CLUSTER
TRADING SERVICES

UNIT
eThekwini Water and Sanitation

DEPARTMENT
Engineering

PROCUREMENT DOCUMENT

INFRASTRUCTURE

Documents are to be obtained, free of charge, in electronic format, from the National Treasury's eTenders website or the eThekwini Municipality's website.

Contract No:	**WS-7759**
Contract Title:	**OGUNJINI WATER TREATMENT WORKS: EMERGENCY CAPACITY UPGRADE FROM 1 ML/D TO 3 ML/D**
Est. CIDB Grade/ Class:	**6 ME**

CLARIFICATION MEETING AND QUERIES

Clarification Meeting:	**Compulsory Clarification Meeting**
Meeting Location, Date, Time:	**Ogunjini Water Treatment Works on Wednesday, 13 September at 10h00** **GPS coordinates: -29.592595, 30.982367**
Queries can be addressed to: The Employer's Agent's: Representative:	**Name: Dershan Narainsamy** **Tel: 031 266 8363** **email: dnarainsamy@ingerop.co.za**

TENDER SUBMISSION

Delivery Location:	**The Tender Box in the foyer of the Municipal Building** **166 KE Masinga Road, Durban**
Closing Date/ Time:	**Friday, 29 September 2023 at 11h00**

FACSIMILE, eMAIL, or POSTED TENDERS WILL NOT BE ACCEPTED

Issued by:

ETHEKWINI MUNICIPALITY

Deputy Head: Engineering

Date of Issue: 24/02/2023

Document Version 24/02/2023(c)

FOR OFFICIAL USE ONLY

Tenderer Name:			VAT Registered: Yes No
	Price (excl)	VAT	Price (incl)
Submitted:	R	R	R
Corrected:	R	R	R

INDEX to PROCUREMENT DOCUMENT

PART T1: TENDERING PROCEDURES

T1.1.1: TENDER NOTICE AND INVITATION TO TENDER

Tenders are hereby invited [to tender for Mechanical, Electrical and Civils works for the emergency capacity upgrade of the Ogunjini Water Treatment Works from 1Ml/day to 3Ml/day.]

Subject	Description	Tender Data Ref.
Employer	The Employer is the eThekwini Municipality as represented by: Deputy Head: **Engineering**	F.1.1.1
Tender Documents	Documents can only be obtained in electronic format, issued by the eThekwini Municipality. Documentation can be downloaded from the **National Treasury's eTenders website** or the **eThekwini Municipality's Website**. The entire document should be printed (on A4 paper) and suitably bound by the tenderer.	F.1.2
Eligibility	It is estimated that tenderers should have a CIDB contractor grading designation of **6 ME** (or higher). The CIDB provisions in relation to a Contractor's Potentially Emerging (PE) status do not apply.	F.2.1.1
Clarification Meeting	**Ogunjini Water Treatment Works on Wednesday, 13 September at 10h00** **GPS coordinates: -29.592595, 30.982367**	F.2.7
Seek Clarification	Queries relating to these documents are to be addressed to the Employer's Agent's Representative whose contact details are: **Name: Dershan Narainsamy** **Tel: 031 266 8363** **email: dnarainsamy@ingerop.co.za**	F.2.8
Submitting a Tender Offer	Tender offers shall be delivered to: **The Tender Box in the foyer of the Municipal Building** **166 KE Masinga Road, Durban**	F.2.13
Closing Time	Tender offers shall be delivered on or before **Friday, 29 September 2023** at or before **11h00**.	F.2.15
Evaluation of Tender Offers	**The 80/20** Price Preference Point System, as specified in the PPPFA Regulations 2022 will be applied in the evaluation of tenders. Refer to Clause F.3.11 of the Tender Data for the **Specific Goal(S)** for the awarding of Preference Points, and other related evaluation requirements.	F.3.11

Requirements for sealing, addressing, delivery, opening and assessment of tenders are further stated in the Tender Data

PART C3: SCOPE OF WORK

C3.1: PROJECT DESCRIPTION AND SCOPE OF CONTRACT

C3.1.1 Description of Works

The primary objective of the contract is to appoint a Mechanical and Electrical Contractor, with a Civil subcontractor, to undertake the equipment design, construction, and commissioning of the 3Ml/day emergency capacity increase of the existing Ogunjini Water Treatment Works.

C3.1.2 Description of Site and Access

The Site is situated inland of Verulam (eThekwini Municipality area) as shown on the Locality Drawing given in C3.5.1 of this document. The GPS co-ordinates for the Works are 29°35'31.76"S, 30°58'54.19"E.

C3.1.3 Nature of Ground and Subsoil Conditions

The waterworks site is gently sloping and underlain by alluvium, deposited over sandstone bedrock of the Natal Group. The alluvium generally comprises fine to medium grained sands, whilst the residual sandstone comprises silty to clayey sands. Refer to section C3.5.1. Ground water is likely to be encountered at depth due to the proximity of the river.

C3.2: PROJECT SPECIFICATION

C3.2.1 PROJECT SPECIFICATIONS: GENERAL

TABLE OF CONTENTS

PS 1. *PROJECT DESCRIPTION*

PS 1.1 Employer's Objectives

The Employer's objective under this Contract is to appoint a Mechanical and Electrical Contractor (with a Civil subcontractor) to undertake the equipment design, construction and commissioning of a 2Ml/day capacity increase of the existing 1Ml/day Ogunjini Water Treatment Works.

PS 2. *CONTRACT DESCRIPTION*

PS 2.1 Overview of the Contract

The Scope of Works covered by this Contract includes the following mechanical, electrical and civil works:

a) River abstraction

- Retain existing river intake system, but replace inlet strainers with Employer-designed non-clogging, non-restrictive system.
- Replace existing (non-functional) pump with new self-priming unit drawing directly from existing suction pipework in the river (no changes to existing riverside building housing the pump).
- Waterworks is currently supplied from one of two submersible pumps placed directly in the river which shall remain in operation until new system is commissioned. These, together with their own rising main, are independent of the non-functioning system being replaced.

b) Raw water pipeline

- Construct new 140m 200mm OD HDPE Rising Main

c) Modifications to existing raw water balancing tanks (2 No.)

