 |
| BONNET AND STUFFING BOX | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| STEM | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| STEM AND YOKE NUT | BRONZE (GUNMETAL) | BS 1400 LG2 |
| GLAND | CAST STEEL | BS 1504-161 Gr 480, SABS 1465 Part 1 |
| PEDESTAL PLATE | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| GATE NUT | BRONZE (GUNMETAL) | BS 1400 LG 2 |
| THRUST BEARINGS | CAST STEEL | BS 1504-161 Gr 480, SABS 1465 Part 1 |
| EXTERNAL FASTENERS | STEEL (HOT DIP GALVANISED) | SABS 163 Gr 8.8 |
| INTERNAL FASTENERS | STAINLESS STEEL | ASTM A193 Gr B8M, ASTM A439 Gr D2 |
| HAND WHEEL | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| SEALS | O RING | NITRILE / VITON |
| PACKING | GRAPHITE FIBRE | NOTE : NO ASBESTOS |
| OPERATION ARRANGEMENT LEVER | | SEE AUXILIARY DRIVE SPECIFICATION |
| GEARBOX | | SEE AUXILIARY DRIVE SPECIFICATION |
| ELECTRIC ACTUATOR | | SEE AUXILIARY DRIVE SPECIFICATION |
| HYDRAULIC ACTUATOR | | SEE AUXILIARY DRIVE SPECIFICATION |

## 3.3 WEDGE GATE VALVE (DN 50-500)

| SIZE DN | PRESSURE RATING Kpa | HYDRAULIC TEST PRESSURE IN kPa | |
|---|---|---|---|
| | | STRUCTURAL | SEAT |
| 50-500 | 2 500 / 4 000 | 3750 / 6000 | 2500 / 4000 |
| 200-500 | 6 000 / 8 000 / 10 000 | 9 000 / 12 000 / 15 000 | 6 000 / 8 000 / 10 000 |

| COMPONENT | MATERIAL TYPE | MATERIAL SPECIFICATION |
|---|---|---|
| BODY | CAST STEEL<br>SG IRON | BS 1504-161 Gr 480, SABS 1465 Part 1<br>BS 2789 Gr 420/12, SABS 936 SG42 |
| GATE | CAST STEEL<br>SG IRON | BS 1504-161 Gr 480, SABS 1465 Part 1<br>BS 2789 Gr 420/12, SABS 936 SG42 |
| SEAT AND GATE RING | BRONZE (GUNMETAL) | BS 1400 LG2 |
| BONNET AND STUFFING BOX | CAST STEEL<br>SG IRON | BS 1504-161 Gr 480, SABS 1465 Part 1<br>BS 2789 Gr 420/12, SABS 936 SG42 |
| STEM | STAINLESS STEEL | BS 970 Part 4 Gr 431 S29 |
| STEM AND YOKE NUT | BRONZE (GUNMETAL) | BS 1400 LG2 |
| GLAND | CAST STEEL | BS 1504 -161 Gr 480, SABS 1465 Part 1 |
| PEDESTAL PLATE | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| GATE NUT | STAINLESS STEEL | BS 970 Part 4 Gr 316 S15 |
| THRUST BEARINGS | CAST STEEL | BS 1504 –161 Gr 480, SABS 1465 Part 1 |
| EXTERNAL FASTENERS | STEEL<br>(HOT DIP GALVANISED) | SABS 163 Gr 8.8 |
| INTERNAL FASTENERS | STAINLESS STEEL | ASTM A193 Gr B8M, ASTM A439 Gr D2 |
| SEALS | O RING | NITRILE / VITON |
| PACKING | GRAPHITE FIBRE | NOTE **:** NO ASBESTOS |
| OPERATION ARRANGEMENT (✓) GEARBOX | | SEE AUXILIARY DRIVE SPECIFICATION |
| ELECTRIC ACTUATOR | | SEE AUXILIARY DRIVE SPECIFICATION |
| HYDRAULIC ACTUATOR | | SEE AUXILIARY DRIVE SPECIFICATION |

# STANDARD SPECIFICATION

# DWS 2510
# SUPPLY OF VALVES

## PARTICULAR VALVE SPECIFICATION

# AIR RELEASE AND VACUUM CONTROL VALVES

**TO BE READ IN CONJUNCTION WITH THE PROJECT SPECIFICATION**
**AND**
**SECTION DWS 2510/01 –** GENERAL TECHNICAL SPECIFICATION

# INDEX

PAGE

# 1. GENERAL

## 1.1 TYPE

Air valves shall not exhibit the characteristics of dynamic closure in exhaust and vacuum mode. The valves shall, unless otherwise specified, be dual acting and suitably sized to allow and control the intake and release of air under negative and high-pressure conditions, without creating shock or pressure surges in the piping network.

The valve shall be capable of controlling the release of entrapped air and large volumes of air during a pipeline filling operation. Similarly, should a vacuum condition occur, the valve shall be capable of allowing a controlled intake of air into the system to minimise surge.

Air valves shall have intake and exhaust orifice equal to the nominal size of the valve e.g. a 200mm valve shall have a 200mm inlet and outlet orifice. The valve should have an integral anti-shock orifice mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure. An inherent feature of the valve design must be to ensure that the ball does not close before all the air has been released.

Care shall be taken where air valves are mounted on sloping pipes that the air valves is mounted level.

All air valves shall be hydraulically drop tight when full of water and under pressures of between 1 metre (10 kPa) to 1,5 times the maximum operating pressure of the valve.

Auxiliary valves required to isolate an air release valve shall comply with the Valve Material Specification for a specific category of valve acceptable for use.

# 2. CONSTRUCTION AND OPERATIONAL REQUIREMENTS

## 2.1 BODY

The valve body shall be of a compact single or dual chamber design. The control float(s) shall be easily accessible for maintenance purposes.

Air valves shall be so constructed as to contain no internal or moving parts, other than floats, which may become loose or break free during normal operation and obstruct the operation of the valve.

## 2.2 FLOAT

Valve control float guides shall be designed to prevent the float(s) from being wedged between the internal body parts.

Cylindrical and ball type floats shall preferably be manufactured from polypropylene or similar polymer type material. Water absorption shall be less than 0,01%. Floats shall not be able to adhere to the orifice sealing arrangement nor be affected by deposits on the float surface.

Floats shall not distort or suffer mechanical damage in any form when subjected to structural strength test or conditions of frequent use.

### 2.3 SEAT

The seat and guides shall be so designed as to have sufficient clearance to prevent any abrasion of the float(s) when subjected to frequent operation.

### 2.4 DRAINING FACILITY

Provision shall be made for the drainage of a valve prior to removal or servicing and for the fitting of pressure gauges for testing purposes. If a specific bleeding apparatus is required to bleed an air valve, one shall be supplied with each valve. When receiving a large order for valves, the contractor shall consult the Engineer on the quantity of bleeding apparatus required.

### 2.5 WEATHER COVERS

All air valves shall be supplied with weather covers that will allow free discharge or intake of air but shall exclude the ingress of objects that may cause damage or malfunction of the valves. The covers shall be easily removable, shall be corrosion resistant, and shall have corrosion resistant securing elements.

## 3. VALVE MATERIAL SPECIFICATION

Valve components shall be constructed of the material specified in the following tables unless otherwise specified in the Project Specification.

## 3.1 CYLINDER FLOAT TYPE (DN 25-50)

| SIZE DN | PRESSURE RATING Kpa | HYDRAULIC TEST PRESSURE IN kPa | |
|---|---|---|---|
| | | STRUCTURAL | SEAT |
| 25 - 50 | 1 000 / 1 600<br>2 500 / 4 000 | 1 500 / 2 400<br>3 750 / 6 000 | 1 000 / 1 600<br>2 500 / 4 000 |

| COMPONENT | MATERIAL TYPE | MATERIAL SPECIFICATION |
|---|---|---|
| UPPER BODY FLANGE | MILD STEEL / STAINLESS STEEL | SABS 1431 Gr 300W, BS 970 Part 4 Gr 304 S15 |
| LOWER BODY FLANGE | MILD STEEL / STAINLESS STEEL | SABS 1431 Gr 300W, BS 970 Part 4 Gr 304 S15 |
| BARREL | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| BARREL SEALS | COMPRESSED FIBRE GASKET | BS 1832 Gr A |
| INTERNAL SEALS | O RING | NITRILE / VITON |
| TOP COVER | ALUMINIUM / STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| ANTI SHOCK ORIFICE | PLASTIC | HIGH DENSITY POLYETHYLENE |
| FLOATS | PLASTIC | HIGH DENSITY POLYETHYLENE |
| BAFFLE SPACERS | PVC | |
| NOZZLES | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| NOZZLE SEATS | ELASTOMER | NITRILE / VITON |
| BAFFLE PLATES | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| TIE RODS | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| INTERNAL FASTENERS | STAINLESS STEEL | ASTM A193 Gr B8M, ASTM A439 Gr D2 |
| EXTERNAL FASTENERS | STEEL (HOT DIP GALVANISED) | SABS 163 Gr 8.8 |

## 3.2 CYLINDER FLOAT TYPE (DN 80-200)

| SIZE DN | PRESSURE RATING Kpa | HYDRAULIC TEST PRESSURE IN kPa | |
|---|---|---|---|
| | | STRUCTURAL | SEAT |
| 80 – 200 | 1600 / 2500 / 4000 | 2400 / 3750 / 6000 | 1600 / 2500 / 4000 |

| COMPONENT | MATERIAL TYPE | MATERIAL SPECIFICATION |
|---|---|---|
| UPPER BODY FLANGE | MILD STEEL / STAINLESS STEEL | SABS 1431 Gr 300W, BS 970 Part 4 Gr 304 S15 |
| LOWER BODY FLANGE | MILD STEEL / STAINLESS STEEL | SABS 1431 Gr 300W, BS 970 Part 4 Gr 304 S15 |
| BARREL | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| BARREL SEALS | COMPRESSED FIBRE GASKET | BS 1832 Gr A |

| SIZE DN | PRESSURE RATING Kpa | HYDRAULIC TEST PRESSURE IN kPa | |
|---|---|---|---|
| | | STRUCTURAL | SEAT |
| 80 – 200 | 1600 / 2500 / 4000 | 2400 / 3750 / 6000 | 1600 / 2500 / 4000 |

| COMPONENT | MATERIAL TYPE | MATERIAL SPECIFICATION |
|---|---|---|
| INTERNAL SEALS | O RING | NITRILE / VITON |
| TOP COVER | ALUMINIUM / STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| ANTI SHOCK ORIFICE | PLASTIC | HIGH DENSITY POLYETHYLENE |
| FLOATS | PLASTIC | HIGH DENSITY POLYETHYLENE |
| BAFFLE SPACERS | PVC | |
| NOZZLES | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| NOZZLE SEATS | ELASTOMER | NITRILE / VITON |
| NOZZLE RETAINING RING | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| BAFFLE PLATES | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| TIE RODS | STAINLESS STEEL | BS 970 Part 4 Gr 304 S15 |
| INTERNAL FASTENERS | STAINLESS STEEL | ASTM A193 Gr B8M, ASTM A439 Gr D2 |
| EXTERNAL FASTENERS | STEEL (HOT DIP GALVANISED) | SABS 163 Gr 8.8 |

## 3.3 DUAL PURPOSE BALL FLOAT TYPE (DN 50-200)

| SIZE DN | PRESSURE RATING Kpa | HYDRAULIC TEST PRESSURE IN kPa | |
|---|---|---|---|
| | | STRUCTURAL | SEAT |
| 50 – 200 | 1 000 / 1 600<br>2 500 / 4 000 | 1 500 / 2 400<br>3 750 / 6 000 | 1 000 / 1 600<br>2 500 / 4 000 |

| COMPONENT | MATERIAL TYPE | MATERIAL SPECIFICATION |
|---|---|---|
| BODY | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| COVER | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| COWL | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| LOW PRESSURE BALL | POLYPROPYLENE | PP/PVDF |
| HIGH PRESSURE BALL | POLYPROPYLENE | PP/PVDF |
| SEAL RINGS | ELASTOMER | NITRILE/NEOPRENE |
| STEM AND GUIDE COMPONENTS | STAINLESS STEEL | BS 970 Part 4 Gr 431 S29 |
| INTEGRAL VALVE (Were applicable)<br>THREADED BUSH<br>HAND WHEEL | <br>PHOSPHOR BRONZE/BRASS<br>SG IRON | <br>BS 1400 PB1C, BS 2874 CZ 116<br>BS 2789 Gr 420/12, SABS 936 SG 42 |
| INTERNAL FASTENERS | STAINLESS STEEL | ASTM A193 Gr B8M, ASTM A439 Gr D2 |
| EXTERNAL FASTENERS | STEEL (HOT DIP GALVANISED) | SABS 163 Gr 8.8 |

## 3.4 AUTOMATIC FLOAT TYPE (DN 50 –200)

| SIZE DN | PRESSURE RATING Kpa | HYDRAULIC TEST PRESSURE IN kPa | |
|---|---|---|---|
| | | STRUCTURAL | SEAT |
| 50 – 200 | 1 000 / 1 600 | 1 500 / 2 400 | 1 000 / 1 600 |

**MATERIALS :**

| COMPONENT | MATERIAL TYPE | MATERIAL SPECIFICATION |
|---|---|---|
| BODY | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| COVER | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| COWL | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| BALL | POLYPROPYLENE | PP/PVDF |
| SEAL RING | ELASTOMER | NITRILE/NEOPRENE |
| GUIDE COMPONENTS | STAINLESS STEEL | BS 970 Part 4 Gr 431 S29 |
| INTERNAL FASTENERS | STAINLESS STEEL | ASTM A193 Gr B8M, ASTM A439 Gr D2 |
| EXTERNAL FASTENERS | STEEL (HOT DIP GALVANISED) | SABS 163 Gr 8.8 |

## 3.5 KINETIC BALL TYPE (DN 50 –200)

| SIZE DN | PRESSURE RATING KPa | HYDRAULIC TEST PRESSURE IN kPa | |
|---|---|---|---|
| | | STRUCTURAL | SEAT |
| 50 – 200 | 1 000 / 1 600 / 2 500 | 1 500 / 2 400 / 3 750 | 1 000 / 1 600 / 2 500 |

**MATERIALS :**

| COMPONENT | MATERIAL TYPE | MATERIAL SPECIFICATION |
|---|---|---|
| BODY | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| COVER | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| COWL | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| BALL | POLYPROPYLENE | PP/PVDF |
| SEAL RING | ELASTOMER | NITRILE/NEOPRENE |
| INTEGRAL VALVE (Were applicable) | | |
| THREADED BUSH | PHOSPHOR BRONZE/BRASS | BS 1400 PB1C, BS 2874 CZ116 |
| HAND WHEEL | SG IRON | BS 2789 Gr 420/12, SABS 936 SG 42 |
| SHAFT | STAINLESS STEEL | BS 970 Part 4 Gr 431 S29 |
| PACKING | ASBESTOS FREE | |
| INTERNAL FASTENERS | STAINLESS STEEL | ASTM A193 Gr B8M, ASTM A439 Gr D2 |
| EXTERNAL FASTENERS | STEEL (HOT DIP GALVANISED) | SABS 163 Gr 8.8 |

# STANDARD SPECIFICATION

# DWS 2510/04
# SUPPLY OF VALVES

# BUTTERFLY VALVES

**THE FOLLOWING DOCUMENTS FORM PART OF THIS SPECIFICATION:**

**THE PROJECT SPECIFICATION**
**DWS 2510/01 – GENERAL VALVE SPECIFICATION**
**DWS 2510/02 – AUXILIARY DRIVES**

# INDEX

**PAGE**

# 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

## 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 1 200.

.
Details of the weld deposit areas shall be submitted with the Tender on the detail drawing.

## 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 DWS 9900 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.

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 either comply with DWS 2510/01 clause 3.22.2 or 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 in accordance with DWS 2510/02 paragraph 4.1.

### 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.

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 DWS 2510/02 – Auxiliary drives.

# 3 VALVE MATERIAL SPECIFICATION AND TEST PRESSURES

Valve components, unless otherwise specified in the Project Specification, shall be constructed of the material specified in tables 3.1 and 3.2.

## 3.1 DOUBLE FLANGED BUTTERFLY VALVE (DN 200-3000)

### 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.

### 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.
The structural test shall comply with clause 2.4.2.1.

### MATERIAL SPECIFICATION

| COMPONENT | MATERIAL TYPE | MATERIAL SPECIFICATION (or Better) |
|---|---|---|
| BODY | SG IRON<br><br>CAST STEEL<br><br>MILD STEEL | SANS 936 Gr SG420/12 /<br>ISO 1083 Gr JS-500-15S<br>BS 1504-161 Gr 480 / SANS 1465 Part 1 Gr C3/ SANS 1465 Part 3 Gr CRS 6<br>SANS 50025-2/EN 10025-2 Gr S350JR |
| BLADE | SG IRON<br><br>CAST STEEL<br><br>MILD STEEL | SANS 936 Gr SG420/12 /<br>ISO 1083 Gr JS-500-15S<br>BS 1504-161 Gr 480 / SANS 1465 Part 1 Gr C3/ SANS 1465 Part 3 Gr CRS 6<br>SANS 50025-2/EN 10025-2 Gr S350JR |
| BODY/BODY SEAT | STAINLESS STEEL | BS 970 Part 4 Gr 309L S15<br>INCONEL 625 |
| 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<br>SLEEVE TYPE | BS 1400 PB1C (Cu, Sn10, P)<br>BRONZE BACKED (DUB) |
| SHAFT SEALS | RADIAL LIP SEAL / CUP SEAL /<br>O-RING SEAL | NITRILE / VITON |
| 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)<br>STAINLESS STEEL | SANS 1700 (SANS 121, ISO 1461)<br>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.
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<br><br>CAST STEEL<br><br>MILD STEEL | SANS 936 Gr SG420/12 /<br>ISO 1083 Gr JS-500-15S<br>BS 1504-161 Gr 480 / SANS 1465 Part 1 Gr C3/ SANS 1465 Part 3 Gr CRS 6<br>SANS 50025-2/EN 10025-2 Gr S350JR |
| BLADE | SG IRON<br><br>CAST STEEL<br><br>MILD STEEL | SANS 936 Gr SG420/12 /<br>ISO 1083 Gr JS-500-15S<br>BS 1504-161 Gr 480 / SANS 1465 Part 1 Gr C3/ SANS 1465 Part 3 Gr CRS 6<br>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<br>SLEEVE TYPE | BS 1400 PB1C (Cu, Sn10, P)<br>BRONZE BACKED (DUB) |
| SHAFT SEALS | RADIAL LIP SEAL / CUP SEAL /<br>O-RING SEAL | NITRILE / VITON |
| IDLE SHAFT COVER | STAINLESS STEEL | BS 970 Part 4, Gr 304 S15 |
| EXTERNAL FASTENERS | STEEL (HOT DIP GALVANIZED)<br>STAINLESS STEEL | SANS 1700 (SANS 121, ISO 1461)<br>ASTM A193 Gr B8M |
| INTERNAL FASTENERS | STAINLESS STEEL | ASTM A193 Gr B8M |

**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**

1. 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 *

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 _____

**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 _____

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
42. Power rating of electric actuator motor / pump motor _____kW
43. 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**

46. Is the Offer fully compliant with the requirements of DWS 2020, DWS 2510 and DWS 9900 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

### 3.4 TECHNICAL SCHEDULE FOR CORROSION PROTECTION

| | | | | |
|---|---|---|---|---|
| Applicator proposed | Name: | | | |
| | Contact person: | | | |
| | Tel.: | | | |
| | Address: | | | |
| | | | | |
| | | | | |
| Qualifications of Corrosion Protection Applicator | | | | |
| List of equipment and instrumentation | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Value of corrosion protection (the lot) | R | | | |
| Coating system: | Coat/Stage | Product | Code | Colour |
| Type of paint offered (no primers) | | Append Technical literature | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Top coat | | | | |
| | | | | |
| Pickling paste | Surface prep. | | | |
| Passivating paste | Surface prep. | | | |
| Blasting Media: For stainless steel | Surface prep. | | | |
| : For steel | Surface prep. | | | |
| Remarks/Deviations | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Tenderer: | Name: | | | |
| | Signature: | | | |
| | Date: | | | |

## 3.5 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 Serial No | Description | Delivered to site price (Including VAT) RAND |
|---|---|---|---|---|
| | | | | |
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*Total Price R_____

Name of Tenderer
(block letters) _____

Signature of Tenderer _____

Tel _____

Fax _____

Date _____

# STANDARD SPECIFICATION

# DWS 9900

# SECTION C7

# CORROSION PROTECTION OF EQUIPMENT FOR PUMP STATIONS

**This document shall be read in conjunction with:**

**DWS 2020: Quality Assurance and Procedures**

**Annexures**

**Requirements to be specified**
**Departmental colour code**

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# 1. SCOPE

This specification covers the corrosion protection of steel pipes, plant and equipment subjected to environments with variable corrosive tendencies.