- Add a fabricated stainless steel inlet box (containing a static wedge-wire screen) on top of existing inlet and flow splitter box to tanks (incl minor modifications to existing flow splitting arrangement).
- Provide new outlet from each of the two tanks (core-drill through wall and bolt-on DN200 stainless steel pipework).
- Refurbish concrete walls where necessary (high pressure clean and apply protective coating)

d) Refurbish existing works poly dosing, clarifiers and slow sand filters

- Replace existing raw water pipework, flow control, poly dosing system with new system.

- Minor refurbishment of existing rapid-mix and flocculation channel structure.

- Minor refurbishment of 4 No existing 'Dortmund'-type conical clarifiers

- Minor refurbishment of No. existing slow sand filter structures and pipework and replace sand.

- Modify filtered water pipework to incorporate a new flow meter chamber.

- Specialist subcontractor to remove and safely dispose of all asbestos-cement pipework with civil subcontractor replacing same with uPVC pipework.

- General refurbishment of existing works to restore serviceability to 'as new' condition (e.g. replace all existing valves, refurbish deteriorated concrete etc. – all as directed by the Employer's Agent and measured under agreed Dayworks budget).

e) <u>Raw water feed and poly dosing for New Works</u>

- Provide pumped raw water feed system from raw water tanks to new clarifier module, incl its own poly dosing and flash mixing equipment.

- Construct new building to house old and new works raw water feed systems.

f) <u>New 2Ml/day clarification and filtration module</u>

    - Add a prefabricated 42.5m^3/h Inclined lamella-tube upflow clarifier module plus 2No. 5m^3 settled water balancing tank plus 4 No. pressure filter module (85m^3/h capacity) to work in parallel with (but independently to) the existing 1Ml/d Works.

- Construct new building to house filter plant M&E equipment.

- Construct new 75m long 140mm OD HDPE rising main from filters to new clear water storage and balancing reservoir.

g) <u>On-site clear water storage / balancing / chlorine contact</u>

- Construct new 'SBS' type 500m^3 above-ground storage and balancing reservoir (fed from new 2 Ml/d unit) and all associated pipework and connection to existing clear water reservoir via new equilibrium float control valve

- Minor refurbishment of existing below-ground clear water tank (including retro-fitting baffle walls inside to provide better chlorine contact conditions).

h) <u>Clear water pumping system</u>

- Staged replacement of existing 2 No. end-suction pumps with larger vertical multistage units (one old pump to remain operational until 1st new pump commissioned).

- Provide new suction and delivery pipework (including core-drill through reservoir wall for new suction).

- Modify below-ground pump station structure by retro-fitting an external access stairwell to replace existing cat ladder.

i) Clear water pipeline

- Construct new 1700m DN200 PN25 mPVC rising main from waterworks clear water pump station to existing reservoir.

- Tie-in new rising main to existing remote reservoir and construct pressure-sustaining valve chamber

- Existing rising main to remain in use until new system commissioned, then abandoned.

j) Refurbishment and upgrade of existing sodium hypochlorite batching and dosing system

- Add 3rd electronic salt-to-hypochlorite converter unit.

- Add new 500 litre above-ground batching tank and one new 500 litre below-ground holding tank.

- Replace existing dosing pumps and add two new dosing pumps (total 2 Duty and 2 standby dosing pumps).

- Provide desk-top digital scale for measuring-out 11kg packets of salt for hypochlorite batching.

k) Power supply and control & instrumentation

- Replace standby generator with new 400 kVA diesel-powered unit and remove existing 100 kVA unit to EWS Stores

- Power reticulation for the site

- MCC's for all equipment.

- All signal and power cabling between buildings and structures.

- Various sensing and monitoring instruments (flows, levels, turbidity, pH, conductivity).

- Building DBs as described in the DB schematics and electrical drawings.

- Building lighting and small power points and minor appliances.

- Telemetry between Ogunjini WTW and Hospital Reservoir.

- Decommissioning, stripping, removing and transporting redundant electrical equipment and cabling to EWS stores in Springfield Park.

l) Refurbishment of existing buildings

- Restructuring internal layout of administration building, including refurbishment where required

- Partitioning of interior of disinfection building to separate salt storage area from equipment

- Formalisation and improvement of ablution facilities provided in the laboratory building.

- Refurbishment of chemical dosing laboratory building, including fitting of 2 No 250 litre poly tanks (complete with load cells and bund tank under) inside building and 5000 litre bulk tank (with load cells and bund tank under) outside building.

m) Site works

- Minor earthworks for structures.

- Construction of various interlinking pipelines and replace service water reticulation.

- Relocation / protection of various existing buried and above-ground services (pipes, cables, light poles etc.).

- Formalising entrance access with 80mm roadstone paving.

n) General

- Compliance with environmental Management Plan

- Compliance with OH&S regulations

- O&M Manual

- Supply of polyelectrolyte for raw water and dehydrator for 1 year after

commissioning

- Training of Employer's Ops staff plus twelve month Trial Operation Period (including full-time Operator 8h/d 5d/week for 6 months, 2d/week thereafter) following successful commissioning.

- Servicing and maintenance of whole works and making-good breakdowns etc. over 12-month Defects Liability Period.

PS 2.2 Contractor's Duties

PS 2.2.1 General

In addition to the construction of all civil works, the Contract includes the following duties in respect of the mechanical and electrical components:

- Design of water treatment components and control systems
- Manufacture
- Supply
- Delivery
- Installation / construction
- Testing
- Commissioning
- Training
- 12 month Defects Liability Period / Trial Operation Period (6 months of which shall include 8h/day, 5 days per week on-site Operator, reducing to 8h/day, 2 days per week thereafter)
- Weekly performance reports during Defects Liability Period
- Quarterly servicing and maintenance visits
- Operations & Maintenance Manuals and 'As Built' drawings
- Standard Operating Procedure documents
- Upholding during the Defects Liability Period
- Supply of critical spares
- Maintaining continuous operation (notwithstanding agreed shut down periods) of the WTW while completing upgrade.