# 2. INTERPRETATIONS

## 2.1 PROJECT SPECIFICATION

Steel pipes, plant and equipment shall be manufactured and corrosion protected in accordance with the requirements specified in the Project Specification. No deviation from specification will be allowed without the written consent of the Project Engineer. In the case of there being conflict between specifications, the Project Specification will take preference.

## 2.2 APPLICATION

This specification contains clauses that are generally applicable to the corrosion protection of steel pipes, plant and equipment.

## 2.3 DEFINITIONS

**LINING**

Refers to the internal coating of pipes and specials.

**COATING**

Refers to the external coating of pipes and specials.

**DIS-BONDED AREA**

An area of lining or coating that initially did adhere to the steel substrate after application, but which subsequently became loose from the substrate as a result of mechanical, chemical or other action.

**UN-BONDED AREA**

An area of lining or coating which at no stage adhered to the steel substrate.

# 3. APPROVAL PROCEDURE

## 3.1 APPROVALS BEFORE AWARD OF CONTRACT

(a) The Corrosion Protection System specified in the Project Specification, shall be agreed upon between the Corrosion and Project Engineers.

(b) Approval by the Corrosion Engineer of the corrosion protection system, procedures and specific materials offered in the Tender. Manufacturer's data sheets or legible copies thereof shall be submitted for each product.

(c) Acceptance of the Departmental Quality Control Plan for Corrosion Protection - refer to DWS 2020 QCC1.

## 3.2 APPLICATION APPROVALS

(a) Qualification of personnel

(b) Quality of equipment

(c) Pre-preparation

(d) Surface preparation

(e) Application

(f) Final acceptance

# 4. GENERAL REQUIREMENTS

## 4.1 QUALITY ASSURANCE AND PROCEDURES

Quality procedures as specified in DWS 2020 shall be adhered to.

The production and application shall be in accordance with SABS ISO 9000, Quality System.

The Contractor shall ensure that he is fully conversant with the requirements of this specification and the relevant coating systems.

### 4.1.1 QUALITY PLAN

A detailed quality plan shall be submitted for approval and completion by the Corrosion Engineer before manufacture/coating is initiated – refer to DWS 2020 QCC1 section 1.

## 4.2 QUALIFIED STAFF

### 4.2.1 APPLICATION

A high standard of workmanship is required. Only experienced personnel shall be used to carry out corrosion protection work.

All work shall be carried out under the constant supervision of a qualified supervisor.

### 4.2.2 REPAIR WORK AT SITE

All repair work shall be done by competent personnel of the approved applicator under the supervision of a qualified supervisor.

## 4.3 COMPATIBILITY OF MATERIALS

The Contractor shall ensure that metals or alloys are compatible or are adequately protected if, in the galvanic series, there is more than 0,3 volt difference in the galvanic potential.

### 4.3.1 DESIGN PRECAUTIONS

All equipment shall be designed to suppress corrosion in an exposed environment.

#### 4.3.1.1 ACCESSIBILITY

Easy access for protection and maintenance shall be provided. The use of back to back angles, partially open box sections or inaccessible stiffeners shall be avoided.

Corrosion protection of areas that are unavoidably inaccessible shall be specifically specified or approved by the Corrosion Engineer.

#### 4.3.1.2 WATER RETENTION AREAS

Pockets, recesses and crevices in which water and dirt may collect shall be avoided. Water retention areas shall be properly drained by holes as large as possible i.e. 150 mm diameter – minimum 50 mm diameter.

Surfaces of corrodible metals, such as the insides of tanks or hollow sections that cannot be protected by any method (e.g. painting or dipping), shall be avoided, or where not possible, be fully sealed against ingress of air and moisture.

#### 4.3.1.3 PERMANENT INSTALLATIONS

Permanent installations in concrete shall be manufactured from stainless steel as specified in Section 5.

### 4.3.2 CORROSION PREVENTION

The Contractor shall ensure that the following steps are taken to minimise corrosion:

(a) If dissimilar metals are used:

Coat all surfaces of the whole assembly including the more noble member of the galvanic series.

(b) If the noble member of the assembly cannot be entirely covered:

(i) Keep the anode/cathode ratio as large as possible in the particular component.

(ii) Use electrical insulators between two metals. Insulation must be complete, a bolt requires a sleeve as well as washers of an insulating material.

(c) Joints and crevices between metals shall be sealed.

(d) Where fastening is unavoidable, the fasteners shall be more noble (cathodic) than the base material. Fasteners shall be coated where possible and/or adequately electrically insulated between fasteners and the base material.

## 4.4 EQUIPMENT

### 4.4.1 MEASURING EQUIPMENT

The Contractor shall have the following measuring equipment at his shop or site at all times:

Ambient temperature gauge
Blast profile gauge
Dew point instrument
Dry film thickness gauge
Electric insulation defect detector
Surface temperature gauge
Relative humidity instrument
Wet film comb

All test equipment shall have current calibration certification.

All instruments shall be calibrated daily, except where otherwise specified by manufacturers, to achieve the required accuracy.

Dry film thickness gauges shall be calibrated on a flat surface, provided that the surface profile is in accordance with the specification.

### 4.4.2 SPRAY EQUIPMENT

Spray equipment shall be suitable for the production of high quality work, capable of properly atomising the coating material and equipped with suitable pressure regulators and gauges. Air caps, needles and nozzles shall be of the type recommended by the coating manufacturer.

All spray equipment shall be fitted with suitable oil and moisture traps.

### 4.4.3 MIXER

A low speed mixer, which does not introduce air into the coating material being mixed, shall be utilised.

## 4.5 INSTALLATION REQUIREMENTS

### 4.5.1 SUPPORTS

When pipes are installed or mounted on concrete supports, rubber insertion shall be used to insulate the pipe from the support. The thickness of the rubber insertion shall not be less than 10 mm and protrude not less than 20 mm all round.

### 4.5.2 ANCHORS IN CONCRETE

All permanent anchors in concrete shall be stainless steel to ASTM A240 grade 316.

Special care shall be taken to ensure that anchors be installed to the correct level and depth. Anchors shall not be cut after installation without prior inspection and approval of the Engineer.

To avoid a galvanic reaction (stainless steel/galvanizing) under wet conditions, the nut and washer shall be FBE coated. Where necessary caps shall be specified by the Corrosion Engineer.

### 4.5.3 SEALING

Pipes that enter or exit concrete shall be sealed on their circumference with a continuous polyurethane or polysulphide flexible sealer, in a 25 mm square recess, approved by the Corrosion Engineer.

### 4.5.4 ARMOURING

Armoured or special protection shall be applied to surfaces at all road and rail crossings, through sleeves and culverts, and as requested by the Engineer.

## 4.6 HANDLING AND TRANSPORT

### 4.6.1 PHYSICAL PROTECTION

Adequate provision shall be made for the protection of the pipe coating, between the completion of manufacture and installation.

The coated items shall not be handled within the drying time recommended by the coating manufacturer, relevant to the ambient temperature.

### 4.6.2 END COVERS

After inspection, testing and final acceptance, all ends (including branch ends), shall be sealed as follows:

All plain ends shall be sealed with plastic or other approved sheeting secured to the pipe circumference with double flat steel binding strips and all flanged ends shall be closed off with sturdy timber flanges.

All plastic covers and timber flanges to be clearly marked:

“NOT TO BE REMOVED BEFORE INSTALLATION”

Plastic covers and timber flanges shall remain in place during, handling, transport, storage and laying.

### 4.6.3 LIFTING

All coated items shall only be lifted by means of broad band slings that will not damage the coating. Slings shall not be less than 500 mm wide for pipes up to 500 mm nominal bore, 1 000 mm wide for larger pipes and 50 mm wide for other items, or as approved by the Engineer.

### 4.6.4 MARKING OF PIPES, CRATES AND BAGS

(a) Each pipe and special shall be legibly, indelibly and durably marked, (in such a manner that the coating is not damaged), with the following information:

- Contract number,
- Scheme name,
- Serial number of the pipe or special,
- Nominal diameter,
- Grade and thickness of steel,
- Hydrostatic test pressure,
- Item number.

(b) The bags and crates shall be tagged using metallic tags and shall indicate the following information:

- Contract number,
- Scheme name,
- Part numbers,
- Description,
- Sizes,
- Quantities.

Each bag or crate shall have the delivery address listed on a separate metallic tag.

### 4.6.5 TRANSPORT

Coated items shall be handled with due regard to the relatively soft nature of organic coatings and appropriate precautions shall be taken.

The Contractor is responsible for the safe delivery of all the items and small parts to site without damage. All items shall be securely packed to prevent damage while in transit.

If transported by a third party , the Contractor is responsible for ensuring protection of items as specified.

Precaution shall be taken to support and chock pipes on padded cradles or saw-dust filled bags to prevent movement when loading onto vehicles.

Where items are transported, the packing shall be of a thickness and positioned to ensure that they do not touch when they flex.

Items shall be firmly lashed or chained with padded lashing. The area of padded surfaces shall be adequate to prevent damage to coatings.

Bolts in strong hessian bags and other small components shall be labelled and crated. The bags and crates shall be tagged using metallic tags and shall be marked in accordance with paragraph 4.6.4 (b).

Each bag or crate shall have the delivery address listed on a separate metallic tag.

The Site Engineer shall be notified of the delivery date and of any requirements regarding off-loading and storage at site.

### 4.6.6 OFF-LOADING AT SITE

The supplier shall be responsible for the transportation and supervision during off-loading of the equipment and other small components at the delivery site.

Under no circumstances shall coated equipment be allowed to rest directly on the ground.

The final delivery inspection and acceptance of equipment supplied shall be undertaken on site after off-loading has been completed.

### 4.6.7 STACKING AND STORAGE

The Contractor shall provide all the necessary balks of timber and saw-dust filled bags used to support the items on soil, concrete or other hard surface and to separate them from each other both at his works and on site.

Grass or other vegetation shall not be allowed to grow in the storage area within three metres of the equipment.

### 4.6.8 DAMAGE

Any damage that occurs during the handling and storage of items at the Manufacturer/Contractor's works, including transportation to site, shall be repaired by the Manufacturer/Contractor at his own cost, in accordance with the specification and to the approval of the Engineer.

### 4.6.9 REJECTION

The Engineer has the right to reject any damaged items and materials which have been delivered and off-loaded at site.

# 5. RECOMMENDED COATING SYSTEMS

## 5.1 TOXICITY OF LINING MATERIAL

Materials used for the lining of pipes shall be non-toxic and shall not impart any odour, taste, or colour to the water. Certification shall be submitted to the Corrosion Engineer for his approval.

## 5.2 PROPRIETARY ITEMS

Components that are supplied painted or protected e.g. gearboxes, actuators etc. **shall only be accepted** provided that they meet the corrosion protection requirements of this specification. If this specification cannot be adhered to the Contractor **shall submit full details of the equivalent coating systems** at tendering stage for approval by the Corrosion Engineer.

## 5.3 COATING SYSTEMS FOR PUMP STATIONS

Selection of all corrosion protection systems shall be cleared with the Corrosion Engineer before finalisation of the Project Specification.

The following tables are abbreviated guidelines and the systems are not listed in order of preference.

See **NOTES** under paragraph 5.16.

## 5.4 PUMPS

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **Wet** | SG<br>CI | Lining and Coating | 1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified | 400<br>25 |
| | | | 2. FBE | 250 |
| **Dry** | SG<br>CI | Coating | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane | 250<br>40 |
| | | | 2. FBE plus top coat of Re-coatable Polyurethane | 200<br>40 |
| **Wet** | SG | Machined close tolerance | Long life Molybdenum Disulphide lubricant | 10-15 |
| **Abrasive conditions** | SG<br>CS | Lining | Abrasion resistant coating – refer paragraph 5.3 | |
| **Submerged** | SG | Coating | 1. Two pack Epoxy | 400 |
| | | | 2. FBE | 250 |

## 5.5 MOTORS

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **Dry** | MS | Lining | 1. Two pack Epoxy | 250 |
| | | Coating | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane | 250<br>40 |
| | SG<br>CI | Coating | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane | 125<br>40 |
| | | | 2. FBE plus top coat of Re-coatable Polyurethane | 100<br>40 |
| | DCA | Coating | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane | 75<br>40 |
| | | | 2. FBE plus top coat of Re-coatable Polyurethane | 75<br>40 |
| **Wet** | SG<br>CI | Coating | 1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified | 400<br>25 |

## 5.6 BASE PLATES AND STEELWORK

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **Dry** | MS | | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane | 250<br>40 |
| | | | 2. Multi-purpose Epoxy plus top coat of Re-coatable Polyurethane if required | 250<br>40 |
| | | | 3. HDG | 105 |
| **Submerged** | MS | | 1. Two pack Epoxy | 400 |
| | | | 2. Multi-purpose Epoxy | 400 |
| | SS 316 | | Pickle and passivate – See note 4 | |
| | MS | Machined close tolerance | Long life Molybdenum Disulphide lubricant | 10-15 |

## 5.7 VALVES AND FLOWMETERS

### 5.7.1 VALVES AND FLOWMETERS (INCLUDING HANDWHEELS)

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| | MS<br>SG | Lining | 1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified | 400<br>25 |
| | | | 2. FBE plus top coat of pure Aliphatic Polyurethane – where specified | 250<br>25 |
| | SS 316 | Lining | 1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified | 150<br>25 |
| | | | 2. FBE plus top coat of pure Aliphatic Polyurethane – where specified | 125<br>25 |
| | | | 3. Pickle and passivate – See note 3 | |
| **Dry** | MS<br>SG | Coating | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane | 250<br>40 |
| | | | 2. Multi-purpose Epoxy plus top coat of Re-coatable Polyurethane if required | 250<br>40 |
| | | | 3. FBE plus top coat of Re-coatable Polyurethane | 200<br>40 |
| **Wet** | MS<br>SG | Coating | 1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified | 400<br>25 |
| | | | 2. FBE plus top coat of pure Aliphatic Polyurethane | 250<br>25 |
| | SS 316 | Coating | 1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified | 150<br>25 |
| | | | 2. FBE plus top coat of pure Aliphatic Polyurethane – where specified | 125<br>25 |
| | | | 3. Pickle and passivate – See note 3 | |

### 5.7.2 GEARBOXES

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **Dry/Wet** | CI<br>SG | Lining | 1. Two pack Epoxy | 150 |
| | | | 2. FBE | 125 |
| | | Coating | As per the valve specification – refer paragraph 5.7.1 | |

## 5.7.3 HYDRAULIC EQUIPMENT

### 5.7.3.1 HYDRAULIC CYLINDERS

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **Dry/Wet** | MS<br>SS 304<br>SS 316 | Coating | As per the valve specification – refer paragraph 5.7.1 | |

### 5.7.3.2 PIPES

| ENVIRONMENT | MATERIAL | SYSTEM |
|---|---|---|
| **Dry/Wet** | SS 316 | Pickle and passivate (avoid MS contact and contamination) |

### 5.7.3.3 POWER PACKS

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **Dry** | MS | Lining | Two pack Epoxy | 200 |
| | | | FBE | 125 |
| | | Coating | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane | 250<br>40 |
| | | | 2. Multi-purpose Epoxy plus top coat of Re-coatable Polyurethane if required | 250<br>40 |
| | | | 3. FBE plus top coat of Re-coatable Polyurethane | 200<br>40 |
| **Wet** | MS | Coating | 1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane | 400<br>25 |
| | | | 2. FBE plus top coat of pure Aliphatic Polyurethane | 250<br>25 |
| | 3CR12 | Lining | Two pack Epoxy | 150 |
| | | | FBE | 125 |
| | | Coating | 1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane | 250<br>25 |
| | | | 2. FBE plus top coat of pure Aliphatic Polyurethane | 125<br>25 |
| | SS 304 | Coating | Pickle and passivate - See note 3 | |

### 5.7.4 ELECTRICAL EQUIPMENT

#### 5.7.4.1 ACTUATORS

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **Dry/Wet** | SG CI | Coating | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane – where specified | 250<br>40 |
| | | | 2. FBE plus top coat of Re-coatable Polyurethane – where specified | 200<br>40 |
| | DCA | Coating | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane – where specified | 200<br>40 |
| | | | 2. FBE plus top coat of Re-coatable Polyurethane – where specified | 150<br>40 |
| | SG/CI gearbox | Lining | 1. Two pack Epoxy | 125 |
| | | | 2. FBE | 100 |

## 5.8 PIPES AND SPECIALS

### 5.8.1 ABOVE GROUND

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **Above ground**<br><br>**For wet conditions see paragraph 5.8.5** | MS | Lining | 1. Two pack Epoxy | 400 |
| | | | 2. FBE | 300 |
| | | | 3. Elastoplastic Polyurethane | 1-3 mm |
| | | | 4. HDG – See note 1 | 105 |
| | | Coating | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane | 250<br>40 |
| | | | 2. Multi-purpose Epoxy plus top coat of Re-coatable Polyurethane if required | 250<br>40 |
| | | | 3. FBE plus top coat of Re-coatable Polyurethane | 200<br>40 |
| | | | 4. HDG – See note 1<br>If required: Epoxy primer for galvanised surfaces plus top coat of Re-coatable Polyurethane | 105<br>40-80<br><br>40 |

### 5.8.2 ENCASED IN CONCRETE

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **Encased in concrete** | 3CR12 (See note 9) MS (See note 10) | Lining | 1. Two pack Epoxy | 400 |
| | | | 2. FBE | 300 |
| | | | 3. Elastoplastic Polyurethane | 2 mm |
| | 3CR12 | Coating | 1. Two pack Epoxy | 250 |
| | | | 2. FBE | 200 |
| | MS | Coating | 1. Two pack Epoxy | 300 |
| | | | 2. FBE | 250 |
| | SS 304 or SS 316 See note 6 | Lining | 1. Two pack Epoxy | 250 |
| | | | 2. FBE | 175 |
| | | | 3. Elastoplastic Polyurethane | 1 mm |
| | | Coating | 1. Two pack Epoxy plus sealant of Polyurethane or Polysulphide – See note 2 | 150 |
| | | | 2. FBE plus sealant of Polyurethane or Polysulphide - See note 2 | 100 |
| | | | 3. Pickle and passivate – See note 3 | |
| **Buried in soil - chamber to coupling** | All materials | Coating | Petrolatum wrapping system – refer Section 12 | |

### 5.8.3 BURIED IN SOIL

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **Buried in soil** | MS | Lining | 1. Two pack Epoxy | 400 |
| | | | 2. FBE | 300 |
| | | | 3. Elastoplastic Polyurethane | 1-3 mm |
| | | Coating Depth < 4 m | 1. Reinforced bitumen – refer paragraph 11.3.4 | |
| | | | 2. FBPE | 2-3 mm |
| | | | 3. Tape wrapping – refer paragraph 12.3.4 | |
| | | | 4. Two pack Epoxy plus tape wrapping – refer paragraph 12.3.5 | 300 |
| | | | 5. FBE plus tape wrapping – refer paragraph 12.3.5 | 200 |
| | | Coating Depth > 4 m and proximity of other services | 1. Reinforced bitumen – armour wrapping - refer paragraph 11.3.4 | |
| | | | 2. FBPE | 2-3 mm |
| | | | 3. Armoured tape wrapping – refer paragraph 12.3.4 | See par. 12.3.5 |
| | | | 4. Two pack Epoxy plus tape wrapping – refer paragraph 12.3.5 | 400 |
| | | | 5. FBE plus tape wrapping – refer paragraph 14.4 | 300 |

### 5.8.4 IN CHAMBER WALLS

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **In chamber walls** | 3CR12 MS | Lining | 1. Two pack Epoxy | 400 |
| | | | 2. FBE | 300 |
| | | | 3. Elastoplastic Polyurethane | 1-3 mm |
| | | | 4. HDG plus<br>Epoxy primer plus<br>two pack Epoxy | 105<br>40-80<br>300 |
| | | | 5. HDG plus<br>FBE | 105<br>250 |
| | | Coating<br>See note 2 | 1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane plus sealant of Polyurethane or Polysulphide - See note 2 | 400<br>25 |
| | | | 2. FBE plus top coat of pure Aliphatic Polyurethane plus sealant of Polyurethane or Polysulphide - See note 2 | 300<br>25 |
| | | | 3. HDG plus<br>Epoxy primer plus<br>two pack Epoxy plus top coat of pure Aliphatic Polyurethane | 105<br>40-80<br>300<br>25 |
| | | | 4. HDG plus<br>FBE plus top coat of pure Aliphatic Polyurethane | 105<br>275<br>25 |
| | SS 304 or SS 316 | Lining | 1. Two pack Epoxy | 250 |
| | | | 2. FBE | 175 |
| | | | 3. Elastoplastic Polyurethane | 1 mm |
| | | Coating | 1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane plus sealant of Polyurethane or Polysulphide – See note 2 | 150<br>25 |
| | | | 2. FBE plus top coat of pure Aliphatic Polyurethane plus sealant of Polyurethane or Polysulphide - See note 2 | 100<br>25 |
| Buried in soil – chamber to coupling | All materials | Coating | Petrolatum wrapping system – refer Section 12 | |

### 5.8.5 IN WATER

| ENVIRONMENT | MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|---|
| **In water and severe corrosion conditions** | 3CR12 MS | Lining | 1. Two pack Epoxy | 400 |
| | | | 2. FBE | 300 |
| | | | 3. Elastoplastic Polyurethane | 1-3 mm |
| | | Coating | 1. Two pack Epoxy plus pure Aliphatic Polyurethane | 400<br>25 |
| | | | 2. FBE | 300 |
| | | | 3. Elastoplastic Polyurethane | 1-3 mm |
| | | | 4. FBPE | 2-3 mm |
| | SS 304 See note 6 | Lining | 1. Two pack Epoxy | 250 |
| | | | 2. FBE | 150 |
| | | | 3. Elastoplastic Polyurethane | 1 mm |
| | | Coating | 1. Two pack Epoxy | 250 |
| | | | 2. FBE | 150 |

## 5.9 COUPLINGS AND FLANGE ADAPTORS ( SEE PARAGRAPH 5.10 )

| MATERIAL | SURFACE | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| MS | Lining and Coating | 1. Two pack Epoxy | 400 |
| | | 2. FBE | 300 |
| | | 3. HDG plus<br>Epoxy primer plus<br>Two pack Epoxy | 105<br>40-80<br>250 |
| | | 4. HDG plus<br>FBE | 105<br>250 |
| SS 304 | Lining and coating | Pickle and passivate – See note 4 | |
| SS 304 buried | Lining and coating | 1. Two pack Epoxy | 150 |
| | | 2. FBE | 125 |

## 5.10 JOINTS

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Plain Ended Pipes where couplings or flange adaptors are to be fitted** | MS | Same as lining material for 300 mm from end | 400 |
| | | Two pack Epoxy for cement mortar lining with 100 mm overlap inside and outside | 400 |
| **Flanges of Bitumen wrapped pipes** | MS | Same as lining material on top and back of flange with an overlap of 100 mm from the flange | 400 |
| | | Two pack Epoxy for cement mortar lining with 100 mm overlap inside and outside | 400 |
| **Flange faces** | MS | Two pack Epoxy or FBE | 60 - 90 |
| **Coupling or Flanged Joints Buried in Soil or in Wet Chambers** | MS<br>SS 304<br>SS 316 | Coating system plus Petrolatum wrapping system - refer Section 13 | |
| **Welded Joints Buried in Soil and encased in concrete** | MS<br>SS 304<br>SS 316 | As specified for lining and coating | |

## 5.11 STAINLESS STEEL ITEMS

| SURFACES | COATING | MINIMUM DFT (µm) |
|---|---|---|
| **Stainless steel components (Dissimilar materials in submerged conditions)** | Two pack Epoxy or FBE to a smooth, glossy and uniform finish | 125 |
| **3CR12 steel components (All submerged conditions)** | Two pack Epoxy or<br>FBE | 400<br>250 |
| **Stainless steel components (Dry or compatible metal conditions)** | Pickle and passivate – See note 4 | |
| **3CR12 steel components (Dry conditions only)** | Pickle and passivate – See note 4 | |

## 5.12 FASTENERS AND ANCHORS

### 5.12.1 FASTENERS

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Fasteners and washers - Dry** | MS | HDG plus threads coated with Molybdenum Disulphide lubricant or wax | 45 |
| | SS 304 | Threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound | Uniform cover |
| **Fasteners and washers - Wet/Submerged** | SS 316 | 1. Pickle and passivate - See note 3 plus threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound | Uniform cover |
| | | 2. FBE coated (thread surfaces excluded) plus threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound | 50 |
| **Fasteners and washers – Buried in soil** | MS | 1. HDG plus threads coated with Molybdenum Disulphide lubricant or wax plus Bitumen or Tape wrapping | 45 |
| | SS 304 | 1. Threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound plus Bitumen or Tape wrapping | Uniform cover |
| **Fasteners for flange adaptors – Drilled and tapped** | MS | HDG plus wet assembly with Epoxy or threads coated with Molybdenum Disulphide lubricant | 45 |
| | SS 304 | Pickle and passivate - See note 3 plus wet assembly with Epoxy | Uniform cover |
| **Fasteners for flange adaptors – Welded** | SS 304 | Pickle and passivate - See note 3 | |

### 5.12.2 ANCHORS

| ENVIRONMENT | MATERIAL | SYSTEM | |
|---|---|---|---|
| **Anchors in concrete - Dry**<br>See paragraph 4.5.1 | SS 316 | Threads coated with Molybdenum Disulphide Lubricant or Nickel Anti-seize compound | Uniform cover |
| **Anchors in concrete – Wet**<br>See paragraph 4.5.1 | SS 316 | Threads coated with Molybdenum Disulphide Lubricant or Nickel Anti-seize compound plus nut and washer FBE coated | Uniform cover<br><br>50 |

## 5.13 CRANES AND HOISTS

### 5.13.1 CRANE STRUCTURES

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor and outdoor** | MS | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane | 250<br>40 |
| | | 2. Multi-purpose Epoxy plus top coat of Re-coatable Polyurethane if required | 250<br>40 |
| | | 3. HDG – See note 1<br>if required:<br>Epoxy primer for galvanised surfaces plus top coat of Re-coatable Polyurethane | 85<br><br>40-80<br>40 |

### 5.13.2 CRANE STRUCTURES FIXED TO CONCRETE

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor and outdoor** | MS | 1. Two pack Epoxy plus top coat of Re-coatable Polyurethane plus grout under base plus Polyurethane sealant | 250<br>40 |
| | | 2. Multi-purpose Epoxy plus top coat of Re-coatable Polyurethane if required plus grout under base plus Polyurethane sealant | 300<br>40 |
| | | 3. HDG - See note 1<br>if required: Epoxy primer for galvanised surfaces plus<br>top coat of Re-coatable Polyurethane plus grout under base plus Polyurethane sealant | 85<br>40-80<br><br>40 |

### 5.13.3 CRAWL BEAMS

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor - Dry** | MS | HDG - See note 1 | 85 |
| **Indoor - Wet** | MS | HDG - See note 1<br>Plus duplex system. See paragraph 9.7 | 85 |
| **Outdoor** | MS | HDG - See note 1 | 85 |

### 5.13.4 RAILS BOLTED TO CONCRETE

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor - Dry** | MS | Multi-purpose Epoxy:<br>Sides and bottom<br>Rolling surface | <br>250<br>60-90 |
| **Indoor – Wet** | MS | Coal Tar Epoxy:<br>Sides and bottom<br>Rolling surface | <br>250<br>60-90 |
| **Outdoor** | MS | Multi-purpose Epoxy:<br>Sides and bottom<br>Rolling surface | <br>250<br>60-90 |

## 5.14 PLATFORMS, LADDERS, HANDRAILS AND FLOORING

### 5.14.1 PLATFORMS, WALKWAYS AND FLOORING

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor – Dry** | MS | HDG – See note 1 | 85 |
| | 3Cr12 | Pickle and passivate – See note 3 | |
| | SS 304 | Pickle and passivate | |
| **Indoor – Wet** | 3Cr12 | Pickle and passivate – See note 3 | |
| | SS 304 | Pickle and passivate | |
| **Outdoor** | MS | HDG – See note 1 | 85 |
| | 3Cr12 | Pickle and passivate – See note 3 | |
| | SS 304 | Pickle and passivate | |
| **Immersed** | SS 304 | Pickle and passivate – See note 3 | |
| | SS 316 | Pickle and passivate | |

### 5.14.2 LADDERS

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor – Dry** | MS | HDG – See note 1 | 85 |
| | SS 304 | Pickle and passivate | |
| **Indoor – Wet** | SS 304 | Pickle and passivate | |
| **Outdoor** | MS | HDG – See note 1 | 85 |
| | SS 304 | Pickle and passivate | |
| **Immersed** | SS 304 | Pickle and passivate – See note 3 | |
| | SS 316 | Pickle and passivate | |

### 5.14.3 HANDRAILS AND BALUSTRADES

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor – Dry** | MS | HDG – for material refer paragraph 10.2 (b) (i) | 85 |
| | 3Cr12 | Pickle and passivate – See note 3 | |
| | | Two pack Epoxy plus<br>Re-coatable Polyurethane | 125<br>40 |
| | | FBE | 75 |
| | | FBP | 75 |
| | SS 304 | Pickle and passivate | |
| | Al | Anodised | 25 |
| **Indoor – Wet** | 3Cr12 | FBE | 100 |
| | | Two pack Epoxy plus<br>pure Aliphatic Polyurethane | 125<br>25 |
| | SS 304 | Pickle and passivate | |
| | Al | FBE | 100 |
| **Outdoor** | MS | HDG – for material refer paragraph 10.2 (b) (i) | 85 |
| | 3Cr12 | Two pack Epoxy plus<br>Re-coatable Polyurethane | 125<br>50 |
| | | FBP | 100 |
| | SS 304 | Pickle and passivate | |
| | Al | Anodised | 25 |
| | | FBP | 100 |

## 5.15 CONTROL CABINETS/PANELS

### 5.15.1 ELECTRICAL PANELS AND ENCLOSURES

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor – Dry** | MS | 1. Multi-purpose Epoxy plus<br>Re-coatable Polyurethane if required | 250<br>40 |
| | | 2. Two pack Epoxy plus<br>Re-coatable Polyurethane | 250<br>40 |
| | | 3. FBE | 125 |
| | PC<br>ABS<br>DCA | Un-coated | |
| | GRP | Polyester gelcoat | 250 |
| | 3Cr12 | 1. Multi-purpose Epoxy plus<br>Re-coatable Polyurethane if required | 125<br>40 |
| | | 2. Two pack Epoxy plus<br>Re-coatable Polyurethane | 125<br>40 |
| | | 3. FBE | 100 |
| **Indoor – Wet** | 3Cr12<br>SS 304 | 1. Two pack Epoxy plus<br>Re-coatable Polyurethane | 250<br>40 |
| | | 2. FBE | 125 |
| | DCA | FBE | 75 |
| | PC<br>ABS | Un-coated | |
| | GRP | Polyester gelcoat | 250 |
| **Outdoor** | 3Cr12<br>SS 304 | 1. FBP | 150 |
| | | 2. Multi-purpose Epoxy plus<br>Re-coatable Polyurethane if required | 250<br>40 |

### 5.15.2 TRANSFORMERS

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor and Outdoor** | MS | Multi-purpose Epoxy | 300 |

### 5.15.3 DIESEL GENERATOR

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor and outdoor** | MS | Multi-purpose Epoxy – See note 11 | 300 |
| | 3Cr12 | Multi-purpose Epoxy | 150 |
| | SS 304 | Multi-purpose Epoxy | 150 |
| Items subjected to high temperatures | | See note 11 | |

### 5.15.4 INDUSTRIAL SWITCHED SOCKET OUTLETS AND LIGHT SWITCH HOUSINGS

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor – Dry** | PVC | Un-coated | |
| | DCA | FBE | 50 |
| **Indoor – Wet** | PVC | Un-coated | |
| | DCA | FBE | 75 |
| **Outdoor** | DCA | FBP | 75 |

### 5.15.5 CABLE SUPPORT SYSTEMS

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Dry Not exposed to UV** | MS | 1. Two pack Epoxy | 250 |
| | | 2. Multi-purpose Epoxy | 250 |
| | | 3. FBE | 150 |
| | | 4. HDG | 85 |
| | 3Cr12 | Pickle and passivate – See note 4 | |
| **Dry Exposed to UV** | MS | 1. Two pack Epoxy plus Re-coatable Polyurethane | 250 40 |
| | | 2. Multi-purpose Epoxy | 300 |
| | | 3. FBP | 150 |
| | | 4. HDG | 85 |
| | 3Cr12 | Pickle and passivate – See note 4 | |
| **Wet** | 3Cr12 | FBE | 100 |
| | SS 304 SS 316 | Pickle and passivate – See notes 3 and 4 | |

### 5.15.6 INDUSTRIAL LIGHT FITTINGS

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor – Dry** | MS | FBE | 50 |
| | DCA | FBE | 50 |
| **Indoor – Wet** | DCA | FBE | 75 |
| | GRP | Polyester gelcoat | 250 |
| **Outdoor** | DCA | FBP | 75 |
| | GRP | Polyester gelcoat | 250 |

### 5.15.7 CONDUIT

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor - Dry** | MS | HDG | 65 |
| | PVC | Un-coated | |
| **Indoor - Wet** | SS 304 | Pickle and passivate – See notes 3 and 4 | |
| | PVC | Un-coated | |
| **Outdoor** | MS | HDG | 65 |
| | SS 304 | Pickle and passivate – See notes 3 and 4 | |
| **Underground** | HDPE<br>PVC | Un-coated | |
| | SS 304 | Pickle and passivate – See notes 3 and 4 | |

### 5.15.8 JUNCTION BOXES

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor – Dry** | DCA | FBE | 50 |
| | PVC | Un-coated | |
| | GRP | Polyester gelcoat | 250 |
| **Indoor - Wet** | DCA | FBE | 75 |
| | PVC | Un-coated | |
| | GRP | Polyester gelcoat | 250 |
| **Outdoor** | DCA | FBP | 75 |

### 5.15.9 LIGHT POLES AND MASTS

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor** | GRP | Polyester gelcoat | 250 |
| | SS 304 | Pickle and passivate – See note 4 | |
| **Outdoor** | MS | HDG | 105 |
| | GRP | Polyester gelcoat | 250 |
| | 3Cr12<br>SS 304 | Pickle and passivate – See note 4 | |

### 5.15.10 CABLE MOUNTING STRAPS AND CLAMPS

| ENVIRONMENT | MATERIAL | SYSTEM | MINIMUM DFT (µm) |
|---|---|---|---|
| **Indoor** | MS | HDG | 45 |
| | PVC | Un-coated | |
| | SS 304 | Un-coated | |
| **Outdoor** | SS 304 | Un-coated | |

## 5.16 ABBREVIATIONS AND NOTES

### ABBREVIATIONS

ABS : Acrylnitrile-butadiene-styrene
Al : Aluminium
CI : Cast iron - grade 220
CS : Cast steel
DCA : Die cast aluminium
DFT : Dry film thickness
FBE : Fusion-bonded Epoxy
FBP : Fusion-bonded Polyester
FBPE : Fusion-bonded Polyethylene
GRP : Glass fibre reinforced Polyester
HDG : Hot-dip galvanized
HDPE : High Density Polyethylene
PC : Polycarbonate
PVC : Polyvinylchloride
MS : Mild steel – grade 300WA
SG : Spheroidal graphite cast iron – grade 420
SS : Stainless steel – grades 304, 304L, 316 and 316L
UV : Ultra Violet
3Cr12 : Corrosion resistant steel
µm : Micrometer

### NOTES

**The following items shall be approved by the Corrosion Engineer**

1. Hot-dip galvanizing
   - Only for pipes up to 200 mm diameter maximum and flow less than 2 m/s.
   - Pipes shall not be embedded in concrete.
   - Water analysis shall be provided.
   - Pipes over 200 mm diameter to be coated with a duplex system

2. Sealant
   - Interfaces of different environments shall be sealed with a Polyurethane or Polysulphide flexible sealant to be applied in accordance with the manufacturers data sheets.

3. Un-coated stainless steel
   - Only to be used if no galvanic reaction and anaerobic conditions are found.

4. Pickle and passivate
   - If not in contact with less noble material.
   - If exposed to anaerobic conditions seal-coat all crevices with Elastoplastic Epoxy.
   - Shall be done by the dipping process.

5. Galvanic cells
   - Where a galvanic cell is situated within a water path <150 mm and concrete cover <75 mm, both the MS, 3Cr12 or SS shall be coated.

| | | |
|---|---|---|
| 6. | Anaerobic conditions | - SS grade 316L shall be used under anaerobic and aggressive water conditions. |
| 7. | Polyurethane for colour coding | - Re-coatable or pure Aliphatic Polyurethane where required for colour coding.<br>Only UV resistant Polyurethane shall be used. |
| 8. | Primers | - Primers shall only be used in special cases i.e. over-coating of galvanized surfaces. |
| 9. | 3CR12 | - In view of superior corrosion resistance, coated 3CR12 material is preferred |
| 10. | Mild steel | - Mild steel may only be used where the pipe lining can be refurbished in situ |
| 11. | Items subjected to high temperatures | - Items to be manufactured out of stainless steel or coated with heat resistant paint. |
| 12. | Epoxy primer | - Epoxy primer may not be required if appropriate two pack Epoxy/ Re-coatable or pure Aliphatic Polyurethane is being used. |

# 6 MANUFACTURE AND PRE-PREPARATION

## 6.1 RESPONSIBILITY

### 6.1.1 PRE-PREPARATION

The Manufacturer or Refurbisher shall be responsible for all the pre-preparation of equipment prior to surface preparation. Pre-preparation shall be carried out to the approval of the Corrosion Engineer and the Corrosion Protection Contractor.

### 6.1.2 PERSONNEL

Pre-preparation shall be carried out by competent personnel, under the supervision of an experienced supervisor.

### 6.1.3 MARKING

All items shall be permanently and indelibly marked to identify each individual item as specified by the Engineer.

## 6.2 FABRICATION REQUIREMENTS

### 6.2.1 SURFACE DEFECTS

All extrusions, rolled steel and castings shall be clean and free of score marks, pits, protrusions, blisters, porosity, blowholes, cracks or any other flaws which may be detrimental.

Laminations, scabs or occluded scale shall be ground out. If such grinding penetrates deeper than 7% of the metal thickness, the area shall be repaired by welding or the metal shall be rejected at the discretion of the Engineer.

### 6.2.2 UNDERCUTS, CAVITIES AND PITS

Weld undercuts and cavities as well as pits in metal surfaces are not permitted.

All undercuts, cavities and pits shall be ground out, re-welded and ground to a smooth contour.

### 6.2.3 WELDS

All welds shall be continuous and shall have a smooth contour.

Staggered welds, where specified, shall only be permitted with prior approval of the Corrosion Engineer on submission of appropriate remedial corrosion protection procedures.

Welding processes used shall limit heat input to a minimum to restrict the heat affected zone.

### 6.2.4 LIFTING LUGS

Where required, lugs shall be fitted by the manufacturer to the requirements of the Corrosion Contractor and the approval of the Engineer.

#### 6.2.4.1 LUGS TO BE REMOVED

After removal the damaged coating area shall be repaired in accordance with the original Specification.

#### 6.2.4.2 PERMANENT LUGS

Lugs, not intended to be removed, shall be manufactured of equal or more noble grade than the base material in accordance with the Specification.

## 6.3 REFURBISHMENT

### 6.3.1 INSPECTION PROCEDURE

Corrosion damage must be exposed by manual, mechanical or abrasive blast-cleaning for inspection. The refurbishment procedures shall then be specified by the Engineer.

### 6.3.2 PREPARATION METHODS

(a) Smooth out all shallow pits with a pencil grinder.

(b) Weld up and grind to a smooth finish where:

- More than 25% of the material has been lost by pitting corrosion.
- Material loss detrimentally affects the strength of the item.

(c) Replace damaged section.

## 6.4 PRE-PREPARATION

### 6.4.1 GENERAL REQUIREMENTS

#### 6.4.1.1 PROTRUSIONS

Protrusions shall be removed by grinding and dressing to a smooth contour.

#### 6.4.1.2 SHARP EDGES

Burrs and rough faces caused by guillotining, flame cutting, drilling, machining or punching shall be removed by grinding.

All sharp edges shall be radiused to a minimum of 2 mm.

#### 6.4.1.3 WELDS

Welds shall be free from slag, slag inclusions, cracks, surface cavities and under-cuts.

Irregular projections shall be ground to a smooth contour.

Areas adjacent to welds shall be free from weld spatter. Such spatter shall be removed by grinding or scraping.

### 6.4.2 MATERIALS

#### 6.4.2.1 CASTINGS

Castings with defects exceeding the restrictions given in the table below shall be rejected.

In the case of blowholes occurring opposite each other, the combined depth shall be taken into account.

Blowholes and cavities not exceeding 2 mm depth shall be smoothed out by grinding.

**Acceptance criteria for the repair of blowholes and cavities.**

| SURFACE | DEPTH OF BLOWHOLES | DIAMETER OF BLOWHOLES | REPAIR |
|---|---|---|---|
| **Internal** | Maximum 20% of material thickness | 40% maximum of material thickness | Welding only |
| **External** | Maximum 10% of material thickness | 20% maximum of material thickness | Solvent free Epoxy or welding |
| **External** | 10 to 20% maximum of material thickness | 40% maximum of material thickness | Welding only |

Castings shall, after inspection by the Engineer, be ground smooth.