PS 2.2.2 Design Brief

The proposed upgrading shall be confined to the existing waterworks boundary. The Site is very flat and space for new structures and equipment is very limited. A conceptual design by the Employer has shown that the various components for a 2 Ml/d conventional plant can be accommodated (as shown on the tender drawings). In submitting a tender, the Contractor shall have carried out his / her own evaluations and allow for a system designed to fit within the available space without loss of functionality explicitly or implicitly given in the tender documents. Any proposed departure from the Employer's concept design shall be clearly described in the tender submission. Any such departure is subject to the approval of the Employer and Employer's Agent and any associated additional costs / savings included in the overall tender price.

PS 2.2.3 Drawings

PS 2.2.3.1 Manufacturing drawings

The Contractor shall submit shop drawings for all equipment and pipework to be fabricated under this Contract to the Employer's Agent for approval and allow at least 15 working days for the Agent's response when compiling his / her programme.

Manufacture shall not commence until these drawings have been approved in writing by the Employer's Agent.

PS 2.2.3.2 Record (as-built) drawings

The Contractor shall provide 'To-Scale' record (as-built) drawings of all the relevant equipment. Such drawings shall be made available in an approved electronic format such as AutoCAD.

PS 2.2.4 Design procedures

The Contractor shall properly interface the proposed equipment with the existing structures. Any modification to the existing works or temporary measures required shall be detailed on drawings and sent to the Employer's Agent for approval. Modifications and the provision of temporary measures shall only commence once the Contractor has received written approval from the Employer's Agent.

PS 3. *THE SITE*

PS 3.1 Location

The Site is situated inland of Verulam (eThekwini Municipality area) as shown on the Locality Drawing given in C4.1 of this document. The GPS co-ordinates for the Works are 29°35'31.76"S, 30°58'54.19"E.

PS 3.2 Access

The waterworks is situated off a tarred District Road which is accessed off Oakford Road in the Iqadi area.

PS 3.3 Nature of Ground and Subsoil Conditions

The waterworks site is gently sloping and underlain by alluvium, deposited over sandstone bedrock of the Natal Group. The alluvium generally comprises fine to medium grained sands, whilst the residual sandstone comprises silty to clayey sands. Refer to section C4.1. Ground water is likely to be encountered at depth due to the proximity of the river.

PS 3.4 General Conditions

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

Altitude above sea level :	38 masl
Operating voltage:	400 V, 3 phase
Electrical supply frequency:	50 Hz
Maximum temperature :	35 ºC
Minimum temperature :	11 ºC
Corrosion conditions:	High
Lighting:	High

PS 3.5 Contractor's Camp Establishment

No provision for the Contractor’s site established has been made. There is no suitable space available within the waterworks boundary. There is some space available between the waterworks boundary and the access road. The Contractor is to make his / her own arrangements in consultation with the local community leadership structures.

PS 3.6 Security

The Contractor may be exposed to criminal actions, including theft and vandalism, and shall make the necessary security arrangements for the duration of the Contract.

The Contractor shall be responsible for the security of his works on the waterworks site whist active on Site. EWS will remain responsible for the security of the existing

waterworks infrastructure. Suitable temporary measures shall be put in place where it is necessary to remove sections of the existing boundary fence.

PS 3.7 Services and facilities existing and/or provided by the Employer

PS 3.7.1 Water supply

The eThekwini Water and Sanitation Unit is the Water Supply Authority. The Contractor may make use of the treated water produced by the waterworks; however, he shall make his own arrangements for a metered offtake for the supply of water for construction purposes and for the water testing of the pipelines. Water usage will be billed at the applicable EWS tariff.

PS 3.7.2 Power supply

eThekwini Metro Electricity is the Electrical Supply Authority. There is electricity supply available at the site; however, the Contractor shall make his own arrangements for a metered offtake for the supply of electricity for construction purposes. Electricity usage will be billed at the applicable eThekwini Metro Electricity tariff.

PS 3.7.3 Ablution facilities

The Contractor shall make his own arrangements for ablution facilities.

PS 3.7.4 Accommodation

No accommodation for the Contractor’s employees will be permitted on site. The Contractor shall make his own arrangements to house his employees and transport them to and from Site.

No informal housing or squatting will be allowed.

PS 3.8 Disposal Sites

The Contractor shall dispose of material resulting from clearing and demolition operations at a registered land-fill to be determined by the Contractor. Such a site shall have the approval of the Employer's Agent, the Local Authority and the Environmental Officer.

All mechanical and electrical equipment removed from site shall be taken to EWS Springfield Stores.

Payment for the clearing, loading, transport, dumping fees and any other requirement or costs incurred shall be included in the rate submitted.

PS 3.9 Dealing with Water

The Contractor shall deal with water on the Site so that the Works are kept sufficiently dry for their proper execution. The Contractor shall:

a) Prevent flooding of the Works.

b) All completed Works to be free-draining.

c) Not inhibit surface runoff.

d) Note that, and allow for, the possibility that the chamber/below ground structure excavation could be below the water table and that it could therefore be necessary to dewater the excavation.

PS 3.10 Existing Services

PS 3.10.1 General

The site is crossed by services which include the clear water rising main, other waterworks-related pipelines and power cables.

PS 3.10.2 Known services

The 'As Built' General Layout Drawing of the existing works (included in the tender drawings) indicates the position of some of the existing buried pipework. The positions of the existing pipelines will be pointed out to the Contractor on site.

Although every effort has been made to depict these services accurately the positions shown must be regarded as approximate.

There is no 'As Built' information available for electricity cables.

PS 3.10.3 Treatment of existing services

The Contractor shall take all reasonable precautions to not damage / protect the existing services for the full duration of this Contract and shall immediately effect repairs should any service be damaged / broken.

PS 3.10.4 Continuous operation of existing works

All of the construction works takes place at or close to existing works. Other than for connection purposes, these works must remain in operation at all times. The Contractor shall ensure that, wherever possible, the Employer's personnel have unhindered access to, and use of, all parts of the existing works at all times, as necessary.

The Contractor shall provide one week notice to the Employer's Agent when he intends to interrupt the operations of the existing works in order to effect connections with the new works. Approval for such work will be given only when the timing of the work is suitable to the Employer.

PS 3.10.5 Connection to existing services

All connections to the existing water systems shall be undertaken in a manner and at times to be approved by the Employer's Agent. No claims for additional payment will be considered in this regard. Unless otherwise authorised by the Employer's Agent, shut downs for modifications and connections shall be limited to a period of 8 hours.