Small and repaired blowholes shall be ground level and smooth.

### 6.4.2.2 HOT-DIP GALVANIZED ITEMS

The design and manufacture of all items to be hot-dip galvanized shall conform to SABS Code of Practice 0214.

Vent holes shall be drilled by the manufacturer, in accordance with the above Code of Practice, to the approval of the Engineer and Galvanizer.

The Silicon and Phosphorus contents of materials to be galvanized shall comply with the standard below. If no material certificates are available, samples of the materials shall be analysed for their Silicon and Phosphorus contents.

The following materials shall be used:

(a) For aesthetic appearance
- Aluminium-killed steel or
- Silicon-killed steel with a Silicon content not exceeding 0,04% and a Phosphorus content not exceeding 0,02%.

**NOTE: Material certification shall be supplied.**

b) For general corrosion protection
- Aluminium killed steel or
- Silicon killed steel with a Silicon content not exceeding 0,25% and a Phosphorus content not exceeding 0,02%.

### 6.4.2.3 CORROSION RESISTANT STEELS

Fabrication shall take place in dedicated areas separated from carbon steel.

All equipment used in the forming and manipulation of stainless steel items during fabrication shall be clean and free of materials that may contaminate the metal with carbon steel.

The manufacture of items from corrosion resistant steels shall be in accordance with the SASSDA's Information Series and the guidelines of the material supplier.

Discoloration caused by welding or cutting shall be mechanically cleaned by buffing followed by pickling and passivation in accordance with the SASSDA's Information Series and the guidelines of the material supplier.

Organic contamination shall be removed by degreasing.

Iron contamination shall be removed by pickling and passivation, by the dipping process, after degreasing.

All surfaces shall be tested for free iron contamination by the water or the ferroxyl test method.

## 6.5 PRIMARY CLEANING

The Manufacturer or Refurbisher shall remove excessive oil, grease or other surface contaminants with a water soluble solvent degreaser followed by rinsing with clean soft water before the items are despatched to the Corrosion Protection Contractor.

# 7 SURFACE PREPARATION

## 7.1 STANDARDS

| | | |
|---|---|---|
| SABS | 1344 | Medium duty solvent detergent. |
| SABS | 064 | The preparation of surfaces for coating. |
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after overall removal of previous coatings. |
| SABS ISO | 8504-2 | Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning. |
| SABS Method | 770 | Cleanliness of blast-cleaned steel surfaces for painting (freedom of soluble salts). |
| SABS Method | 772 | Profile of blast-cleaned steel surfaces for painting (profile gauge). |
| SABS Method | 769 | Cleanliness of blast-cleaned steel surfaces for painting (freedom from dust and debris). |
| ISO | 11125 | Preparation of steel substrates before application of paints – Metallic blast-cleaning abrasives. |
| ISO | 11127 | Preparation of steel substrates before application of paints – Non-metallic blast–cleaning abrasives. |

## 7.2 RESPONSIBILITY

### 7.2.1 SURFACE PREPARATION

The corrosion protection Contractor shall be responsible for preparation of all surfaces to be coated.

On completion of the Contract, all plant, equipment, temporary structures and materials shall be removed from the site.

### 7.2.2 PERSONNEL

The Contractor carrying out the surface preparation shall have competent personnel with the necessary technical knowledge of the processes involved.

All work shall be carried out under the supervision of an experienced supervisor.

### 7.2.3 EQUIPMENT

Plant and equipment shall, to achieve the specified surface preparation, comply with the following:

(a) Equipment and air supply free of oil and moisture.

(b) Compressors shall have a capacity and pressure output to achieve the required nozzle pressures.

(c) Worn nozzles shall be replaced.

If the correct surface preparation is not achieved due to inadequate plant and equipment, the Engineer may order the Contractor to obtain such plant and equipment as may be necessary to achieve the specified results.

All plant, equipment and temporary structures shall at all times be maintained in good and safe working order.

### 7.2.4 WORKING CONDITIONS

Surface preparation shall not take place when conditions are likely to affect the corrosion protection processes adversely.

The Contractor shall provide screens, covers, trestles or any other equipment necessary to avoid contamination of surfaces and to minimise time delays caused by inclement weather.

### 7.2.5 HEALTH AND SAFETY

The Contractor's shall at all times enforce health and safety measures necessary to comply with the Occupational Health and Safety Act No. 85 of 1993 and the manufacturer's requirements.

## 7.3 PROCEDURE

### 7.3.1 APPROVAL OF WORKS AND PROGRAMME

The Contractor's programme, plant and equipment and works shall be approved by the Corrosion Engineer prior to commencement of surface preparation.

### 7.3.2 INITIAL INSPECTION

Before accepting items from the Fabricator, the corrosion protection Contractor shall check the initial condition of the surface for:

(a) Visible surface defects
(b) Corrosion or contamination
(c) Any required metal dressing
(d) Elimination of burrs and radiusing of edges
(e) Removing of weld spatter and weld imperfections such as blowholes
(f ) Suitable lifting lugs

### 7.3.3 DEGREASING

All surfaces to be coated shall be tested for oil and grease contamination by the water break free test.

Oil and grease contamination shall be removed by:
- Steam-cleaning.
- An emulsifiable or aqueous detergent applied in accordance with SABS 1344.
- An alkaline cleaning solution.

Allow to react, then rinse off with clean, potable water to remove all residues prior to surface preparation, all in accordance with clauses 3.3 and 3.4 of SABS 064.

The surfaces shall be tested after degreasing and show no oil, grease and chemical contamination after degreasing.

Care shall be taken to avoid entrapment of cleaning agents in recesses or other retention areas.

### 7.3.4 ROUGH-BLAST

All rust, millscale, old coating or marking paint shall be removed by rough-blasting.

The Engineer shall be advised when blast-cleaning of the appropriate section will be completed so that an inspection can be carried out to determine if repairs are required.

Blast-cleaning shall be done in accordance with the code of practice SABS 064 to achieve a cleanliness of Sa 2. (SABS ISO 8501-1)

### 7.3.5 WATER SOLUBLE SALTS

The surfaces to be coated shall be tested for water soluble salts after blast-cleaning. The maximum level of salts allowable on the surfaces shall not exceed the values given in paragraph 7.4.1.

Should these values be exceeded, the surfaces shall be cleaned by:

(a) A liquid soluble salt remover approved by the Corrosion Engineer or
(b) Washing with a high pressure jet of clean potable water or
(c) Water injected blast-cleaning or
(d) Flash blast-cleaning until the soluble salts are within the specified limits.

### 7.3.6 FINAL-BLAST

#### 7.3.6.1 FINAL-BLAST

##### 7.3.6.1.1 Humidity and Temperature

All blast-cleaned surfaces shall be coated within:

Four (4) hours when humidity is below 70% or

Two (2) hours when humidity is between 70% and 85%.

Final-blasting shall not be carried out if the steel temperature is less than 3°C above dew point.

##### 7.3.6.1.2 Blasting-material

Final blast-cleaning shall be carried out using clean, uncontaminated blast-medium in accordance with paragraph 7.4.2.

##### 7.3.6.1.3 Cleanliness

All surfaces for “wet/submerged conditions” and for “dry conditions” shall be blast-cleaned to Sa 3 and Sa 2½ respectively.

##### 7.3.6.1.4 Profile

The required surface profile specified in paragraph 7.4.1 shall be achieved by final-blasting in accordance with SABS 064 and SABS ISO 8504-2.

##### 7.3.6.1.5 Residual Dust and Debris

Prior to coating, dust and debris shall be removed by vacuum-cleaning in accordance with SABS 769. Dust and debris may only be removed by blowing with clean uncontaminated compressed air, with prior approval of the Corrosion Engineer.

##### 7.3.6.1.6 Contamination

After final-blasting un-coated steel shall not be touched with bare hands. All applicators shall wear white gloves and shoe covers where applicable.

#### 7.3.6.2 FLASH-BLAST

Flash blast-cleaning shall be carried out to reinstate the surfaces specified in paragraph 7.4.1, in accordance with paragraph 7.3.6.1.

#### 7.3.6.3 SWEEP-BLASTING

Sweep blast-cleaning is used to create a fine, even profile on soft materials and to remove portions of a coating.

The parameters for sweep blast-cleaning are as follows:

| | |
|---|---|
| Equipment and air supply | Free of oil and moisture |
| Nozzle pressure | Not greater than 300 kPa |
| Nozzle angle to the surface being cleaned | 30 to 60° |
| Sweeping distance | 450 to 600 mm |
| Abrasive – ultra fine non-metallic grit | Minimum 0,2 mm – maximum 0,8 mm |
| Grit | Only new grit shall be used |

## 7.4 REQUIREMENTS

### 7.4.1 SURFACE CONDITIONS

Prepared surfaces shall be in accordance with the table below.

| PROPERTY | FOR DRY CONDITIONS | FOR WET/SUBMERGED CONDITIONS | TAPE WRAPPING |
|---|---|---|---|
| Cleanliness to ISO 8501-1 (min) (SIS 055900) | Sa 2½ | Sa 3 | St 2 |
| Residual dust and debris (SABS Method 769) | 0,5% | 0,3% | 0,5% |
| Oil, grease and perspiration | Nil | Nil | Nil |
| Surface Profile (min)<br>Coats up to 200 µm (max) | 30 µm<br>50 µm | 30 µm<br>50 µm | -<br>- |
| Surface Profile (min)<br>Coats up to 300 µm (max) | 50 µm<br>80 µm | 50 µm<br>80 µm | -<br>- |
| Surface Profile (min)<br>Coats up to 500 µm (max) | 60 µm<br>100 µm | 60 µm<br>100 µm | -<br>- |
| Water soluble salts:<br>Maximum at any point.<br>Average of any 250 cm. | <br>500 mg/m$^2$<br>100 mg/m$^2$ | <br>100 mg/m$^2$<br>100 mg/m$^2$ | <br>500 mg/m$^2$<br>100 mg/m$^2$ |

Note: Surface profile shall be about ↓ of the coating thickness.

### 7.4.2 ABRASIVE MATERIAL

#### 7.4.2.1 MATERIAL

The blast-cleaning abrasive shall be composed of clean, sound hard particles free from foreign substances such as dirt, oil, grease, toxic substances, organic matter, water soluble salts and foreign metals.

#### 7.4.2.2 CERTIFICATION

The abrasive material supplier shall certify that all products supplied conform to all the requirements specified.

#### 7.4.2.3 SHAPE AND SIZE

The individual abrasive particles shall be angular in shape and within the following sizes:

| | |
|---|---|
| Non-metallic material | 0,2 to 0,8 mm or 0,4 to 1,4 mm |
| Metallic material | 0,3 to 0,9 mm |

#### 7.4.2.4 HARDNESS

The minimum hardness of abrasive material shall be as follows:

| | | |
|---|---|---|
| For non-metallic material | – | 6 on the Moh's scale |
| For metallic material | – | 390 HV |

#### 7.4.2.5 pH

The pH of the prepared slurry mixture shall not be below 6,2.

#### 7.4.2.6 WATER SOLUBLE SALTS

The conductivity of slurry shall be less than 25 mS/m in accordance with ISO 11127.

#### 7.4.2.7 MOISTURE CONTENT

The moisture content for abrasive material shall not exceed 0,2%.

#### 7.4.2.8 RE-CYCLING

Re-cycled blasting-material shall only be used if:

(a) Blasting-materials were only used on degreased surfaces
(b) Dust and debris is removed from the blasting-material
(c) Particles are kept angular and within specified sizes

### 7.4.3 AIR SUPPLY

The air pressure at the nozzle shall be a minimum of 600 to 700 kPa.

Air supply equipment shall be fitted with efficient oil and water traps to avoid contamination of the surface.

## 7.5 SURFACE PREPARATION OF OTHER MATERIALS

### 7.5.1 GALVANIZED SURFACES TO BE COATED

#### 7.5.1.1 PASSIVATION

Surfaces to be coated shall **not** be passivated.

#### 7.5.1.2 DEGREASING

Galvanized steel surfaces shall be degreased prior to coating, using either a water soluble solvent degreaser in accordance with SABS 1344 and the manufacturer's instructions, or a mild acid-detergent degreasing solution to be approved by the Corrosion Engineer.

#### 7.5.1.3 PROFILE

##### 7.5.1.3.1 Sweep-blasting

Large areas shall be prepared by sweep-blasting with non-metallic abrasive in accordance with paragraph 7.3.6.3. Cracking, flaking, or any form of delamination of the zinc coating due to excessive blast-cleaning shall not be permitted. Removal of zinc by blast-cleaning shall not exceed 10 µm.

##### 7.5.1.3.2 Mechanical

Surfaces that can not be sweep-blasted shall be abraded manually or mechanically with abrasive paper grade 220 or by using non-metallic abrasive pads.

#### 7.5.1.4 DUST AND DEBRIS

Finally, all dust and debris shall be removed by vacuum-cleaning.

#### 7.5.1.5 PRIMER

Primer for galvanised surfaces shall be applied immediately after surface preparation, not exceeding the time limits specified in paragraph 7.3.6.1.1.

### 7.5.2 ALUMINIUM SURFACES TO BE COATED

Aluminium surfaces to be coated shall be treated as follows:

#### 7.5.2.1 DEGREASING

Surfaces shall be degreased in accordance with paragraph 7.3.3.

#### 7.5.2.2 PROFILE

Sweep-blast with non-metallic abrasive in accordance with paragraph 7.3.6.3.

#### 7.5.2.3 DUST AND DEBRIS

All dust and debris shall be removed by vacuum-cleaning.

#### 7.5.2.4 PRIMER

Primer for aluminium surfaces shall be applied immediately after surface cleaning, not exceeding the time limits specified in paragraph 7.3.6.1.1.

### 7.5.3 CORROSION RESISTANT AND STAINLESS STEEL

Components fabricated from stainless steel shall not be contaminated with iron or mild steel.

#### 7.5.3.1 UN-COATED SURFACES

Stainless steel surfaces shall not be contaminated with carbon steel, scratched or stressed.

The following areas shall be pickled and passivated:

(a) All un-coated areas.

(b) Ground and sheared edges.

(c) Heat affected zones caused by welding or cutting.

It is recommended that, if possible, pickling and passivation be done by the dipping process.

Proprietary pickling and passivation chemicals (as supplied by approved suppliers) shall only be used in accordance with the manufacturer's recommendations. Care shall be taken not to exceed the maximum contact time recommended.

After pickling and passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. Surfaces shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturer.

#### 7.5.3.2 SURFACES TO BE COATED

##### 7.5.3.2.1 Degreasing

Surfaces shall be degreased in accordance with paragraph 7.3.3.

##### 7.5.3.2.2 Profile

Corrosion resistant steel surfaces shall be blast-cleaned with stainless steel grit or non-metallic abrasive to create a profile in accordance with table 7.4.1. The use of steel shot and steel or cast iron grit is strictly prohibited.

Where blasting is impractical, the surface shall be roughened manually with abrasive paper grade 220, disc grinders or flapper wheel abrasive pads. In all instances, clean, uncontaminated equipment must be used.

Surface profile shall be in the range of 30 to 50 µm.

##### 7.5.3.2.3 Dust and Debris

Dust and debris shall be removed by vacuum-cleaning.

### 7.5.4 SYNTHETIC MATERIALS TO BE COATED

#### 7.5.4.1 DEGREASING

Surfaces shall be degreased in accordance with paragraph 7.3.3.

#### 7.5.4.2 PROFILE

Abrade the surface with abrasive paper grade 220 to achieve a uniform matt finish.

#### 7.5.4.3 DUST AND DEBRIS

Dust and debris shall be removed by vacuum-cleaning.

### 7.5.5 COATED SURFACES

#### 7.5.5.1 PRIMED SURFACES TO BE OVER-COATED

##### 7.5.5.1.1 Degreasing

Surfaces shall be degreased in accordance with paragraph 7.3.3.

#### 7.5.5.1.2 Profile

Primers to be over coated outside the over-coating period shall be abraded with abrasive paper grade 220 to a uniform matt finish.

All un-coated areas and all areas with micro rust shall be re-blasted to the original surface finish as specified.

#### 7.5.5.1.3 Dust and Debris

Dust and debris shall be removed by vacuum-cleaning.

### 7.5.5.2 COATED SURFACES TO BE REPAIRED

Spot repairs shall be carried out in accordance with the original specification or as specified by the Corrosion Engineer. Repairs shall overlap the undamaged area by a minimum of 25 mm. Repairs shall be built up to the original undamaged coating thickness.

#### 7.5.5.2.1 Preparation of Bare Areas.

Bare areas shall be prepared by spot-blasting to Sa 3 in accordance with paragraph 7.3.6. If spot-blasting is not possible, clean with abrasive paper grade 220 to a bright metal surface.

#### 7.5.5.2.2 Soluble Salts

The surfaces shall be tested for water soluble salts in accordance with paragraph 7.3.5.

#### 7.5.5.2.3 Feathering of Coated Surfaces

The surrounding paint, which must be intact, shall be feathered for a minimum distance of 25 mm beyond the damaged areas.

#### 7.5.5.2.4 Dust and Debris

Dust and debris shall be removed by vacuum-cleaning.

### 7.5.5.3 COATED SURFACES TO BE OVER COATED

#### 7.5.5.3.1 Degreasing

Surfaces shall be cleared of all contamination and degreased in accordance with paragraph 7.3.3.

#### 7.5.5.3.2 Profile

Coated surfaces to be over-coated outside the over-coating period shall be abraded with abrasive paper grade 220 to a uniform matt finish.

#### 7.5.5.3.3 Dust and Debris

Dust and debris shall be removed by vacuum-cleaning.

#### 7.5.5.3.4 Solvent-wiping

The surfaces to be coated shall be wiped with the solvent specified by the coating manufacturer and approved by the Corrosion Engineer.

Further coats shall then be applied as specified in the Project Specification.

## 7.6 TEST METHODS

Tests, instruments, methods and criteria shall be as specified below or in the Project Specification.

### 7.6.1 FREE OF OIL AND GREASE

#### 7.6.1.1 WETTING WITH WATER

All surfaces cleaned of oil and grease shall be tested using the "water-break-free" method. The surface shall be wetted with water and the entire surface shall be covered by an unbroken film.

#### 7.6.1.2 SOLVENT-WIPING

Where water soluble lubricants may be present the surface shall be further tested by wiping with a clean cotton wool swab soaked in solvent. No stain shall be evident on the swab after solvent-wiping.

### 7.6.2 WATER SOLUBLE SALT CONTAMINANTS

Substrate surfaces shall be tested for the presence of water soluble salt contaminants in accordance with SABS Method 770 or by means of the Weber Reilly Test.

### 7.6.3 STANDARD OF MECHANICAL SURFACE PREPARATION

Mechanical surface preparation shall be visually compared to the standard shown in SABS ISO 8501-1.

### 7.6.4 BLAST PROFILE

The blast profile of the substrate surfaces shall be determined in accordance with SABS Method 772.

### 7.6.5 RESIDUAL DUST AND DEBRIS

Substrate surfaces shall be tested for the presence of residual dust and debris in accordance with SABS Method 769.

### 7.6.6 BLASTING-MATERIAL

All blasting-materials shall be approved by the Corrosion Engineer.

#### 7.6.6.1 METALLIC ABRASIVE

Abrasive shall be tested in accordance with ISO 11125 for particle size, hardness, density, foreign matter and moisture.

#### 7.6.6.2 NON-METALLIC ABRASIVE

Abrasive shall be tested in accordance with ISO 11127 for particle size, hardness, density, moisture and water soluble contaminants.

# 8 EPOXY COATING SYSTEM

## 8.1 STANDARDS

Equipment, materials and operational methods shall comply with the relevant SABS, ISO, BS, DIN or equivalent American Standard.

The Contractor shall ensure that he is in possession of the latest editions of all the relevant National Specifications, Codes of Practice or Standards referred to in this specification.

Reference is made to the latest issues of the following Standard Specifications:

| | | |
|---|---|---|
| SABS | 1091 | National colour standards for paint. |
| SABS | 1217 | The production of painted and powder coated steel pipes. |
| SABS Method | 769 | Cleanliness of blast-cleaned steel surfaces for painting (dust and debris). |
| SABS Method | 772 | Profile of blast-cleaned steel surfaces for painting. |
| SABS ISO | 2808 | Determination of film thickness. |
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| BSS | 5493 | Protective coating of iron and steel structures against corrosion. |
| SABS ISO | 9000 | Model for quality assurance in production and installation. |

## 8.2 MATERIAL

(a) The Contractor shall have the latest editions of all the relevant National Specifications and Codes of Practice and the manufacturer's data sheets of materials to be used available.

(b) Two pack Epoxies shall be in accordance with SABS 1217. Preference will be given to Contractor's utilising solvent free Epoxies in confined spaces.

Two pack Epoxies offered shall be either polyamide or polyamine cured.

(c) Multi-purpose Epoxy shall be of the high build, modified aluminium Epoxy mastic type, containing at least 90% solids.

(d) Materials and procedures shall comply with the relevant SABS Specifications and Codes of Practice.

(e) All materials in a coating system shall be purchased from the same manufacturer unless approved by the Corrosion Engineer.

(f) Details of coating materials to be supplied and approved – refer to paragraph 3.1.
The Contractor shall only proceed with the purchase of coating materials upon receipt of written approval from the Corrosion Engineer.

(g) Materials offered and subsequently approved shall not be changed without written approval of the Corrosion Engineer.

Coating material selection shall also be approved by the material manufacturer/supplier. The Contractor shall receive a written assurance from the material suppliers that the materials comply with the specified requirements.

(h) All coating materials shall be delivered in the manufacturer's original containers, clearly marked with the following:

- Manufacturer's name
- Product Brand and Reference Number
- Batch Number which may incorporate the date of manufacture
- Abbreviated instructions for storage and use of material, which shall include mixing ratios of the components of multi-component materials, minimum and maximum temperature of application and the method of application
- The SABS mark where applicable

(i) All coating materials shall be kept in an approved dry and enclosed store. The temperature shall not drop below 0°C nor exceed 40°C.

(j) Usage of materials shall be on a first in, first out basis and no materials shall be used that have exceeded the shelf life recommended by the manufacturer.

## 8.3 SPECIAL COATING AREAS

(a) Areas that are inaccessible after assembly shall be prepared and fully coated with the specified system to the specified requirements before assembly. The coating shall be fully cured before assembly.

(b) Mating surfaces of joints shall be coated with primer (where specified) or first coat only. The coating shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the outside surface of the joints shall be fully coated.

(c) Steel edges to be welded after coating shall not be coated for a distance of 50 mm from the welding edge. The unlined strip of grit blasted surface shall be temporarily protected with a coat of (red or a different colour to the lining/coating) weldable primer between coating application and installation.

(d) Friction grip areas shall be left un-coated unless otherwise specified.

## 8.4 APPLICATION

### 8.4.1 ACCEPTABILITY OF ITEMS TO BE COATED

Shall conform to sub-clause 4.1.1 of SABS 1217, with the proviso that pipes shall read items to be coated.

### 8.4.2 SURFACE PREPARATION

The Contractor shall satisfy himself that the condition of each item to be coated is such that it is fit for coating or lining, or both, as relevant. Immediately after surface preparation each item or special shall be examined, including the inside surface, where possible, for compliance with the relevant requirements of this sub-clause.

Pre- and surface preparation shall conform to Sections 6 and 7 respectively.

For pipes and specials intended for butt welding the prepared surfaces shall extend to the pipe ends.

### 8.4.3 COATING THICKNESSES

Coating thicknesses shall conform to Section 5 or as specified in the Project Specification.

### 8.4.4 MANUFACTURER'S INSTRUCTIONS

Recommendations supplied by the manufacturer in the form of the latest edition of printed data sheets, or given in writing on the manufacturer's letterhead, shall be followed.

The following details shall be made available to the applicator:

(a) Brand and type of epoxy resin
(b) Mixing and thinning instructions
(c) Recommended type and quantity of solvent required for thinning during application
(d) Pot life of mixed product
(e) Minimum and maximum recommended dry film thickness per coat
(f) Recommended time intervals between coats
(g) Recommended minimum and maximum steel surface temperatures during application
(h) Time for complete drying and curing on steel surfaces
(i) All relevant information the Supplier wishes to submit on his product
(k) Recommended method of coating application

Verbal information by the manufacturer's representative will not be accepted unless confirmed in writing by the Company.

### 8.4.5 COATING APPLICATION

#### 8.4.5.1 ENVIRONMENTAL CONDITIONS

##### 8.4.5.1.1 Dusty Conditions

Coatings shall not be applied in dusty or contaminated conditions.

##### 8.4.5.1.2 Surface Temperature

Coatings shall not be applied if the surface temperature of the steelwork is less than 3°C above dew point or outside the range 5-40°C, unless otherwise specified by the coating manufacturer.

##### 8.4.5.1.3 Relative Humidity and Time of Application

The first coat shall be applied as soon as possible after blast cleaning, but not exceeding four (4) hours if the relative humidity (RH) is below 70% or two (2) hours if the RH is between 70% and 85%. Refer to paragraph 7.3.6.1.

##### 8.4.5.1.4 Ambient Temperature

Coatings shall not be applied when the ambient temperature is less than the minimum or greater than the maximum specified by the manufacturer of the coating material.

#### 8.4.5.2 MIXING

The Contractor shall ensure that all paints are mixed in accordance with the requirements of Specification BS 5493.

All coating components, particularly two- or multi-component materials, shall be thoroughly mixed until a homogeneous mixture is achieved.

In the case of two-pack materials, each component containing pigments shall be thoroughly mixed. The two components shall then be mixed together in the proportions supplied by the Manufacturer until the mixture is completely homogeneous. For two pack materials, the use of part of the contents (split packs) is strictly forbidden unless the components can be accurately measured to within 0,5% of material by volume. Splitting of packs will only be accepted if

measurement of components is done by the use of a laboratory volume beaker (0-1000 ml) and mixed in the precise volume specified by the manufacturer.

In the case of solvent based Epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period, as recommended by the manufacturer, before use.

During application, coating materials shall be agitated regularly to keep the solids in suspension. The preparation time, induction time and pot life of these materials shall be closely adhered to.

#### 8.4.5.3 APPLICATION REQUIREMENTS

##### 8.4.5.3.1 Equipment

Application equipment shall be maintained in a clean condition and in good working order.

The use of equipment not maintained in good condition may lead to rejection of the coating.

##### 8.4.5.3.2 Compatibility of Coats

All primer, intermediate and finishing coats shall be mutually compatible.

##### 8.4.5.3.3 Surface Restoration

Should immediate lining/coating not be possible, or should any atmospheric oxidisation take place between the completion of blast cleaning and commencement of lining/coating, such oxidisation shall be removed by flash blasting to restore the specified surface finish. Removal of dust and debris shall be in accordance with paragraph 7.3.6.1.5.

##### 8.4.5.3.4 Supports

During coating application, the items shall be so supported to prevent damage to the wet coatings until the coatings have hardened adequately. Items shall remain supported during curing, storing and handling.

#### 8.4.5.4 METHOD OF APPLICATION

##### 8.4.5.4.1 Application

Epoxy coatings shall be applied by any appropriate method recommended by the manufacturer thereof, and approved by the Corrosion Engineer.

##### 8.4.5.4.2 First Coat

The first coat shall be applied to a minimum dry film thickness of 40 µm above the peaks of the blast profile.

##### 8.4.5.4.3 Cleanliness

During application and curing of the layers, the items shall be protected against contamination by dust or other foreign matter and shall be kept dry and shaded from direct sunlight.

All coats shall be clean and free from dust, oil, moisture and perspiration before over-coating.

Operators handling blast-cleaned or partially painted surfaces shall wear clean gloves to avoid contamination of the surface.

#### 8.4.5.4.4 Stripe Coat and Crevices

All metal edges, up stands, welds, bolts and nuts shall be adequately coated. Additional stripe coatings shall be applied after initial priming, if ordered by the Engineer.

Special attention shall be given to crevices and edges to ensure complete coverage and uniform paint thickness.

#### 8.4.5.4.5 Second and Subsequent Coats

The second and subsequent layers shall then be applied within the recommended over-coating periods.

#### 8.4.5.4.6 Coat Colours

The colour of each subsequent coat shall be different to that of the previous coat except where two finishing coats of the same colour are necessary to achieve colour uniformity.

#### 8.4.5.4.7 Over-coating Times

Over-coating times shall be not less than the minimum nor greater than the maximum specified by the manufacturer relevant to the ambient temperature.

Strict adherence to over-coating times is particularly important for coatings which are subsequently immersed.

### 8.4.5.5 PIPE ENDS

(a) Extension of Lining

For flanged pipes or specials and pipes or specials intended for joining with flexible couplings or for site welding by means of double sleeve weld-on couplings, the lining shall extend to the ends of pipes and specials including edges and shall overlap by at least 300 mm on the outside of the pipe. Coatings shall overlap epoxy surfaces on the outside by at least 25 mm.

(b) Butt Weld Edges

For pipes and specials intended for site butt welding, lining and coating shall extend up to a distance of 80 mm from the pipe ends.

The unlined circumferential strip of grit blasted surface shall be temporarily protected between the works and the site with a coat of (red or a different colour to the lining/coating) weldable primer.

### 8.4.5.6 IN-SITU APPLIED EPOXY LINING

In-situ application shall only be used to make good defects. No welding whatsoever shall be performed on any pipe or special on which the lining or coating has been completed, without the approval in writing of the Engineer. The temporary protected surfaces shall be blast cleaned before coating with the specified system. The approval shall only be considered by the Corrosion Engineer after submission by the Contractor of acceptable proposals for making good un-coated and damaged areas.

### 8.4.5.7 PROTECTION WITH TAPE WRAP

Pipes to be tape wrapped (when buried in soil) shall be wrapped in accordance with paragraph 12.3.4.

#### 8.4.5.8 OVER-COATING WITH POLYURETHANE

##### 8.4.5.8.1 Wet, Submerged or High Humidity Conditions

**Pure Aliphatic Polyurethane**

(a) The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

(b) The surface shall be vacuum-cleaned to remove dust and debris – refer paragraph 7.3.6.1.5.

(c) Contaminants shall be removed and surfaces prepared by wiping with an organic solvent.

(d) Over-coat with a 25 to 35 µm layer of pure Aliphatic Polyurethane in accordance with the Departmental colour code.

##### 8.4.5.8.2 Dry or UV Conditions

**Re-coatable Polyurethane**

(a) The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

(b) The surface shall be vacuum-cleaned to remove dust and debris – refer paragraph 7.3.6.1.5.

(c) Over-coat with a 40 µm minimum layer of Re-coatable Polyurethane in accordance with the Departmental colour code.

#### 8.4.5.9 QUALITY OF COATING

##### 8.4.5.9.1 Finish

The fully cured coating shall have a uniform, smooth, gloss finish with proper adhesion.

##### 8.4.5.9.2 Dry Film Thickness (DFT)

The Epoxy coating shall be evenly applied to the minimum final film thickness as specified in section 5 and shall be tested in accordance with paragraph 8.5.4.

##### 8.4.5.9.3 Electrical Insulation Defects

All coated surfaces intended for water immersion or where likely to be frequently wetted under normal service conditions shall show no electrical insulation defects when tested in accordance with paragraph 8.5.3.

##### 8.4.5.9.4 Finishing Coat Colours

The finishing coat colours shall be as specified in the Project Specification in accordance with the Departmental Colour Code.

Colours shall be in accordance with SABS 1091 as follows:

| | |
|---|---|
| Valves and outlet pipes for raw water | Brilliant green to SABS 1091 code - H10 |
| Valves and outlet pipes for chlorinated filtered water | Arctic blue to SABS 1091 code – F28 |
| Handwheels | Golden yellow to SABS 1091 code – B49 |

Where not specified, the selection of final colours shall be approved by the Engineer.

#### 8.4.5.9.5 Solvent Entrapment

Coatings showing evidence of entrapped solvents after full cure will be rejected. No inter-coat de-lamination shall be allowed.

The Contractor shall be held responsible for blistering of coatings, when shown to be caused by solvent retention.

## 8.5 TESTING

To be read in conjunction with paragraph 4.1, Quality Assurance.

### 8.5.1 CONTRACTOR'S AND ENGINEER'S INSPECTIONS

Paragraphs 1.4 and 3.1 of DWS 2020 shall apply.

### 8.5.2 VISUAL INSPECTION

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

### 8.5.3 HOLIDAY INSPECTION (ELECTRICAL INSULATION DEFECTS INSPECTION)

100% of the lining and coating of all pipes shall be tested and there shall be no electrical insulation defects on any area inspected.

Except for coating containing conductive pigment (Zn, Al), low-voltage wet sponge electrical insulation defects inspection shall be carried out in accordance with SABS 1217 for coatings and linings of thickness not exceeding 500 µm.

For films exceeding 500 µm thickness, the high voltage, sparking electrical insulation defects detector is used in accordance with SABS 1217.

Inspection procedure shall ensure that sufficient moisture is present at all times i.e. only measure the bottom section of pipes.

### 8.5.4 DRY FILM THICKNESS (DFT)

(a) Measurements shall be taken in accordance with SABS ISO 2808, unless the frequency of readings is specified in the Project Specification.

(b) 100% of all coating thicknesses measured shall comply with the minimum requirements of the Project Specification.

(c) In the case of coats applied after the erection of steel work on Site, the frequency at which measurements of the DFT are taken shall be at the discretion of the Engineer's Inspector or the Engineers Representatives, and may be dictated by accessibility.

(d) DFT in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the paint film is demonstrated to be sound in all respects.

(e) Owing to delayed solvent release, solvent-borne coatings shrink over a period of time resulting in a lower film thickness and therefore it is important that DFT measurements be taken within seven days.

DFT measurements taken at times beyond seven days after application, shall not constitute a valid claim against the original satisfactory and documented execution of the work.

(f) The method used to measure DFT, and the significance of the readings for each particular project, shall be agreed upon by all parties prior to commencement of the work.

#### 8.5.4.1 AUTOMATED SHOP APPLIED LINING AND COATING

The film thickness on the first pipe and thereafter on at least one pipe selected at random from every day's production, but not less than one pipe out of every ten pipes, shall be measured non-destructively by an approved eddy current instrument. At least four readings at equally spaced intervals around the circumference, approximately 300 mm from each end of the pipe, shall be taken. The first reading shall be over the weld bead. When practicable an additional four readings at equally spaced intervals around the circumference in the centre of the pipe shall be taken. The thickness shall not be less than the minimum specified over 100% of the area including weld beads. The Inspectorate may at their discretion supplement the above test by checking wet film thickness on any or all pipes during application of the epoxy resin.

#### 8.5.4.2 HAND AND IN-SITU APPLIED LINING AND COATING

All the applied lining and coating thicknesses shall be tested by means of an approved eddy current or magnetic instrument. At least four readings shall be taken at equally spaced intervals around the pipe circumference at any test point. The first reading shall be over the weld bead. The thickness shall not be less than the minimum specified over 100% of the area including weld beads.

### 8.5.5 DEGREE OF CURE OF TW0-COMPONENT MATERIALS

The degree of cure of a two-component material will vary with time, temperature and ventilation and shall be assessed by solvent wiping in accordance with the method given in SABS 1217 (methyl ethyl ketone resistance test)

## 8.6 DAMAGED COATINGS

(a) All repairs and procedures shall be approved by the Corrosion Engineer and subject to inspection procedures as set out in paragraph 8.5.1.

Where the damage is extensive the remedial procedures shall be agreed with the Corrosion Engineer in writing

(b) All repairs shall comply with the requirements of the repair-product manufacturer's data sheet. The Engineer may at his discretion request that repaired coating areas undergo adhesion tests.

(c) Any damage occurring during transit from the Contractor's premises to the site, shall be the responsibility of the Contractor. The Contractor responsible for installation of equipment at site shall repair and damage occurring on site during handling, assembly, storage, transport and erection.

(d) The repaired area shall be tested in accordance with sub-clauses 8.4 and 8.12 of SABS 1217 for compliance with the relevant requirements for thickness and electrical insulation defects respectively.

(e) Any item showing electrical insulation defects exceeding an average of five per square metre (a cluster of pinholes within a radius of 25 mm being regarded as a single defective area), or flaking or other signs of loss of adhesion, shall not be repaired. The item shall be blast cleaned and re-coated in accordance with the relevant requirements of the specification

## 8.7 REPAIR METHODS FOR MINOR DEFECTS

The repair of areas showing electrical insulation defects or low film thickness shall, if approved by the Corrosion Engineer, be carried out as follows:

(a) Degrease in accordance with paragraph 7.3.3.

(b) Thoroughly abrade the damaged area, including an adjacent surrounding area of at least 25 mm wide, with a medium grade 220 abrasive paper.

(c) Vacuum-clean the surface to remove dust and debris in accordance with SABS method 769 and paragraph 7.4.1.

(d) Wipe the abraded paint surface with methyl ethyl ketone and allow to dry

(e) Apply as many coats of repair material as necessary to achieve the specified thickness and finish.

**NOTE:** 1. When solvent borne materials are used, curing time between coats, as specified by the coating material manufacturer, shall be adhered to.

2. Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

## 8.8 REPAIR METHODS FOR MAJOR DEFECTS

The repair of areas showing damage down to the steel surface shall, if approved by the Corrosion Engineer, be carried out as follows:

(a) Degrease in accordance with paragraph 7.3.3.

(b) Blast-clean all damaged areas to Sa 3 (SABS ISO 8501-1).

(c) Feather the surrounding paint for a distance of 25 mm beyond the damaged areas with a medium grade 220 abrasive paper.

(d) Vacuum-clean the surface to remove dust and debris in accordance with SABS method 769 and paragraph 7.4.1.

(e) Wipe only the abraded paint surface with methyl ethyl ketone and allow to dry.

(f) Apply as many coats of repair material as necessary to achieve the specified thickness and finish.

**NOTE:** 1. When solvent borne materials are used, curing time between coats, as specified by the coating material manufacturer, shall be adhered to.

2. Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

# 9 FUSION BONDED EPOXY COATING SYSTEMS

## 9.1 FUSION-BONDED EPOXY COATING (HEAVY DUTY)

### 9.1.1 STANDARDS

Equipment, materials and operational methods shall comply with the relevant SABS, ISO, BS, DIN or equivalent American Standard.

The Contractor shall ensure that he is in possession of the latest editions of all the relevant National Specifications, Codes of Practice or Standards referred to in this specification.

Reference is made to the latest issues of the following Standard Specifications:

| | | |
|---|---|---|
| SABS | 1217 | The production of painted and powder coated steel pipes. |
| SABS Method | 769 | Cleanliness of blast-cleaned steel surfaces for painting (dust and debris). |
| SABS Method | 772 | Profile of blast-cleaned steel surfaces for painting. |
| SABS ISO | 2808 | Determination of film thickness. |
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| BSS | 5493 | Protective coating of iron and steel structures against corrosion. |
| SABS ISO | 9000 | Model for quality assurance in production and installation. |

### 9.1.2 MATERIAL

Shall conform to SABS 1217, Type 2, powder coating.

### 9.1.3 APPLICATION

#### 9.1.3.1 SURFACE PREPARATION

Pre- and surface preparation shall conform to Sections 6 and 7 respectively.

#### 9.1.3.2 COATING THICKNESSES

Coating thicknesses shall conform to Section 5 or as specified in the Project Specification.

#### 9.1.3.3 COATING APPLICATION

Items shall be heated to a temperature of 200°C (only applicable to heavy items) and coated with Fusion-bonded Epoxy by means of an electrostatic powder gun.

The normal procedures pertaining to powder application shall apply.

On completion of the coating, items shall be cured for 60 minutes at 200°C (mean temperature).

#### 9.1.3.4 QUALITY OF COATING

##### 9.1.3.4.1 Finish

The fully cured coating shall have a uniform, smooth, gloss finish with proper adhesion.

#### 9.1.3.4.2 Film Thickness

The Epoxy coating shall be evenly applied to the minimum final film thickness as specified in section 5 and shall be tested in accordance with paragraph 9.1.4.4.

#### 9.1.3.4.3 Electrical Insulation Defects

All coated surfaces intended for water immersion or where likely to be frequently wetted under normal service conditions shall show no electrical insulation defects when tested in accordance with paragraph 9.1.4.3.

#### 9.1.3.4.4 Finishing Coat Colours

The finishing coat colours shall be as specified in the Project Specification in accordance with the Departmental Colour Code.

Colours shall be in accordance with SABS 1091.

Where not specified, the selection of final colours shall be approved by the Engineer.

### 9.1.4 TESTING

To be read in conjunction with paragraph 4.1, Quality Assurance and SABS 1217.

#### 9.1.4.1 CONTRACTOR'S AND ENGINEER'S INSPECTIONS

Paragraphs 1.4 and 3.1 of DWS 2020 shall apply.

#### 9.1.4.2 VISUAL INSPECTION

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

#### 9.1.4.3 HOLIDAY INSPECTION (ELECTRICAL INSULATION DEFECTS INSPECTION)

100% of all coated surfaces shall be tested and there shall be no electrical insulation defects on any area inspected.

Inspection procedure shall ensure that sufficient moisture is present at all times.

For films exceeding 500 µm thickness, a high voltage, electrical insulation defects detector shall be used in accordance with SABS 1217.