PS 3.10.6 Damage to services

Where, in the opinion of the Employer's Agent, damage to existing services could reasonably have been foreseen and prevented, all such costs shall be to the Contractor's account. Repair costs where the Employer's Agent accepts that these are to the Employer's account will be measured under Dayworks.

PS 3.10.7 Proving Underground Services

This clause must be read in conjunction with Clause DB.5.1.2, the requirements of which shall be extended to cover all earthworks operations whether for trenching or bulk earthworks, in the vicinity of underground services.

It is stressed that all services in a particular area must be proven before commencing work in that area.

Insofar as bulk earthworks are concerned, where services are indicated on the drawings or where from site observations can reasonably be expected that such services are likely to exist where excavations are to take place, the Contractor shall without instructions from the Employer's Agent carefully excavate by hand to expose and prove their positions.

The cost of the proving trenches is to be included in the work covered by SANS 1200 Clause DA.8.3. When a service is not located in its expected position the Contractor shall immediately report such circumstances to the Employer's Agent who will decide what further searching or other necessary action is to be carried out and shall instruct the Contractor accordingly. The cost of this additional searching shall be to the Council's cost and shall be paid for under SANS 1200 DA.8.3.5 - Existing Services.

Should any service be damaged by the Contractor in carrying out the works and should it be found that the procedure as laid down in this clause has not been followed then all costs in connection with the repair of the service will be to the Contractor's account.

When electrical cables are not in the positions shown on drawings of eThekwini Electricity and cannot be found after proving trenches have been put down, assistance may be obtained by calling an official of the Works Branch on Telephone No. 311-1111 during office hours, or by contacting Control on Telephone No. 305-7171 after hours.

It should be noted that 33,000 Volt and 132,000 Volt cables may only be exposed by the eThekwini Electricity's personnel. The cables are usually protected by concrete covering slabs, and therefore if the slabs are inadvertently exposed, excavation work must stop, and the eThekwini Electricity shall be contacted immediately on the above telephone numbers.

Proving of services shall be completed at least two weeks in advance of the actual programmed date for commencing work in the area. The position of these services located must be co-ordinated and levelled by the Contractor, and the information given in writing to the Employer's Agent's Representative.

The requirements of this clause do not relieve the Contractor of any obligations as detailed in the Conditions of Contract or under Clause 4.17 of SANS 1921-1.

PS 3.10.8 Restriction on heavy equipment

The Contractor is to note that existing watermains traverse the site of the works and special care is to be taken in close proximity to these mains and connections. The existing mains and connections shall be proved on site by the Contractor prior to any construction work commencing in the vicinity of the watermains.

Under no circumstances will heavy plant or vibratory compaction equipment be permitted to operate within 800 mm vertically or horizontally of the existing mains or connections. The permissible compaction plant within this restricted area shall be the equivalent of a "Bomag 90" under static compaction, or similar approved plant. When the roadworks are far enough advanced to provide a minimum of 800 mm cover to the existing mains, the above restriction will fall away.

The Contractor is to take cognisance of the above requirements when entering rates in the Bill of Quantities and in the programming of the works. No claim for additional payment based on the inability to use plant as a result of the requirements of this clause will be accepted. The Contractor will be held liable for any costs should the watermain or electrical cables be damaged during construction.

PS 3.10.9 Reinstatement of services and structures damaged during construction

The Contractor shall reinstate all damaged structures and services to their original state.

PS 3.10.10 Alterations, additions, extensions and modifications to existing works

No alterations to the existing works shall take place without the prior approval of the Employer's Agent.

PS 3.10.11 Notice boards

One Notice board as per the Drawing shall be erected next to the Site. A proof shall be sent to the Employer's Agent for approval prior to printing the notice board.

The position of the board shall be agreed with the Employer's Agent.

PS 3.10.12 Temporary Works

The Contractor shall allow for all necessary temporary works, including the necessary access, shoring of trenches and excavations etc., as he may require to enable the permanent work to be constructed. All excavations must be fenced off with "Haznet" fencing or similar approved used to demarcate the working area and prevent pedestrians or animals from falling into the pits. Spoil material from excavations must not be stockpiled closer than 2.0m to the edges of roads. At completion all surplus soil must be removed from site. The Contractor is to make allowances for this in the tendered excavation rates. The Contractor shall also be responsible for maintaining a temporary perimeter security fence around the Site where the existing fence needs to be temporarily removed for construction activities.

PS 4. *MANAGEMENT*

PS 4.1 Meetings

The Contractor shall attend the following meetings during the Contract:

a) An inaugural site meeting at the GIBB offices or as called by the Employer's Agent.

b) Monthly site meetings, at Ingerop SA offices and on Site or as called by the Employer's Agent, from the commencement of the Works until the issue of the Practical Completion Certificate.

c) Site co-ordination meeting prior to installation of mechanical equipment.

d) Ad hoc technical meetings called by the Employer's Agent.

e) Meetings during the Defects Notification Period called by the Employer's Agent.

PS 4.2 Recording of weather

For the purposes of this Contract, a standard rain gauge shall be installed and maintained on Site for the duration of construction. Readings shall be taken at the commencement of construction each day and submitted to the Employer's Agent at the end of each week.

PS 4.3 Daily records

The Contractor is to maintain a site diary for the purpose of keeping daily records in respect of work performed on site.

PS 4.4 Bonds and guarantees

If the Tenderer, when notified of the acceptance of his tender, fails to provide a guarantee within the period stipulated in the Contract Data and the Council elects to cancel the contract on that ground, the Council may demand a sum of R5000,00 or the Council may take other action whether by way of a claim for loss or damage suffered by the Council arising out of such breach.

PS 4.5 Contractor’s key personnel

Should the Contractor’s key personnel change from what was tendered or at any time during the contract period the Contractor shall replace these personnel with equally experienced or qualified staff to the satisfaction of the Employer’s Agent and the

Employer.

PS 4.6 Planning, Programming and Reporting

PS 4.6.1 General

Planning and programming of the works is addressed in the Contract Data.
The Contractor shall maintain an updated programme and shall submit this to the Employer’s Agent whenever changes are required.

The Contractor's programme and method statement will not be accepted as the basis for claims for additional compensation without due reference to all relevant associated factors.

The Contractor shall submit updated programmes to the Employer’s Agent on a monthly basis.

PS 4.6.2 Progress Reporting

The Contractor shall submit a written progress report to the Employer’s Agent before each site meeting.

PS 4.6.3 Review of progress

The Contractor shall review his progress each month and should progress lag behind the latest accepted programme, by more than 2 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 Employer’s Agent, such revised programme will not make up the lost time, the Employer’s Agent 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.

PS 4.6.4 Contractor’s Programme

The Contractor shall be responsible for planning the sequence of the works. The Contractor's programme 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) Key dates in respect of work to be carried out by others,

d) Key dates in respect of information to be provided by the Employer's Agent and/or others.

The Contractor must take account of and show the following on his / her programme:

a) Time from award of Contract for the approval of shop drawings, fabrication / purchase / assembling of his materials and equipment ready to install relative to the time for 'Ready for Installation' stage of the relevant civil works structures.

b) Time for reviewing Employer's Agent's civil works layouts and designs and agreeing any changes required to better accommodate the equipment and designs offered and allowing at least 4 weeks for Employer's Agent to amend and re-issue drawings.

c) Staged replacement of existing 2 No. pumps with larger units (one old pump and old rising main to remain operational until 1st new pump commissioned using the new rising main).

d) The retro-fitting of baffles in the existing clear water reservoir may not interrupt the pumping of clear water from the waterworks for more than 8 hours at a time and several cycles of draining, installing, disinfecting and re-filling may be necessary.

e) The programme shall show the period required from award of Contract to being ready to submit shop drawings for the Employer's Agent's approval.

f) Periods required for:
   - Installation
   - Pre-commissioning tests
   - Commissioning

g) Twelve-month Trial Operation Period after successful commissioning.

PS 4.6.5 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 Employer's Agent.

PS 4.7 Documentation Required for Site Handover

Refer to Contract Data.

PS 4.8 Cooperation with the Employer

The Contractor shall ensure that:

a) The Contractor’s site staff cooperate with the Employer’s staff.

b) The Employer's rules and requirements for operations are adhered to.

c) Site staff is familiar with and comply with the Employer's emergency procedures.

d) Activities of the Site staff do not adversely affect the health and safety of the Employer's staff once the Works is put into operation.

PS 4.9 Methods and Procedures

PS 4.9.1 Method Statements

The Contractor shall be required to submit Method Statements for constructing the Works were requested by the Employer's Agent.

PS 4.9.2 Quality Assurance System

The Contractor shall institute an approved quality assurance system and shall provide experienced personnel as well as all the necessary transport, instruments and equipment, to ensure adequate supervision and positive control of the works at all times.

PS 4.9.3 Quality Plans and Control

The Contractor shall prepare an approved Quality Management Plan to be followed during the Contract.

The Quality Management Plan shall:

a) Clearly indicate the methods, programmes and procedures that the Contractor intends using 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.

PS 4.10 Work outside normal working hours

Refer to Contract Data

PS 5. *DESIGN OF THE WORKS*

PS 5.1 General

The design responsibility for the works is as per Clause 4.2 of SANS 1921-1 and GCC Clause 4.1.1. Where conflict arises, the Project Specifications take precedence.

THE GENERAL PROVISIONS OF ALL SUBSEQUENT TECHNICAL PROJECT SPECIFICATIONS, STANDARD SPECIFICATIONS, AND PARTICULAR SPECIFICATIONS PERTAINING TO THE DESIGN OF THE WORKS SHALL APPLY UNLESS STATED OTHERWISE BELOW.

The Contractor is responsible for the detailed design of all mechanical, electrical, control and instrumentation systems, in accordance with the technical specifications herein.

The Employer is responsible for concept, feasibility, basic engineering and layout for the mechanical and electrical works to tender stage of the project.

The Employer is responsible for the detailed design of the civil works as detailed in the layout drawings. Once the Contractor has had time to develop his / her designs, any required adjustments to the Employer's Agents' civil works layouts / designs shall be discussed and the Employer's Agent will carry out the amendments and re-issue the drawings.

The Contractor is also responsible for the design for any temporary works required.

PS 5.2 Design Responsibilities

The design responsibilities are as follows:

Design Process	Responsibility
Concept	Employer responsible
Engineering and layout and control philosophy to tender stage	Employer responsible
Detailed design of: - Earthworks platforms; - Reinforced concrete platforms and structures; - Modifications to existing structures; - All pipework except that associated with chemical dosing (poly and hypochlorite), flocculation, clarification, filtration, air scour, backwashing, pump manifolds, pipe supports, compressed air; - Clear water rising main; - Roads and paved areas; - All new buildings and structures mentioned in Scope of Works; - Small power and lighting; - Site power cables; - Site lighting.	Employer responsible
Detailed design of the Water Treatment Process & Control mechanical and electrical equipment, structures, units and associated pipework; including detailed control philosophy/functional design and accommodating units and equipment in the space available inside the current waterworks boundary fence. Detailed design of all pumping systems.	Contractor responsible including designing the Works in accordance with the Employer's control philosophy and functionality requirements stated in the tender document. While the Employer has allocated particular earthworks platforms and buildings to house equipment for the various components to be supplied under this Contract, these are based on estimated space requirements. Should these require amendment to better suit the Contractor's proposed design and equipment, the Employer's Agent will amend the civil works drawings accordingly and the actual quantities for civil works measured for payment.
Access for installation and sequencing planning	Contractor is responsible for the design of all access planning and all temporary works.

	The Contractor’s design shall include sequencing planning such that the operation of the existing works can be maintained by the Employer until the new system has been successfully commissioned and all shutdowns for change-overs / tie-ins must be completed within 12 hours (or as agreed).

PS 5.3 Drawings Prepared by the Employer

The Contractor’s design shall be based on agreed changes to the civil layout and detail drawings at time of tender, the existing structures and any existing equipment installations and the Contractor shall ensure that the design can be satisfactorily accommodated.

The Contractor shall accommodate actual dimensions and details measured on Site. Any inconsistencies, including any conflict between the Employer’s Agent's drawings and the actual dimensions measured on site, shall immediately be drawn to the attention of the Employer’s Agent, in writing.

PS 5.4 Design Principles to be complied with

The general provisions of SPEC GM and all other Particular Specifications included in this document shall apply to this Contract.