#### 9.1.4.4 FILM THICKNESS

(a) Measurements shall be taken in accordance with SABS ISO 2808.

(b) 100% of all coating thicknesses measured shall comply with the minimum requirements of the Project Specification.

(c) Film thickness in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the coating is demonstrated to be sound in all respects.

(d) The method used to measure film thickness, and the significance of the readings for each particular project, shall be agreed upon by all parties prior to commencement of the work.

#### 9.1.4.5 DEGREE OF CURE OF FUSION-BONDED MATERIALS

The degree of cure of fusion-bonded material shall be assessed by solvent wiping in accordance with the method given in SABS 1217 (methyl ethyl ketone resistance test)

### 9.1.5 DAMAGED COATINGS

(a) All repairs and procedures shall be approved by the Corrosion Engineer and subject to inspection procedures as set out in paragraph 8.5.1.

Where the damage is extensive the remedial procedures shall be agreed in writing with the Corrosion Engineer.

(b) All repairs shall comply with the requirements of the repair-product manufacturer's data sheet. The Engineer may at his discretion request that repaired coating areas undergo adhesion tests.

(c) Any damage occurring during transit from the Contractor's premises to site, shall be the responsibility of the Contractor. The Contractor responsible for installation of equipment on site shall repair any damage occurring on site during handling, assembly, storage, transport and erection.

(d) The repaired area shall be tested in accordance with sub-clauses 8.4 and 8.12 of SABS 1217 for compliance with the relevant requirements for thickness and electrical insulation defects respectively.

(e) Any item showing electrical insulation defects exceeding an average of five per square metre (a cluster of pinholes within a radius of 25 mm being regarded as a single defective area), or flaking or other signs of loss of adhesion, shall not be repaired. The item shall be blast cleaned and re-coated in accordance with the relevant requirements of the specification

### 9.1.6 REPAIR METHODS FOR MINOR DEFECTS

The repair of areas showing electrical insulation defects or low film thickness shall, if approved by the Corrosion Engineer, be carried out as follows:

(a) Degrease in accordance with paragraph 7.3.3.

(b) Thoroughly abrade the damaged area, including an adjacent surrounding area of at least 25 mm wide, with a medium grade 220 abrasive paper.

(c) Vacuum-clean the surface to remove dust and debris in accordance with paragraph 7.4.1.

(d) Wipe the abraded paint surface with methyl ethyl ketone and allow to dry

(e) Apply as many coats of the following repair material as necessary to achieve the specified thickness and finish.

(i) Solvent free Epoxy or

(ii) Fusion-bonded Epoxy powder repair kit.

**NOTE:** 1. Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

### 9.1.7 REPAIR METHODS FOR MAJOR DEFECTS

The total un-coated areas for renovation by the applicator shall not exceed 0,5 percent of the total surface area of a component. Each un-coated area for renovation shall not exceed 2 500 mm². If damaged areas are larger, the items containing such areas shall be re-coated.

The repair of areas showing damage down to the steel surface shall, if approved by the Corrosion Engineer, be carried out as follows:

(a) Degrease in accordance with paragraph 7.3.3.

(b) Blast-clean all damaged areas to Sa 3 (SABS ISO 8501-1).

(c) Feather the surrounding paint for a distance of 25 mm beyond the damaged areas with a medium grade 220 abrasive paper.

(d) Vacuum-clean the surface to remove dust and debris in accordance with SABS method 769 and paragraph 7.4.1.

(e) Wipe only the abraded paint surface with methyl ethyl ketone and allow to dry.

(f) Apply as many coats of the following repair material as necessary to achieve the specified thickness and finish.

  (i) Solvent free Epoxy or

  (ii) Fusion-bonded Epoxy powder repair kit.

**NOTE:** 1. Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

## 9.2 POWDER COATINGS AS SPECIFIED IN SABS 1274

### 9.2.1 STANDARDS

Equipment, materials and operational methods shall comply with the relevant SABS, ISO, BS, DIN or equivalent American Standard.

The Contractor shall ensure that he is in possession of the latest editions of all the relevant National Specifications, Codes of Practice or Standards referred to in this specification.

Reference is made to the latest issues of the following Standard Specifications:

| | | |
|---|---|---|
| SABS | 064 | The preparation of steel surfaces for coating |
| SABS | 1217 | The production of painted and powder coated steel pipes. |
| SABS | 1274 | Coatings applied by the powder-coating process. |
| SABS Method | 769 | Cleanliness of blast-cleaned steel surfaces for painting (dust and debris). |
| SABS Method | 772 | Profile of blast-cleaned steel surfaces for painting. |
| SABS ISO | 2808 | Determination of film thickness. |
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| BSS | 5493 | Protective coating of iron and steel structures against corrosion. |
| SABS ISO | 9000 | Model for quality assurance in production and installation. |

### 9.2.2 MATERIAL

Shall conform to SABS 1274, Type as specified in the Project Specification.

### 9.2.3 APPLICATION

#### 9.2.3.1 SURFACE PREPARATION

Pre- and surface preparation shall conform to Sections 6 and 7 respectively.

If abrasive blast-cleaning is not practical, a surface conversion hot applied coating in accordance with SABS 064, Section 5 shall be applied.

#### 9.2.3.2 COATING THICKNESSES

Coating thicknesses shall conform to Section 5 or as specified in the Project Specification.

#### 9.2.3.3 COATING APPLICATION

The coating shall be applied by means of an electrostatic powder gun and the application of heat treatment to initiate fusion of the powder.

#### 9.2.3.4 QUALITY OF COATING

##### 9.2.3.4.1 Finish

The fully cured coating shall have a uniform, smooth, gloss finish with proper adhesion.

##### 9.2.3.4.2 Film Thickness

The Epoxy coating shall be evenly applied to the minimum final film thickness as specified in Tables 1 to 6 of SABS 1274 and shall be tested in accordance with paragraph 9.2.4.4.

#### 9.2.3.4.3 Electrical Insulation Defects

All coated surfaces likely to be frequently wetted under normal service conditions shall show no electrical insulation defects when tested in accordance with paragraph 9.2.4.3.

#### 9.2.3.4.4 Finishing Coat Colours

The finishing coat colours shall be as specified in the Project Specification in accordance with the Departmental Colour Code.

Colours shall be in accordance with SABS 1091.

Where not specified, the selection of final colours shall be approved by the Engineer.

### 9.2.4 TESTING

To be read in conjunction with paragraph 4.1, Quality Assurance.

Testing shall be done in accordance with SABS 1274, Section 6 to comply with the requirements of Tables 1 to 6, Section 3.

#### 9.2.4.1 CONTRACTOR'S AND ENGINEER'S INSPECTIONS

Paragraphs 1.4 and 3.1 of DWS 2020 shall apply.

#### 9.2.4.2 VISUAL INSPECTION

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

#### 9.2.4.3 HOLIDAY INSPECTION (ELECTRICAL INSULATION DEFECTS INSPECTION)

100% of all coated surfaces shall be tested and there shall be no electrical insulation defects on any area inspected.

Inspection procedure shall ensure that sufficient moisture is present at all times.

For films exceeding 500 µm thickness, a high voltage, electrical insulation defects detector shall be used in accordance with SABS 1217.

#### 9.2.4.4 FILM THICKNESS

(a) Measurements shall be taken in accordance with SABS ISO 2808.

(b) 100% of all coating thicknesses measured shall comply with the minimum requirements of the Project Specification.

(c) DFT in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the paint film is demonstrated to be sound in all respects.

(f) The method used to measure DFT, and the significance of the readings for each particular project, shall be agreed upon by all parties prior to commencement of the work.

#### 9.2.4.5 DEGREE OF CURE OF FUSION-BONDED MATERIALS

The degree of cure of fusion-bonded material shall be assessed by solvent wiping in accordance with the method given in SABS 1217 (methyl ethyl ketone resistance test for Epoxy materials).

### 9.2.5 DAMAGED COATINGS

No repairs of damaged coatings shall be accepted.

# 10 GALVANIZING

## 10.1 STANDARDS

Reference is made to the latest issues of the following Standard Specifications:

| | | |
|---|---|---|
| SABS ISO | 14713 | Protection against corrosion of iron and steel in structures - guidelines. |
| SABS EN | 10240 | Internal/external protective coatings for steel tubes. |
| SABS ISO | 1461 | Hot-dip galvanized coatings on fabricated iron and steel articles. |
| SABS Method | 772 | Profile of blast-cleaned steel surfaces for painting. |
| SABS ISO | 2063 | Metallic and other inorganic coatings – Thermal spraying. |
| SABS ISO | 2808 | Determination of film thickness. |
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| SABS | 0374-1 | The suitability of hot-dip galvanized steel piping for the transportation of water. |
| SABS | 1344 | Medium duty solvent detergent. |
| ISO | 752 | Zinc ingots. |
| EN | 1179 | Zinc and zinc alloys – primary zinc |
| SABS ISO | 9000 | Model for quality assurance in production and installation. |

## 10.2 MATERIAL

(a) The impurities in the molten zinc, as defined in ISO 752 and EN 1179, shall not exceed a total of 1,5%.

(b) Steel to be hot-dip galvanized shall be:

(i) For aesthetic appearance

- Aluminium-killed steel or
- Silicon-killed steel with a Silicon content not exceeding 0,04% and a Phosphorus content not exceeding 0,02%.

**NOTE: Material certification shall be supplied.**

(ii) For general corrosion protection

- Aluminium killed steel or
- Silicon killed steel with a Silicon content not exceeding 0,25% and a Phosphorus content not exceeding 0,02%.

(c) The condition of articles to be hot-dip galvanized shall comply with “Annexure C” of SABS ISO 1461.

(d) The condition of tubes to be hot-dip galvanized on a continuous line shall comply with “Annexure A” of SABS EN 10240.

## 10.3 APPLICATION

(a) Shall only be done by members of the Hot Dip Galvanizers Association of Southern Africa (HDGASA) in accordance with SABS ISO 9000.

(b) Shall be in accordance with SABS ISO 1461 and SABS EN 10240 for tubes.

## 10.4 TOLERANCES

### 10.4.1 STEEL SPECIALS

Shall be in accordance with clause 6 of SABS ISO 1461.

#### 10.4.1.1 SURFACE

The surfaces shall be free from nodules, blisters, roughness and sharp points. Un-coated areas, flux residues, lumps and zinc ash shall not be permitted.

Notwithstanding Clause 6.1 of SABS ISO 1461, in the case of handrails etc. a high quality surface finish is required and a bright smooth surface shall be achieved. Only materials specified under paragraph 10.2 (b) (i) shall be utilised. Double dipping shall not be allowed.

#### 10.4.1.2 THICKNESS

The thickness of hot-dip galvanizing shall comply with the requirements of the table below.

**Minimum coating thicknesses on items that are not centrifuged.**

| ARTICLES AND ITS THICKNESS | HEAVY DUTY COATING | LIGHT DUTY COATING | |
|---|---|---|---|
| | Coating thickness µm (min) | Local coating thickness µm (min) | Mean coating thickness µm (min) |
| ≥ 6 mm ≤ Steel | 105 | 70 | 85 |
| 3,0 mm ≤ Steel < 6,0 mm | 80 | 55 | 70 |
| 1,5 mm ≤ Steel < 3,0 mm | 65 | 45 | 55 |
| Steel < 1,5 mm | 55 | 35 | 45 |
| Castings ≥ 6,0 mm | 105 | 70 | 80 |
| Castings < 6,0 mm | - | 60 | 70 |

Heavy duty coatings are required except in the following cases:

(a) Where a high surface finish is required.

(b) Where otherwise specified in the Project Specification.

### 10.4.2 STEEL TUBES

Shall be in accordance with clause 7 of SABS EN 10240.

#### 10.4.2.1 SURFACE

The surface of the coating shall be continuous, smooth and free from flux residues.

#### 10.4.2.2 THICKNESS

The thickness shall comply with the requirements of the coating quality A1, in accordance with clause 8, Table 1 of SABS EN 10240, as specified below.

**Minimum local coating thickness requirements for coating quality A1**

| Requirements | Coating quality A1 |
|---|---|
| Minimum local coating thickness on the inside surface except at the weld bead | 55 µm |
| Minimum local coating thickness on the inside surface at the weld bead | 28 µm |
| Minimum local coating thickness on the outside surface | 55 µm |

#### 10.4.2.3 ADHESION

The coating shall show no evidence of flaking or cracking when tested in accordance with clause 11.4 of SABS EN 10240.

#### 10.4.2.4 COATING QUALITIES

(a) Coating qualities shall be A1 for water installations – see sub-clause 8.2 of SABS EN 10240.

(b) The surface of the coating on the inside shall be as smooth as can be achieved by steam blowing.

## 10.5 TESTING

### 10.5.1 STEEL ITEMS

To be read in conjunction with paragraph 4.1, Quality Assurance.

#### 10.5.1.1 VISUAL EXAMINATION

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

#### 10.5.1.2 THICKNESS

Thicknesses shall be in accordance with paragraph 10.4.1.2 and shall be tested in accordance with sub-clause 6.2 of SABS ISO 1461.

### 10.5.2 STEEL TUBES

To be read in conjunction with paragraph 4.1, Quality Assurance.

#### 10.5.2.1 VISUAL EXAMINATION

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

#### 10.5.2.2 THICKNESS

Shall be tested in accordance with sub-clause 11.3 of SABS EN 10240.

#### 10.5.2.3 ADHESION

Shall be tested in accordance with sub-clause 11.4 of SABS EN 10240.

#### 10.5.2.4 CHEMICAL ANALYSIS

Shall be tested in accordance with sub-clause 11.5 of SABS EN 10240.

## 10.6 REPAIR METHODS

### 10.6.1 STEEL ITEMS

The total un-coated areas for renovation by the galvanizer shall not exceed 0,5% of the total surface area of a component. Each un-coated area for renovation shall not exceed 400 mm². If un-coated areas are larger, the item containing such areas shall be re-galvanized.

The repair method shall be approved by the Corrosion Engineer before repairs are initiated.

Repairs shall be by zinc thermal spray in accordance with SABS ISO 2063 or three component zinc solvent free Epoxy repair system. The repair shall include removal of any scale, cleaning and any necessary pre-treatment to ensure adhesion – refer surface preparation Section 7.

The coating thickness on the renovated areas shall be a minimum of 30 µm more than the local coating thickness specified in paragraph 10.4.1.2 for the relevant hot-dip galvanized coating unless otherwise specified by the Corrosion Engineer. The coating on the renovated areas shall be capable of giving sacrificial protection to the steel to which it is applied.

### 10.6.2 STEEL TUBES

- Repairs shall not be allowed on internal surfaces of tubes. Tubes shall be re-galvanized.
- Repairs on external surfaces shall be in accordance with paragraph 10.6.1.

## 10.7 DUPLEX SYSTEM (HOT-DIP GALVANIZING + ORGANIC COATING)

### 10.7.1 SURFACE PREPARATION

#### 10.7.1.1 SURFACE PASSIVATION

Items to be over-coated shall not be passivated.

#### 10.7.1.2 CONTAMINANTS AND PHYSICAL FACTORS

The following contaminants shall be removed:

(a) Galvanizing residues and passivation products.

(b) Oil and grease.

(c) Perspiration and oil contamination from contact with hands.

(d) Dust and chemical contamination.

#### 10.7.1.3 DEGREASING

Galvanized steel surfaces shall be degreased prior to coating, using either a water soluble solvent degreaser in accordance with SABS 1344 and the manufacturer's instructions, or a mild acid-detergent degreasing solution to be approved by the Corrosion Engineer.

#### 10.7.1.4 SWEEP BLAST-CLEANING

Large areas shall be prepared by sweep-blasting with non-metallic abrasive in accordance with paragraph 7.3.6.3. Cracking, flaking, or any form of de-lamination of the zinc coating due to excessive blast-cleaning shall not be permitted. Removal of zinc by blast-cleaning shall not exceed 10 µm.

#### 10.7.1.5 MECHANICAL CLEANING

Surfaces that can not be sweep-blasted shall be abraded manually or mechanically with abrasive paper grade 220 or non-metallic abrasive pads.

### 10.7.2. APPLICATION

Coatings shall be applied immediately after surface preparation in accordance with paragraph 8.4.5. All coating materials shall be applied strictly in accordance with the manufacturer's instructions.

In the case of nuts, bolts and other fasteners, care shall be taken to ensure that all edges are over-coated to the minimum specified thickness.

Only coatings approved by the Corrosion Engineer for application on hot-dip galvanized surfaces shall be used.

For additional protection under high humidity conditions and for colour coding Epoxy and Polyurethane coatings shall be applied to thicknesses specified in paragraph 5.

Epoxy primer may not be required if appropriate two pack Epoxy/ Re-coatable or pure Aliphatic Polyurethane is being used.

### 10.7.3. REPAIRS OF DUPLEX SYSTEM

To repair coatings damaged during transportation, handling or erection, the following procedures shall be followed:

#### 10.7.3.1 DAMAGE DOWN TO BARE STEEL

(a) Degrease in accordance with paragraph 7.3.3.

(b) Thoroughly abrade the damaged area, including an adjacent surrounding area of at least 25 mm wide, with grade 80 abrasive paper.

(c) Vacuum-clean the surface to remove dust and debris in accordance with SABS method 769 and paragraph 7.4.1.

(d) Where originally over-coated with two component Epoxies, wipe the surface with methyl ethyl ketone and allow to dry.

(e) Apply sufficient coats of three component zinc solvent free Epoxy to a dry film thickness of 30 µm more than the original thickness of the zinc.

(f) When dry, apply the same system as originally applied so as to cover the damaged area extending for 25 mm over the surrounding area.

**NOTE:** 1. When solvent borne materials are used, curing time between coats, as specified by the coating material manufacturer, shall be adhered to.

2. Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

#### 10.7.3.2 DAMAGE DOWN TO ZINC SURFACE

(a) Prepare the surface as described in paragraph 10.7.3.1 - (a), (b) (c) and (d).

(b) Apply coating as described in paragraph 10.7.3.1 – (e) and (f).

**NOTE:** 1. When solvent borne materials are used, curing time between coats, as specified by the coating material manufacturer, shall be adhered to.

2. Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

# 11. BITUMEN COATING SYSTEMS

## 11.1 STANDARDS

Reference is made to the latest issues of the following Standard Specifications:

| | | |
|---|---|---|
| SABS | 1130 | Glass fibre reinforcing material for pipe wrapping. |
| SABS | 1136 | Cold-applied bitumen primer for steel pipeline protection. |
| SABS | 1137 | Hot-applied bitumen for steel pipeline protection. |
| SABS | 1178 | The production of lined and coated steel pipes using bitumen or coal tar enamel. |
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| SABS ISO | 9000 | Model for quality assurance in production and installation. |

## 11.2 MATERIAL

### 11.2.1 HOT APPLIED BITUMEN AND PRIMER

Shall conform to SABS 1137 & 1178. In all cases where bitumen or primer is to be stored in open tanks at elevated temperatures, or the storage temperature of the bitumen in enclosed tanks exceeds 180°C, the supplier shall be consulted and certificates obtained from him indicating recommended maximum temperatures and temperature/time relationships for storage. These certificates shall be made available to the Engineer or the Inspectorate on request.

**NOTE:** Bitumen that has been heated to a temperature in excess of 230°C shall be discarded.

### 11.2.2 COLD APPLIED BITUMEN PRIMER

Shall conform to SABS 1136

### 11.2.3 GLASS FIBRE TISSUE AND WOVEN WRAP

Shall conform to SABS 1130.

## 11.3 APPLICATION

### 11.3.1 ACCEPTABILITY OF PIPES

Shall conform to sub-clause 3.3.1 of SABS 1178.

### 11.3.2 SURFACE PREPARATION

Surfaces shall be prepared in accordance with Section 7 and shall conform to sub-clause 3.3.2 of SABS 1178 with preparation grade Sa 2½ of ISO 8501-1 and surface profile amplitude 75 micrometers (**µm**)

### 11.3.3 LINING

(a) Primers shall be applied in accordance with clause 3.5 of SABS 1178. The lining shall then be applied in accordance with clause 3.6 of SABS 1178, except that the maximum lining thickness shall be 5 mm.

(b) Where pipe ends are intended for jointing by butt welding, the lining shall be cut back 100 mm from each end of the pipe. The primer shall however extend over the full length of the pipe.

### 11.3.4 COATING

#### 11.3.4.1 COATING PROCEDURE

The coating procedure shall conform to sub-clauses 3.5.2, 3.7.2 and 3.7.3 of SABS 1178 and as specified here.

#### 11.3.4.2 RE-INFORCED COATING

The re-inforced wrapping shall be of glass fibre tissue and shall have a fifty (50) percent overlap from one end of the pipe to the other. On completion of the first wrap a further coat of hot bitumen of temperature not exceeding 230°C shall be applied, whilst a second wrap shall be applied in the same manner as the first, but in the reverse direction. On no account shall the bitumen layer between two wraps be less than 1 mm thick.

The minimum cover of bitumen over the second glass fibre tissue wrap shall not be less than 1 mm. The nominal thickness of the completed coating shall be 5,5 mm. The coating surface shall be free of surface craters, crazing, laminations, and pinholes and shall have an acceptable smooth surface.

#### 11.3.4.3 ARMOURED COATING

Armoured coated pipes shall, where specified in the Schedule of Quantities and in the documents, be "armoured" against mechanical damage as follows:

Immediately after completion of the second glass fibre tissue (to SABS 1130, Type 1) wrap, a further coat of hot bitumen, not exceeding 230°C, shall be applied with bitumen impregnated woven glass fibre reinforcement, (to SABS 1130, Type 2 or Type 3) as in the above paragraphs (a) and (b).

It shall be helically wound around the pipe as a single wrap from end to end, applied under tension with a minimum overlap of 35 mm.

On no account shall the minimum thickness of the bitumen layer between the outer wrap and the second tissue wrap be less than 1,5 mm.

The minimum cover of bitumen over the woven glass fibre outer wrap shall not be less than 1,0 mm.

The nominal thickness of "armoured" coatings shall be 7 mm.

#### 11.3.4.4 PIPE ENDS

Treatment of pipe ends shall conform to sub-clause 3.7.11 of SABS 1178.

Where pipe ends are intended for jointing by slip couplings, the coating shall be cut back 250 mm from the end of the pipe.

#### 11.3.4.5 REFLECTIVE FINISH

Reflective finishes shall conform to paragraph 11.3.7 and sub-clause 3.7.10 of SABS 1178.

### 11.3.5 BITUMEN COATING OF PIPES WITH LININGS OTHER THAN BITUMEN

Bitumen and glass fibre reinforcement shall comply with paragraphs 11.2.1 and 11.2.3 respectively. Cold applied bitumen primer shall conform to SABS 1136.

#### 11.3.5.1 APPLICATION OF COATING

(a) Within four (4) hours of having been grit blasted, and provided the pipes and specials are kept dry and free of dust, cold applied bitumen primer shall be applied by brush, spray, roller or mechanical equipment. The pipe or special shall be supported on skids or in any other suitable manner to avoid damage to and contamination of the primed surface. Primer shall be applied in a uniform manner and at the coverage rate specified or as recommended by the manufacturer, but at a rate of not less than 0,8 litres per square metre of pipe surface. Particular care is required to ensure complete penetration and coverage of welds and sharp edges. All defects in priming shall be immediately touched up by brush, care being taken to overlap the joint with the correctly primed area. Care shall be taken not to contaminate the inside of the pipes or specials with the primer.

All equipment used for priming shall be maintained in a clean condition. Primer shall be stored in sealed containers and before material is drawn from containers, the contents shall be agitated or stirred to ensure uniformity. After sufficient material for application is withdrawn, containers shall be sealed immediately to prevent contamination or loss of solvent. Material shall not be kept in open containers overnight, nor shall it be exposed to the sun. Primer which has become fouled with foreign substances shall be discarded. Primer shall be maintained at the correct consistency by mechanical agitation during application. Thinners may be used as recommended by the manufacturer, provided the thinners are uniformly mixed with the primer before use.

(b) As soon as the primer is dry to the touch, but not later than three (3) days after application of the primer and provided primed surfaces are kept clean, dry, free from dust and shaded from sunlight, the primed pipes shall be transferred to a lathe-like coating machine. Coating shall further proceed strictly in accordance with paragraph 11.3.4.

Reflective finishes shall only be applied and the specified inspections and non-destructive tests shall only be carried out after the lining, if applicable, has been completed and fully cured.

### 11.3.6 LINING AND COATING OF SPECIALS

In the case of specials, where length and/or shape preclude the application of lining and coating by the mechanical processes as described for pipes, the lining and coating shall be applied by hand. The lining and coating shall not be inferior to that applied by machine. The standards of pre-cleaning of specials and linings and coatings applied to specials shall comply with all the requirements of this specification.

### 11.3.7 REFLECTIVE FINISH

Bitumen coated pipes shall be given a temporary reflective finish of white wash to minimise heat absorption in transit and prior to laying and back filling on site.

## 11.4 TOLERANCES

The minimum acceptable lining thickness shall be 2,5 mm and the maximum acceptable thickness 5 mm.

The nominal coating thickness shall be 5,5 mm with a tolerance of -0,5 mm and +0,5 mm.

The nominal thickness of "armoured" coatings shall be 7,0 mm with a tolerance of –0,5 mm and +0,5 mm.

## 11.5 SPARE PIPES

Spare pipes shall be lined and coated in accordance with paragraph 4.7.

## 11.6 TESTING

To be read in conjunction with paragraph 4.1, Quality Assurance.

### 11.6.1 VISUAL INSPECTION

(a) Linings shall have a smooth glossy finish and shall be free from ripples, runs, pinholes, craters, bubbles, laminations and visible impurities.

(b) Coatings shall be free of surface craters, crazing lamination, dis-bonding, un-bonded areas, pinholes and shall have an acceptable smooth surface. No hollow sounds shall be detected when the coating is tapped. The glass fibre reinforcement of the fibre pattern thereof shall not be discernible on the bitumen surface.

### 11.6.2 NON-DESTRUCTIVE TESTS

#### 11.6.2.1 HOLIDAY TESTING

Shall conform to sub-clause 7.2.2 of SABS 1178.

#### 11.6.2.2 THICKNESS TESTING

On each pipe in the sample, taken in accordance with paragraph 11.6.4.2 (b), the thickness of lining and coating shall be measured by means of a suitable magnetic or eddy current instrument. The instrument must be designed for non-destructive measurement of the thickness of non-metallic films on a magnetic base and be suitable for use on curve surfaces. Set zero and calibrate the instrument on steel similar to that used in the manufacture of the pipe, using a suitable shim of which the thickness is approximately equivalent to the thickness of the coating/lining under test. Take readings as specified in sub-clause 7.2.1 (a) and (b) of SABS 1178.

### 11.6.3 DESTRUCTIVE TESTS

#### 11.6.3.1 PEEL TEST ON LINING

Shall conform to sub-clause 7.3.2 of SABS 1178. Three tests shall be carried out, one of which shall be over the longitudinal or spiral weld seam, the test areas being approximately 120° apart. The lining shall not be accepted as having passed the test if the average of the three peel length readings is greater than 3 mm.

#### 11.6.3.2 CONDITION OF BITUMEN

Shall conform to sub-clause 7.3.3 (a) and (b) of SABS 1178, to the following standards:

| | | | |
|---|---|---|---|
| (a) | Fraas breaking point | : | no failure to +10°C |
| (b) | Softening point | : | 100 - 125°C |
| (c) | Penetration | : | 1,0 - 2,2 mm |
| (d) | Resistance to cracking | : | no cracking down to –10°C |

In the event of the condition of bitumen test results not satisfying all these requirements, a series of three (3) other tests shall be carried out by the Contractor, and witnessed by the Inspectorate. The average of the three (3) results for each test shall be determined. If the average does not comply with the requirements, then the day's production, from which lining and coating samples were obtained, shall be rejected.

### 11.6.4 TEST SAMPLES

#### 11.6.4.1 VISUAL

All pipes to be inspected.

#### 11.6.4.2 NON-DESTRUCTIVE TESTING

(a) Holiday testing

All pipes to be inspected.

(b) Thickness

On the first pipe and thereafter on at least 10 percent of the number of pipes and specials in each day's production.

#### 11.6.4.3 DESTRUCTIVE TESTING

Sufficient lining and coating material shall be removed from the ends of at least one pipe selected at random from that day's production for the purpose of carrying out the tests. The peel test shall be carried out the next day on the same pipe.

## 11.7 REPAIR METHODS

### 11.7.1 DAMAGE TO SUBSTRATE

Areas dis-bonded or damaged through to the substrate shall be repaired as follows:

(i) The problem areas shall be stripped back to the substrate and the edges feathered back for 100 mm minimum to achieve St2 of ISO 8501.

(ii) The repair shall be effected by firstly applying a coat of primer

(iii) (a) Using liquid bitumen and cut pieces of glass fibre tissue or a blanket, rebuild the coating to the original specification. Gas heated repair irons shall be used to blend in the various layers or

(b) Apply a layer of the “torch on” bitumen tape with 50 mm overlap by heating the side of the tape with a gas torch until the compound is glossy and just molten. Then smooth firmly onto the surface to eliminate air pockets and voids.

Overlaps and seams shall be smoothed and sealed by tooling with a heated bullnose trowel

### 11.7.2 PARTIALLY DAMAGED

Areas partially de-laminated or damaged through the thickness shall be repaired as follows:

The de-laminated or damaged areas shall be stripped back to the lamination or bottom of the damage and using liquid bitumen and cut pieces of glass fibre tissue, the coating shall be rebuilt to the original specification. Gas heated repair irons shall be used to blend in the various layers.

### 11.7.3 ELECTRICAL INSULATION DEFECTS

Electrical insulation defects (holidays) shall be repaired by hot ironing.

### 11.7.4 TOP COAT

Completed repairs shall be protected as per paragraph 11.3.7.

# 12 TAPE WRAPPING SYSTEM

## 12.1 STANDARDS

Reference is made to the latest issues of the following Standard Specifications:

| | | |
|---|---|---|
| SABS | 1117 | Plastic wrappings for the protection of steel pipelines. |
| SABS | 0129 | Plastics tape wrapping of steel pipelines. |
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| SABS ISO | 9000 | Model for quality assurance in production and installation. |

## 12.2 MATERIAL

Polyethylene pressure-sensitive or polyethylene laminated to an elastomeric layer of butyl rubber tapes shall conform to SABS 1117, types A, B or C.

## 12.3 APPLICATION

### 12.3.1 GENERAL

Steel pipes, fittings and specials, protected by means of tapes, shall be wrapped in accordance with SABS 0129 as amended and extended by this Specification. All pipes shall be wrapped outside the trench in accordance with acceptable factory applications. Tape wrapping may be carried out in an "over the trench" operation for pipe diameters up to 450 mm.

If in the opinion of the Engineer adverse weather conditions are such as to interfere with the successful application of an efficient corrosion protective wrapping, he shall order a stoppage of work. It shall be regarded that the Contractor has accepted this risk and made provision for it in his tender.

The production and application of the tapes shall be controlled by SABS ISO 9000, Quality System.

### 12.3.2 SURFACE PREPARATION

Shall conform to clause 3.2 of SABS 0129.

### 12.3.3 PRIMING

Immediately after cleaning but not later than 4 hours after cleaning, provided the pipe surfaces are kept dry and free from dust, a primer shall be applied according to sub-clause 4.2.1 of SABS 0129.

### 12.3.4 NORMAL WRAPPING

Tape wrapping shall be applied with sufficient pre-tensioning immediately after priming, in accordance with sub-clause 4.2.2 of SABS 0129, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects even at temperatures up to 65°C.

For normal wrapping, tape shall be applied in two layers with a minimum overlap of 50 mm on both the inner and outer wraps.

Tape joints and repairs shall be done in accordance with sub-clause 4.2.3 of SABS 0129.

Hand wrapping shall only be allowed for short lengths that are inaccessible to a wrapping machine, specials, joints, small diameter pipes and small repairs – refer paragraph 12.6.

### 12.3.5 ARMOURING

Where armour wrapping is specified, two layers of tape wrapping shall first be applied with sufficient pre-tensioning immediately after priming, in accordance with sub-clause 4.2.2 of SABS 0129, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects even at temperatures up to 65°C.

The first layer of wrap shall overlap by half the tape width plus 25 mm and the second wrap shall overlap by not less than 50 mm.

The above-mentioned layers of tape shall then be armoured by the application of a third layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometers and a minimum overlap of 50%.

Armoured wrappings shall generally be applied at the following positions:

(a) all road crossings through sleeves and culverts;
(b) all railway crossings through sleeves or culverts; and
(c) wherever the Engineer may consider that special conditions warrant such measures.

### 12.3.6 WRAPPING OF SPECIALS

In the case of specials or pipe lengths where length and/or shape preclude the application of a protective wrapping system by any means, the protection shall be carried out either by bitumen-fibre glass or epoxy coating in accordance with paragraphs 11.3 or 8.4.5 respectively. In the case of access, scour, air valve and farmers off-take tees the special shall be deemed to incorporate at least two (2) diameter lengths either side of the main tee barrel.

### 12.3.7 ARMOUR WRAPPING OF COATED PIPES

Where armour wrapping of coated pipes is specified, a single layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometers and a minimum overlap of 50% shall be applied.

## 12.4 TOLERANCES

### 12.4.1 PRESSURE SENSITIVE TAPE WRAPPING

The minimum thickness of the inner low-density polyethylene tape carrier component shall be 300 µm and the maximum thickness of the outer high-density tape carrier shall be 1000 µm. Total minimum polyethylene thickness of 1450 µm.

The adhesive part of the inner layer shall be a minimum thickness of 1.5 times the polyethylene tape carrier thickness. For the outer layer the adhesive layer shall be at least equal to the thickness of the polyethylene tape carrier thickness.

### 12.4.2 BUTYL RUBBER LAMINATES

The minimum thickness of the completed wrapping shall be 750 µm. The inner layer shall be a butyl rubber laminate of 450 µm minimum thickness of which the butyl rubber film shall not be less than 200 µm thick and the polyethylene film shall not be less than 200 µm thick.

The outer layer shall be high density pressure tape of 300 µm minimum thickness.

## 12.5 TESTING

To be read in conjunction with paragraph 4.1, Quality Assurance.

### 12.5.1 VISUAL INSPECTION

The wrapping shall have a smooth appearance, free from wrinkles, blisters, bridging across weld beads, frayed edges, cracks, dis-bonding and any signs of physical damage.

### 12.5.2 NON-DESTRUCTIVE TESTING

(a) Electrical Insulation Defect (Holiday) Testing

The entire wrapping of the pipeline shall be tested with an approved holiday detector equipped with a rolling ring detector around the pipe by the Contractor to the Engineer's satisfaction. The ring shall be in close contact with the surface of the wrapping along the pipe circumference. The test shall be carried out immediately prior to lowering the pipe into the trench. The wrapping on specials or short pipe lengths shall be tested with an approved holiday detector fitted with a copper bristle brush detector of suitable form. The wrapping shall exhibit no holidays when tested with an effective voltage of 12 kV at a nominal pulse frequency of not less than 30 Hz.

The Engineer may instruct any length of pipe or any number of specials to be re-tested using a holiday detector with a copper bristle brush detector.

(b) Coating Insulation Test

The Engineer shall carry out a conductance test on the wrapping over any section of pipeline between valves when the pipeline has been wrapped and installed in the trench with padding and back filling completed. The test shall be conducted with the valves temporarily removed from the line, at the Contractor's expense, to ensure complete isolation of the pipeline section under test or between gaps left for tie-ins.

The length of the section of pipeline under test shall be carefully measured and the conductance over the section tested shall not exceed 180 micro-Siemens per square metre of pipe surface under all conditions of test. If the results of the test for the section of pipeline tested are not satisfactory, two sections immediately adjacent to the testing section will be tested. If the results on one or both of these sections tested are not satisfactory, all sections of wrapped pipeline shall be tested.

### 12.5.3 DESTRUCTIVE TESTING

The Engineer may from time to time collect samples of 10 metres of each type of tape and one litre of primer for testing, for compliance with the specification, by any independent laboratory appointed by the Engineer. The supply of samples shall be for the Contractor's account. The Engineer reserves the right to reject the whole batch of materials from which unsatisfactory samples were obtained.

### 12.5.4 REPAIRS

The Contractor shall be required to locate areas of faulty protection on all sections on which unsatisfactory results are obtained and to affect the necessary repairs. The cost of this work and all additional materials provided or supplied, including the reinstatement of the trench and the retest shall be for the Contractor's account.

## 12.6 REPAIR METHODS

Where damage to the wrapping on a pipeline has occurred and where there are creases, wrinkles and folds in the wrapping, proceed as follows:

### 12.6.1 SMALL DAMAGED AREAS

If the width of the tape being used exceeds by at least 100 mm the length of the section affected, cut the area of damaged wrapping away to bare metal leaving no raised edges or protrusions.

Clean and prime the exposed area in accordance with paragraphs 12.3.2 and 12.3.3 and apply a patch of tape, ensuring an overlap of not less than 50 mm on all sides onto the surrounding wrap.

Apply by hand-wrapping with a 55% overlap, a further layer of tape commencing two turns before and continuing for two turns beyond the patch.

### 12.6.2 LARGE DAMAGED AREAS

Where the extent of damaged or faulty wrapping is such that the tape cannot span the affected area and provide a 50 mm overlap on all sides it must be completely remove from the pipe over the affected section. The area must be cleaned and primed in accordance with paragraphs 12.3.2 and 12.3.3. The pipe must be re-wrapped with a 55% overlap, commencing two turns before and finishing two turns beyond the bared section.

### 12.6.3 DAMAGE ON DOUBLE WRAP

Where damage or a defect has occurred in a section that has been double wrapped and in the case of small holidays, the outer wrap shall be removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area.

The appropriate procedure given in paragraphs 12.6.1 or 12.6.2 shall be used to effect the repair of the inner wrap.

The outer wrap shall be re-instated in accordance with paragraph 12.3.5.

### 12.6.4 OUTER WRAP DAMAGE

Where damage extends through an outer wrap/rockshield (see Section 6 of SABS 0129), this should be carefully removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area without damaging the inner wrapping.

The repair shall be carried out by the appropriate method given in paragraphs 12.6.1 or 12.6.2 and the outer wrap/rockshield re-instated in accordance with paragraph 12.3.5.

# 13 PETROLATUM WRAPPING SYSTEM

Profiling mastic and mastic blankets are used for corrosion protection of couplings and flanges in chambers with high humidity and buried in soil.

## 13.1 STANDARDS

Reference is made to the latest issues of the following Standard Specifications:

| | | |
|---|---|---|
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| SABS | 0129 | Plastics tape wrapping of steel pipelines. |
| SABS ISO | 9000 | Model for quality assurance in production and installation. |

## 13.2 SURFACE PREPARATION

Mechanically clean and wire brush the joint to remove all loose rust, scale, old coating and foreign matter to St 2 (ISO 8501-1).

Areas subjected to chemical attack, salt spray, fungus or bacteria shall be neutralised, rinsed with clean potable water and mechanically cleaned as specified above.

## 13.3 PRIMING

Brush priming solution well over the entire joint area, leaving a thin film (at a nominal coverage rate of 0,8 m²/litre). Apply a liberal amount around the bolt threads, narrow cavities and crevices.

Paste shall be used where excessive surface corrosion has occurred and under high humidity or submerged conditions.

## 13.4 APPLICATION OF MASTIC AND TAPE

(a) Use profiling mastic and/or strips to fill all voids, crevices and sharp or irregular contours.

(b) Apply mastic tape circumferentially over the area to be coated with a 25 mm overlap on either side of the mastic with a 75 mm end overlap.

(c) Pre-formed petrolatum mastic blanket system (10 mm thick), supported by a coated tape backing, is available to provide a quick and easy method to apply this system.

(d) Eliminate all air pockets, wrinkles and creases.

## 13.5 TOP COAT

### 13.5.1 BURIED CONDITIONS

Two complete turns of the polyethylene sheeting shall be applied circumferentially. The ends are secured to the pipe barrels with 48 mm wide bands of PVC adhesive tape, which is also applied to the outside diameter of the bolted joint.

### 13.5.2 HIGH HUMIDITY CONDITIONS

Overcoat with a synthetic coating mixed with a cementitious filler to give a tough, flexible coating. The base coat may be over-coated with water based Acrylics or Epoxies.

**NOTE:** Detail of application shall be in accordance with the manufacturer's data sheets and approved by the Corrosion Engineer.

# 14 POLYOLEFIN-BITUMEN WRAPPING SYSTEM

This system shall be used for corrosion protection of galvanised pipes up to 200 mm diameter.

The system comprises an inner layer and outer coating whereby the inner layer is made up of a self-adhesive rubber bitumen compound reinforced with a fully impregnated heat set polyester mat. The outer layer is a tough medium density cross-linked Polyolifin heat shrinkable sleeve.

## 14.1 STANDARDS

Reference is made to the latest issues of the following Standard Specifications:

| | | |
|---|---|---|
| SABS ISO | 1461 | Hot-dip galvanized coatings on fabricated iron and steel articles. |
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| SABS | 1117 | Plastic wrappings for the protection of steel pipelines. |
| SABS | 0129 | Plastics tape wrapping of steel pipelines. |
| SABS ISO | 9000 | Model for quality assurance in production and installation. |

## 14.2 MATERIAL

Tapes shall conform to SABS 1117, type C.