PS 5.5 Attendance at HAZOP-4 Workshop

As soon as the Contractor’s designs are complete, the Employer will arrange for a 5-day HAZOP-4 Workshop in Durban to review all aspects of the completed design. The Contractor’s Electrical and Mechanical Design Engineers, as well as the Site Agent, are required to attend for the full 5-day period. A technical representative from the specialist supplier of the proprietary dehydrator equipment shall attend for the relevant part dealing with sludge, for which 1 days attendance is to be allowed for. All costs associated with the Contractor’s attendance at the Workshop shall be measured for payment as a Lump Sum item in the BoQ.

PS 6. *CONTRACTOR’S DOCUMENTS*

PS 6.1 Drawings

Drawings shall comply with the following:

- The Contractor shall sign each drawing to indicate approval. This shall be done before the Contractor submits the drawing to the Employer’s Agent (in accordance with Clause 5.9.7 of GCC 2015).

- Drawings shall be prepared in accordance with the latest issue of SANS 10111 or an equivalent international standard.

- General Arrangement drawings shall be to A1 size or larger.
- 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.
- Item lists shall be provided and shall include the material of construction, quantity, make, model, rating, duty, etc.
- Requirements for civil and building details shall be specifically noted.
- Three hard copies and an electronic copy of all drawings shall be provided.

PS 6.2 Contractor’s Documents to be submitted

PS 6.2.1 Introduction

The Contractor’s Documents to be submitted by the Contractor to the Employer’s Agent for review and approval in accordance with Clause 5.9.7 of GCC 2015 are listed below. In addition to the lists of documents in this sub-clause the Contractor shall provide further documents that may be requested by the Employer’s Agent in accordance with the requirements of Clause 4.1.1 of the GCC 2015.

PS 6.2.2 General

Each submission shall include a notice stating that the documents are ready for the Employer’s Agent’s review and approval (in accordance with Clause 5.9.7 of GCC 2015).

The Contractor’s notice shall include a register of all current Contractors’ documents.

PS 6.2.3 Manufacturing drawings

The Contractor shall submit shop drawings for all equipment and pipework to be fabricated under this Contract to the Employer’s Agent for approval and allow at least 15 working days for the Agent’s response when compiling his / her programme.

Manufacture shall not commence until these drawings have been approved in writing by the Employer’s Agent.

PS 6.2.4 Installation drawings

The Contractor shall provide ‘To-Scale’ General Arrangement Drawings (A1 or larger) of the proposed designs, including at least one plan view, two elevations, equipment dimensions, layout dimensions, sectional views where necessary for clarity and an item list including make, model, rating, number and material. The drawings shall include pipework and pipe supports. Such drawings shall be made available in an approved electronic format such as AutoCAD.

PS 6.2.5 Record (as-built) drawings

The Contractor shall provide Record Drawings in accordance with SPEC GM.

PS 6.2.6 Equipment

The Contractor shall submit the following documents:

- Equipment list with the make, model and details of all items.
- Data sheets for all items of equipment giving performance, sizing, physical and general technical data.
- Motor and instrumentation list.
- Detail design calculations for the selection of member sizes, bearings, etc.
- Pipe shop drawings.
- Pipe support designs and drawings including the calculations for supporting the weight of the valves and for restraining thrust forces resulting from pipe reducers, check valves and bends.
- Baseplate design, including anchoring to plinth.
- Pump performance curves including Head, Power and NPSHr.
- Pump performance test and inspection report.
- Corrosion protection detail sheet.

PS 6.2.7 Control

The Contractor shall submit the following documents:

- The design of the control system, including drawings, functional design,
- control panel layouts, circuit diagrams and protection systems.
- Control panel layouts.

PS 6.2.8 Reports

The Contractor shall be required to submit Reports for the Works as requested by the Employer's Agent.

PS 6.2.9 Sundry

The` Contractor shall submit the following sundry documents:

- Signage design.

PS 6.2.10 LV Installation

The Contractor shall submit the following documents for the LV installation:

- Cable support layout drawings.
- Busbar trunking layout drawings

PS 6.2.11 LV Switchgear and Control Gear Assemblies

The Contractor shall submit the following documents for the LV Switchgear and

Control Gear Assembly (MDB):

- Design documentation as per SANS 1973-1.
- General arrangement and schematic drawings
- Type and routine test certificates

PS 6.2.12 Telemetry Inputs

The Contractor shall submit the following documents for the PLC, HMI and Telemetry System:

- Functional Design Specification (see Section PS6.3 Function Design Document)

PS 6.2.13 Instrumentation

The Contractor shall submit the following documents for Instrumentation:

- Instrumentation list
- Data sheets
- Loop diagrams
- Hook-up drawings

PS 6.2.14 Training

The Contractor shall submit the following documents related to training:

- Training Schedule.

- Pre-commissioning Testing Documentation.
- Commissioning Schedule.

PS 6.2.15 As-built Documents

The Contractor shall provide As-built documents in accordance with SPEC GM.

PS 6.2.16 Operation and Maintenance Manuals

The Contractor shall provide O&M Manuals in accordance with SPEC GM.

PS 6.2.17 Standard Operating Procedures

The Contractor shall provide a Standard Operating Procedure document in accordance with ISO standards.

PS 6.2.18 Tests on Completion

The Contractor shall submit the following:

- Report containing the records of pre-commissioning tests undertaken and the results of these, demonstrating that the Works have passed the pre-commissioning tests.

- Report containing the records of commissioning tests undertaken and the results of these, demonstrating that the Works have passed the commissioning tests
- Training logs and weekly reports detailing the plant performance, problems and equipment failures during the Trial Operation Period.
- At the end of the Trial Operation Period, an overall report.

PS 6.2.19 Functional Design document

The Contractor shall submit a document detailing the functional design which complies with the following (as applicable).