## 14.3 APPLICATION

### 14.3.1 SURFACE PREPARATION

Surfaces, hot-dip galvanised in accordance with SABS ISO 1461, shall be degreased as per Sections 6 and 7.

### 14.3.2 APPLICATION

(a) Apply an adhesive bitumen layer at 130°C.

(b) Allow the compound to cure for thirty (30) minutes and cool to room temperature.

(c) Fit the oversized sleeve onto the pipe protruding 75 mm beyond the pipe ends.

(d) Shrink the sleeve with a yellow LPG or propane flame.

(e) Trim the sleeve edges.

## 14.4 TOLERANCES

| | |
|---|---|
| Prime coat | 20 µm DFT |
| Inner layer | 900 µm nominal |
| Outer layer | 600 µm nominal |
| Overall thickness | 1,5 mm nominal |
| Colour | Black |

## 14.5 TESTING

To be read in conjunction with paragraph 4.1, Quality Assurance.

### 14.5.1 VISUAL INSPECTION

The wrapping shall have a smooth appearance, free from wrinkles, blisters, bridging across weld beads, frayed edges, cracks, dis-bonding and any signs of physical damage.

### 14.5.2 ELECTRICAL INSULATION DEFECT (HOLIDAY) TESTING

The entire wrapping of the pipeline shall be tested with an approved holiday detector equipped with a rolling ring detector around the pipe by the Contractor to the Engineer's satisfaction. The ring shall be in close contact with the surface of the wrapping along the pipe circumference. The test shall be carried out immediately prior to lowering the pipe into the trench. The wrapping on specials or short pipe lengths shall be tested with an approved holiday detector fitted with a copper bristle brush detector of suitable form. The wrapping shall exhibit no holidays when tested with an effective voltage of 12 kV at a nominal pulse frequency of not less than 30 Hz.

The Engineer may instruct any length of pipe or any number of specials to be re-tested using a holiday detector with a copper bristle brush detector.

### 14.5.3 ADHESION

Shall be tested in accordance with SABS 1117 (Type C).

## 14.6 REPAIRS

### 14.6.1 SMALL REPAIRS ( LESS THAN 10 MM )

(a) Remove any contaminants from the damaged area.

(b) Cut away any protrusions.

(c) Use a weld stick and seal the damaged area by gently heating the point of the weld stick until it begins to flow. Press the weld stick firmly over the damaged area.

### 14.6.2 LARGE REPAIRS

(a) Remove any contaminants from the damaged area.

(b) Cut away any protrusions.

(c) Using a 100 mm wide bitumen tape and beginning 100 mm from the affected area, spirally wrap the tape utilising a 55 percent overlap. Continue to apply the tape until the repair is 100 mm beyond the affected area.

(d) Alternatively, if the pipe has not yet been installed, a section of sleeve may be placed over the defect and shrunk to at least 100 mm beyond each side of the defect.

# 15 POLYETHYLENE (MEDIUM DENSITY) COATING SYSTEM

## 15.1 STANDARDS

Reference is made to the latest issues of the following Standard Specifications:

| | | |
|---|---|---|
| AS | 4321 | Fusion bonded medium-density polyethylene – coating and lining for pipes and fittings. |
| AS | 3894 | Method 3: Determination of dry film thickness. |
| ASTM | D1693 | Environmental stress cracking. |
| SABS ISO | 1183 | Plastics – Methods for determining the density and relative density of non-cellular plastics. |
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| SABS method | 1264 | Cathodic dis-bonding test for pipeline coatings. |
| SABS ISO | 2808 | Paints and varnishes – Determination of film thickness. |
| SABS ISO | 3270 | Paints and varnishes and their raw materials – Temperatures and humidities for conditioning and testing. |
| SABS | 1217 | The production of painted and powder coated steel pipes. |
| SABS Method | 767 | Cleanliness of blast-cleaned steel surfaces for painting (pictorial standards). |
| SABS Method | 769 | Cleanliness of blast-cleaned steel surfaces for painting (dust and debris). |
| SABS Method | 772 | Profile of blast-cleaned steel surfaces for painting |
| SABS ISO | 9000 | Model for quality assurance in production and installation. |

## 15.2 MATERIAL

Shall conform to AS 4321

## 15.3 APPLICATION

### 15.3.1 SURFACE PREPARATION

All surfaces to be coated shall be abrasive blast-cleaned in accordance with Section 7.

### 15.3.2 APPLICATION

The pipes and specials shall be heated in such a way as not to produce any deleterious contaminants on the surface to be coated.

The polyethylene compound shall be applied to obtain a smooth finished surface.

The coating shall not be post-heated by use of a torch or other flame treatment being applied directly to the coating.

### 15.3.3 TREATMENT

(a) Where the coating is terminated externally it shall be set back a nominal distance of 100 mm from the closest assembly weld point and sealed with a primer.

(b) Where the coating in the joint region terminates internally and the pipe is cement mortar lined, the mortar shall overlap by a minimum of 25 mm.

(c) The end coating be tapered over a distance not less than the coating thickness.

## 15.4 TOLERANCES

### 15.4.1 COATING THICKNESS

When determined with a magnetic thickness gauge in accordance with method 5 of SABS ISO 2808, the minimum coating thickness of the fusion bonded polyethylene applied to pipes and specials shall be as tabled below.

**Coating And Lining Thickness**

| Pipe OD in mm | Minimum coating thickness in mm | | |
|---|---|---|---|
| | Coating | Lining | Area at coupling |
| OD ≤ 273 | 1.6 | 1.0 | 0.8 |
| 273 < OD ≤ 508 | 1.8 | 1.0 | 0.8 |
| 508 < OD ≤ 762 | 2.0 | 1.0 | 1.0 |
| 762 < OD | 2.3 | 1.0 | 1.0 |

## 15.5 TESTING

To be read in conjunction with paragraph 4.1, Quality Assurance.

### 15.5.1 VISUAL INSPECTION

The coating shall be smooth, glossy free from pinholes, excessive orange peel, bubbling or excessive runs or sags.

### 15.5.2 THICKNESS

When tested using a thickness gauge complying with AS 3894 Method 3, the minimum coating thickness of the FBPE shall be as specified in the above-mentioned table. On any pipe the minimum thickness may be up to 0,2 mm less than that specified in the table provided that the area of coating or lining with reduced thickness does not cover more than five (5) percent of the total pipe coating or lining area. Pipes with reduced thickness shall comprise not more than five (5) percent of the pipe coating order.

### 15.5.3 ELECTRICAL INSULATION DEFECTS

The total coated and lined surfaces of every pipe and fitting. Shall be tested in accordance with Appendix L of AS 4321. All holidays detected shall be repaired in accordance with clause 8 of AS 4321.

## 15.6 TEST REQUIREMENTS

### 15.6.1 TYPE TEST

#### 15.6.1.1 GENERAL

Type tests shall be carried out at intervals of no greater than three (3) years and at any change in formulation or source of polyethylene compounds and at any change in application process.

#### 15.6.1.2 POLYETHYLENE COMPOUND

The polyethylene compound to be used for coating, lining and repairs shall be type tested for thermal stability, water absorption, penetration resistance, tensile stress at yield , environmental stress-cracking resistance, density and impact resistance as specified in clauses 6.1.2.2 to 6.1.2.8 of AS 4321.

Test samples may be prepared in the laboratory or in the coating plant.

If the same formulation and source of polyethylene is used for both the coating and lining, then tests on the coating shall also qualify the lining. The impact resistance test is not required for the lining.

#### 15.6.1.3 PRODUCTION TESTS

The coating and lining shall comply with the production test requirements specified in clauses 6.3.2 to 6.3.4 of AS 4321.

## 15.7 REPAIR METHODS

### 15.7.1 GENERAL

Where a holiday is located it shall be repaired to produce a continuous coating and lining. Damaged areas that pass the continuity test need not be repaired provided the coating or lining thickness remains greater than or equal to 1.0 mm.

The bare steel surface shall be prepared in such a way to produce a rust-free, clean, abraded surface. The adjacent FBPE coating or lining shall be tapered as specified in clause 5.4 of AS 4321.

All lining repairs shall be in accordance with clause 7.2 of AS 4321.

Where practicable the following coating repair methods shall be used:

(a) Fusion-bonded repairs as specified in clause 7.2 of AS 4321.

(b) Heat shrink sleeve repair.

(c) Hot gas welding repair (for the joint region shown in Figure 1 of AS 4321).

NOTES:

1. The repair methods outlined apply to repairs at the application plant only.

2. The Corrosion Engineer may specify a particular repair method (see Appendix A of AS 4321).

### 15.7.2 REPAIR LIMITS

The number of coating repairs (this includes repairs to the joint region, see Figure 1 of AS 4321) shall not exceed three per pipe or fitting. An allowance is made for up to six repairs per pipe or fitting provided that the number of pipes or fittings with this larger number of repairs does not exceed five (5) percent of a pipe coating order. The number of lining repairs shall not exceed three per pipe or fitting.

The area of any single coating repair shall not exceed 0.1 $m^2$, and the length of such repair shall not exceed 2 m in the longitudinal direction. The area of any single lining repair shall not exceed 5 000 $mm^2$.

### 15.7.3 REPAIR TEST METHODS

All repairs shall comply with the continuity test requirements of clause 6.3.3 of AS 4321.

# 16 ELASTOPLASTIC POLYURETHANE COATING SYSTEM

Two component solvent free elastoplastic polyurethane.

## 16.1 STANDARDS

Reference is made to the latest issues of the following Standard Specifications:

Manufacturer's data sheets/recommendation

| | | |
|---|---|---|
| SABS | 1217 | The production of painted and powder coated steel pipes. |
| SABS Method | 767 | Cleanliness of blast-cleaned steel surfaces for painting (pictorial standards). |
| SABS Method | 769 | Cleanliness of blast-cleaned steel surfaces for painting (dust and debris). |
| SABS Method | 772 | Profile of blast-cleaned steel surfaces for painting. |
| SABS Method | 776 | Adhesion of coatings (direct pull-off method). |
| SABS ISO | 2808 | Determination of film thickness. |
| SABS ISO | 8501-1 | Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings. |
| SABS ISO | 9000 | Model for quality assurance in production and installation. |

## 16.2 MATERIAL

### 16.2.1 PRIMER

The primer, supplied by the manufacturer of the coating material, shall be compatible with the coating material applied at the manufacturer's specified thickness within the specified over coating time.

### 16.2.2 COATING

The coating material shall be a solvent free two-component polyurethane hybrid based on a polyester type polyol and aromatic isocyanate. The cured coating shall comply with the following requirements:

(a) Tensile strength at 3 mm thickness - ASTM D 638 - not less than 15 MPa.

(b) Adhesion to primed steel - SABS Method 776 - not less than 10 MPa.

(c) Impact resistance (direct) - ASTM G 14 - not less than 9 Joules.

(d) Dielectric Strength - not less than 10 kV/mm.

(e) Elongation at break - not less than 25 %.

(f) Compressibility - not less than 25 MPa.

(g) Surface hardness of 5 mm thick sample - not less than 60 nor greater than 80 Shore 'D'.

(h) Water Vapour Permeability - not greater than 0,5 g/24 h/m$^2$/mm$^2$.

(i) Cathodic dis-bonding - when tested in accordance with ASTM GB Method A, for 60 days, the dis-bonded area shall not exceed 500 mm$^2$.

### 16.2.3 ADHESIVE

Adhesive shall be a two component polyurethane adhesive designed to maximise adhesion between used polyurethane and freshly mixed polyurethane.

## 16.3 APPLICATION

### 16.3.1 SURFACE PREPARATION

(a) Contaminants shall be removed by an appropriate method such as with an organic solvent emulsion cleaner or a suitable detergent.

(b) All sharp edges shall be rounded off to a 2 mm radius. The prepared surfaces shall extend to the ends of the pipes and specials and around the edges for a width of at least 150 mm on the outside of the pipe.

For pipes and specials intended for butt welding the prepared surfaces shall extend to the pipe ends.

(c) The surface shall be blast-cleaned with a suitable abrasive to achieve a surface cleanliness of Sa 3 for lining and Sa 2½ for coating to ISO 8501-1, with an average surface profile of 50-100 micrometers (**µm**), in accordance with SABS method 772.

(d) Water soluble salts present in the steel after blast cleaning shall not exceed the values in paragraph 7.4.1. Should these values be exceeded, the steel shall be cleaned by washing with clean potable water or by water shrouded or water injected blast cleaning until the soluble salts are within the limits specified above. The steel shall then be allowed to dry, after which it shall be flash blast cleaned to achieve the required degree of cleanliness.

(e) The surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris, in accordance with SABS method 769, to not greater than 0,3 percent.

(f) The clean pipe surfaces shall be coated within four (4) hours if the relative humidity is below 70 percent or within two (2) hours if the relative humidity is in the range of 70% to 85%.

No blast cleaning or coating application shall take place when:

(i) The ambient temperature is outside the range of 15 - 40°C or otherwise specified by the manufacturer;

(ii) The relative humidity is above 85 percent,

(iii) The surface temperature is less than 3°C above dew point.

### 16.3.2 APPLICATION

(a) Apply the primer specified in paragraph 16.2.1 to the manufacturer's specified thickness.

(b) Apply the solvent free polyurethane by means of an airless spray fitted with metering pumps. The Contractor shall demonstrate that the machine is delivering components in the correct mixing ratio.

## 16.4 TOLERANCES

(a) For mildly corrosive/abrasive conditions

The dry film thickness shall be 1.0 mm minimum.

(b) For corrosive/abrasive conditions

The dry film thickness shall be 3.0 mm minimum.

## 16.5 TESTING

To be read in conjunction with paragraph 4.1, Quality Assurance.

### 16.5.1 VISUAL INSPECTION

The coating shall be smooth, glossy, free from pin holes, excessive orange peel effect, bubbling or excessive runs or sags.

### 16.5.2 DRY FILM THICKNESS

Shall be inspected in accordance with SABS ISO 2808

### 16.5.3 ELECTRICAL INSULATION DEFECTS (HOLIDAY) INSPECTION

The coating shall be free from electrical insulation defects when tested with a high voltage holiday detector set at 5 kV and 15 kV for 1 mm and 3 mm dry film thickness respectively.

## 16.6 REPAIR METHODS

Since polyurethane systems are chemically cured, very thorough abrasion of damaged or defective coating is required to ensure an adequate physical bond.

### 16.6.1 REPAIRS BEFORE FULL CURE [ WITHIN SIXTEEN (16) HOURS OF APPLICATION OF LAST COAT ]

(a) The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

(b) The surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris.

(c) Apply brush grade polyurethane in as many coats as are required to achieve the specified thickness free of electrical insulation defects.

### 16.6.2 REPAIRS AFTER FULL CURE [ AFTER SIXTEEN (16) HOURS OF APPLICATION OF LAST COAT ]

(a) The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

(b) The surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris.

(c) Apply the coating manufacturer's adhesive primer only to the abraded surface.

(d) Between thirty (30) minutes and four (4) hours apply brush grade polyurethane in as many coats as are required to achieve the specified thickness free of electrical insulation defects.

# ANNEXURE C7

# REQUIREMENTS TO BE SPECIFIED

| A: INFORMATION TO BE SUPPLIED IN TENDER SPECIFICATION | | |
|---|---|---|
| **ITEM** | **INSTRUCTION** | **PARAGRAPH** |
| Corrosion protection system | Agreement and approval | 3.1a |
| | Dry film thickness | 8.5.4 |
| Finishing coat colours | Departmental colour code | 8.4.5.9.4<br>9.3.4.4 |
| Repair kit | Required or not | 9.1.6 |
| Medium duty hot-dip galvanized coating | Medium duty | 10.4.1.2 |

| B: INFORMATION TO BE SUPPLIED BEFORE ORDER IS PLACED | | |
|---|---|---|
| **ITEM** | **INSTRUCTION** | **PARAGRAPH** |
| Approval of specific corrosion systems | Approval | 3.1 (b)<br>3.1 (c) |
| Proprietary items | Corrosion protection | 5.2 |
| Lifting lugs | Design | 6.2.4 |
| Blasting-material with data sheets | Blasting-material | 7.4.2 |
| Method of application | Epoxy | 8.4.5.4.1 |
| Coating for duplex system | Application of duplex system | 10.7.2 |

| C: INFORMATION TO BE SUPPLIED AFTER ORDER IS PLACED | | |
|---|---|---|
| **ITEM** | **INSTRUCTION** | **PARAGRAPH** |
| Quality plan | Approval | 4.1.1 |
| Suitability of design | Hot-dip galvanizing | 6.4.2.2 |
| Programme | Approval | 7.3.1 |

# ANNEXURE C7

# DEPARTMENTAL COLOUR CODE

## MECHANICAL AND GENERAL

| ITEMS | COLOUR | SABS 1091 CODE |
|---|---|---|
| Structural steel, Gates | Light grey | G29 |
| Hydraulic power pack | Strong blue | F11 |
| Hydraulic oil | Salmon pink | A40 |
| Hazardous objects/areas (restricted headroom, crane hook etc) | Golden yellow with black chevron | B49* |
| Handwheels and levers | Golden yellow | B49 |
| Handrails: - vertical<br>- horizontal | Black<br>Golden yellow | <br>G49 |
| Handrails on dam walls - Aluminium<br>- Stainless steel<br>- Galvanized | Un-coated<br>Un-coated<br>Light grey | <br><br>G29 |
| Floors: - safe and walking areas<br>- restricted areas<br>- open flooring (gratings) – MS galvanized<br>3CR12<br>Stainless steel | Emerald green<br>Golden yellow<br>Un-coated<br>Un-coated<br>Un-coated | E14<br>B49*<br><br><br> |
| Fire protection equipment | Signal red | A11* |
| Control panels | Eau de nil | H43 |

## PUMP STATION

| ITEMS | COLOUR | SABS 1091 CODE |
|---|---|---|
| Electric motors | Light beige | C57 |
| Pumps/control valves: for raw water<br>for chem-treated water | Apple green<br>Middle blue | H29<br>F07 |
| Fan and coupling guards | Signal red | A11* |
| Base plates | Black | |
| Overhead travelling cranes | Golden yellow | B49 |
| Isolating valves: for raw water<br>for chem-treated water | Brilliant green<br>Arctic blue | H10<br>F28 |

## ELECTRICAL

| ITEMS | COLOUR | SABS 1091 CODE |
|---|---|---|
| Low voltage panels: indoor<br>outdoor | Light orange<br>Light orange | B26*<br>B26 |
| Medium voltage panels: indoor<br>outdoor | Admiral grey<br>Admiral grey | G12<br>G12 |
| Panel accessories (gland plates, back plates, interior) | White | |
| UPS equipment | Light orange | B26 |
| Transformers | Light stone | C37 |
| LV distribution kiosks, mini subs | Light stone | C37 |
| Standby electrical equipment (Permanently powered) | Signal red | A11* |
| General outdoor | Light grey green | H40 |
| All equipment – interior | White | |

## WATER TREATMENT PLANT

| ITEMS | COLOUR | SABS 1091 CODE |
|---|---|---|
| Equipment | Same colour of respective pipe work | |
| Handwheels (remote valves) | Same colour of respective pipe work | |
| **PIPE WORK** | | |
| Raw water | Brilliant green | H10 |
| Chemical treated raw water | Verdigris green | E22 |
| Clarified raw water | Eau de nil | H43 |
| Filtered water | Pale blue | E39 |
| Chlorinated filtered water | Arctic blue | F28 |
| Backwash water | Cornflower blue | F29 |
| Air saturated water | Turquoise blue | E18 |
| Wash water recovery | Middle buff | B33 |

## SEWAGE PIPE WORK

| ITEMS | COLOUR | SABS 1091 CODE |
|---|---|---|
| Raw sewage | Dark earth | B11 |
| Settled sewage effluent | Brilliant green | H10 |
| Biologically treated sewage effluent | Verdigris green | E22 |
| Final/chlorinated effluent | Eau de nil | H43 |
| Digested sewage sludge | Middle brown | B07 |
| Raw sewage sludge | Dark brown | B03 |
| Humus sludge | Golden brown | B13 |
| Return activated sludge | Golden brown | B13 |
| Waste activated sludge | Middle brown | B15 |
| Supernatants/underflows returning to head of works | Middle buff | B33 |

## DOSING/CONTROL PIPE WORK

| ITEMS | COLOUR | SABS 1091 CODE |
|---|---|---|
| Poly-electrolite | Pinotage | A08 |
| Alum/Ferric chloride | Jacaranda | F18 |
| Chlorine solution | Primrose | C67 |
| Chlorine gas | Lemon | C54 |
| Chlorine liquid | Light orange | B26 |
| Lime slurry | Biscuit | B64 |
| Lime hydrated | Biscuit | B64 |
| Lime saturated water | Biscuit | B64 |
| Air/compressed air | White | |
| Steam | Pastel grey | G54 |

**NOTE:** Colours marked thus * are restricted for specified equipment only.