Table Showing Required Contents List for the Functional Design Specification

Item No	Description of Content
1	**General**
1.1	Contents List
1.2	Introduction
1.3	Drawing List
2	**Control Philosophy**
	Plant should be broken down into its various functional sections and the items below shall be provided for each section.
2.1	Control loops signals required (4-20mA, hart, Modbus etc.)
2.2	Control Unit e.g. PLC/SCADA/MCC for manual mode
2.3	Local Control
2.4	Instrumentation • Instrumentation Signals • Output signal during instrument error.
2.5	Failsafe positions of valves
2.6	Safety Interlocks
2.7	Process Interlocks
2.8	Startup/Shutdown (including for back-up power supply if applicable)
2.9	Alarms and philosophy
2.10	Manual Control Functionality
3	**Electrical and Control System Description**
3.1	Electrical and Control System Description
3.2	Control System Configuration • Detailed Network Diagram
3.3	Controlled Equipment Motor and Equipment List Instrumentation List
3.4	Schematic Drawings • MV Equipment • MCC General Arrangement Drawings MCC Schematic Drawings Instrumentation Wiring

4	**MV and MCC Controls**
4.1	Control gear
4.2	Pushbuttons
4.3	Indicators
4.4	Measuring Instruments
4.5	Alarms
4.6	Alarm functions
4.7	Fault accept and reset
4.8	Alarm Annunciation
5	**PLC & Substation RTU (where applicable)**
5.1	PLC & RTU Configuration
5.2	PLC & RTU functional blocks description
5.3	PLC& RTU Hardware
5.4	PLC& RTU Networks
5.5	PLC& RTU IO list
5.6	Protocols
5.7	HMIs

PS 7. *POST-INSTALLATION*

PS 7.1 Acceptance Testing and Commissioning Procedure

PS 7.1.1 Testing

a) General

No test shall be recognised unless it is documented in a previously agreed format. The test procedure shall ensure that every combination of switches and events is tested for correct functioning and each such combination is recorded on a test sheet and checked off.

The Contractor shall supply all test equipment and consumables and at least 3 radios shall be available at all times during site tests.

The Contractor shall conduct tests at the following stages and the Engineer shall be advised of the tests one week in advance of the test dates:

- Factory test - At place of manufacture before equipment is released to site
- Delivery Acceptance Tests
- Pre-commissioning tests
- Commissioning test / performance testing
- Trial operation tests

After the tests are complete, the Contractor shall compile and submit a report to the Engineer. After submission of the test report, the Engineer may call for all or some of the tests to be repeated in his presence. Should any test be unsatisfactory at this time, the Engineer reserves the right to have his reasonable abortive costs deducted from the contract sum.

b) Factory Acceptance Testing (FAT)

It shall be the responsibility of the Contractor to carry out such factory tests as are practicable to ensure that all plant, equipment and components supplied under this contract comply fully with, the relevant specifications and can function as intended.

c) Site Acceptance Testing (SAT)

On completion of the installation of all plant and equipment, the Contractor will be required to make appropriate arrangements, and supply any necessary instruments or apparatus, etc., for the testing of all plant and equipment, in the presence of the Engineer's Representative in order to demonstrate compliance with the requirements of the specification.

The Engineer may require valid calibration certificates to be submitted to cover any meters, gauges, or other instruments used in the tests and may, if considered necessary, arrange for the use of additional meters or other instruments in order to establish the degree of accuracy of the tests.

For further information on testing refer to the relevant Mechanical and Electrical Specifications.

PS 7.1.2 Preparation

All installation work, including screeding of floors, grouting of machine base plates, grouting-in of pipes etc., shall be complete and approved by the Employer's Agent prior to pre-commissioning.

The Contractor shall allow a reasonable period in the installation programme for this work to be done and no compensation for delay in the commencement of testing and commissioning shall accrue to the Contractor during such period.

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 7.1.3 Starting Up

The Contractor shall arrange for the Employer's Agent to be present at initial start-up and also for any 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 Employer's Agent. All necessary modifications and rectifications shall be carried out during this period.

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

PS 7.1.4 Control system

The Contractor shall submit a schedule of all control functions to be checked on Site. This shall be submitted to the Employer's Agent before commissioning. The format shall be as follows, or similar:

COMMISSIONING - CONTROL SYSTEM TESTS				
Date	Test Function	Test Method	Result	Proposed Corrective Action

PS 7.1.5 Performance Acceptance

Performance acceptance for the various components of the works shall be in accordance with each Particular Specification relevant to that component (e.g. SPEC CD, SPEC CL, SPEC PF, EWS Electrical Spec), failing which in accordance with SPEC GM.

PS 7.1.6 Commissioning

Commissioning shall be carried out generally in accordance with SPEC GM.

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 7.1.7 Commissioning Report

A comprehensive commissioning test report shall be submitted by the Contractor prior to issuing of the Taking-Over Certificate and shall be inserted in the Manual.

PS 7.2 Trial Operational Period

Once the Works has been commissioned to the approval of the Employer's Agent, the twelve-month Trial Operation Period shall start.

The Contractor shall be required to:

- Provide one full-time operator for a period of 6 months following successful commissioning, where the operator is expected to be on site 8 hours per day, 5 days per week. For the remaining 6 months, the operator will be expected to be on site 8h per day, twice per week
- Produce weekly reports on operation
- Make available 24/7 operator and/or mechanical and electrical technicians to attend to any malfunctions / teething problems.

During the Trial Operation Period, the Contractor shall carry out all necessary servicing and any adjustments required. Four No. quarterly service visits will be measured for payment.

The Contractor shall provide any further training during needed during this Period.

PS 7.3 Training

PS 7.3.1 General

The contractor shall be required to provide full operation and maintenance training for EWS staff on the equipment and processes supplied under the contract prior to the issuing of the Taking Over Certificate/s. Requirements are detailed below.

The purpose of the training is to ensure that the Employer's personnel responsible for operating the Plant have sufficient skills to operate the Plant in a safe and proper manner.

The training will be required as an ongoing activity during the periods of installation, commissioning and testing of the works. It is required that all training required will take place on site. The Contractor shall also provide for continued training during the defects liability period when performing the required quarterly service and maintenance visits.

All training personnel shall be fully experienced and qualified in their respective disciplines and be proficient and fluent in the English language and shall be employed to act on behalf of the Contractor.

Where specialised equipment has been supplied the Contractor shall also include for the original equipment supplier / distributer to provide the required specialised training.

All training performed needs to be formally recorded with the following:

- Date of Training
- List of Attendees
- Scope of Training as per approved Training Manual
- Facilitator
- Discipline
- Plant Area
- Recommended additional training required for attendees.

PS 7.3.2 Training Manual

The contactor shall use a training manual developed for the new dewatering facility as a basis for the presentation of the various training sessions. Note: This is not the O&M Manual.

The manual shall be compiled in a user friendly process-orientated format with the use of equipment descriptions, process descriptions, diagrams, photographic material, and SCADA images to ensure that all the required information is included for the user of this manual.

The manual shall be compiled in hardcopy as well as digital (pdf) format.

The final version of these training manuals shall be presented prior to handover for approval of the manual and the training contents by the Engineer.

The information provided in the training manual shall be read in conjunction with the operation and maintenance manual provided separately by the Contractor.

The training manual shall cover the following minimum areas for each of the various disciplines of mechanical, electrical, instrumentation, SCADA, process control and process operation individually for each plant area:

- Basis of operation and/or purpose of equipment (including to programming the PLC or VSD starters)
- Integration of equipment in the overall process
- Fault finding and corrective actions required
- Consequential process effects of equipment malfunction
- SCADA (Parameter setting, alarm causes and effects, screen layouts and symbol functions)

- Basic maintenance required (Lubrication, Adjustments, Settings, Instruments and VSD parameters checking, SCADA parameters setting etc.)
- Advanced maintenance required (Specialised maintenance by the original equipment supplier)
- Frequency of maintenance for basic and advanced maintenance
- Equipment-critical spare part requirements
- Safety related operational and maintenance requirements.

The Contractor's tendered rates shall include for the compilation of this training manual and all the associated costs.

PS 7.3.3 Training Stages

Although some of the training material will be covered well before handover of the plant, the requirement shall be for all the relevant training stages to be completed by the time the plant is handed over.

The Taking Over Certificate will only be issued once all approved training has been completed. No handover of the plant will occur until all training has been completed by the Contractor and accepted in writing by the Engineer.

The Contractor shall indicate in the manual what training will be provided during the various stages (Installation, Pre-Commissioning Testing, Commissioning, and Trial Operation) in the contract.

As a minimum, the training stages required will be the following. For each stage, the Contractor is to provide a break-down of the time required for each component of the works.

i. Construction, including installation and pre-commissioning/testing:
Two working days (minimum). The aim of this phase is to enable the EWS staff to gain a working knowledge and familiarise themselves with the installation and its respective elements.

ii. During and after commissioning/testing:
Five consecutive working days (minimum). The purpose of this phase is to enable the EWS staff to be to restart sections of the plant and evaluate the performance of the plant sections.

iii. During the Trial Operation Period / Defects Notification Period:
It is anticipated that continued training on the plant operation and maintenance will take place during the Defects Notification Period. The Contractor shall spend 5 consecutive working days of 9 hours each in full attendance training EWSs staff in the day-to-day operation, attendance, minor adjustments and maintenance necessary to operate and maintain the installation(s) successfully and efficiently.

The contractor's personnel/sub-contractor(s) used for the training shall be familiar with the plant and equipment and must have been extensively involved in the initial plant construction, commissioning and testing up to the handover of the plant.

Training pertaining to the service/maintenance visits during the Defects Liability Period will be paid for at the end of the Defects Liability Period. The Contractor's tendered rates shall include for this payment structure.

An item has been provided in the Bill of Quantities for the Tenderer to cover these events and the

Tenderer shall allow in his tendered rate for all associated costs (Travelling, accommodation, administration etc.).

A Provisional Sum has been included in the Bill of Quantities for selected operations staff to attend formal accredited training in operating and maintaining mechanical and electrical installations. Details are to be agreed with the Engineer before implementing such training.

PS 7.4 Record Drawings, O&M Manuals, and SOPs

PS 7.4.1 Operating and Maintenance Manuals

The Contractor shall supply, after approval by the Engineer, three (3) bound sets of operating instructions, parts lists, maintenance manuals and as-built drawings.

a) Compilation

These shall come in the form of plastic covered ring files with the following information indelibly printed on their covers:

ETHEKWINI WATER AND SANITATION
OPERATING AND MAINTENANCE INSTRUCTIONS FOR
OGUNJINI WATER TREATMENT WORKS:
SUPPLIED BY:
(Name, address, telephone and fax number of Contractor)

Each page, pamphlet, booklet, diagram, drawing, etc. shall be separately bound into the manuals in a clear plastic pocket. Each pocket shall be number and indexed.

If more than one volume of the Operations and Maintenance Manuals is required, the first page of each set of manuals shall be an index which shall include a list of the numbers and descriptions of all drawings and pamphlets included in the set and also a list of the Engineer's and/or Contractor's drawings relating to the relevant section of the facility.

b) Content

The instructions shall include the following:

i. A list of spares, tools and testing equipment supplied under the contract.
ii. A list of spare parts and testing equipment which are not supplied under the contract but which may be required for future major overhaul and/or testing of mechanical or electrical plant and equipment.
iii. For (a) and (b) above for spares, tools and testing equipment the Supplier's names, addresses, telephone number, fax numbers and costs must be listed.
iv. A list of "Name Plate Data" giving full particulars of serial numbers and other descriptive data pertaining to the plant and equipment installed.
v. A list of points requiring lubrication, stating for each point the type and grade of lubricant recommended and full details as to quantity, timing and renewing of lubrication. Before typing the manuals, the Contractor shall contact the Engineer to obtain the name and brand of lubricants generally in use by the Engineer and, wherever possible, suitable grades of lubricant of that particular brand shall be nominated by the Contractor in the manuals.

vi. Particulars of bearings, contacts and other moving parts with instructions relating to any special attention which may be required.
vii. Precautions to be taken in starting, running and stopping the plant or equipment by remote or manual control.
viii. Safe operational procedures and risk assessment for plant and equipment supplied'
ix. Routine tests which the Contractor/supplier(s) would suggest be carried out.

All information mentioned above shall be cross-referenced to the drawings.

Additionally, the manuals shall provide the following electrical information which shall also be cross-referenced to the drawings:

i. Equipment layout drawings
ii. Power single line diagrams
iii. Control schematic diagrams
iv. Cable layout drawings
v. Cable block diagrams
vi. Instrumentation loop diagrams
vii. As-built instrumentation index
viii. As-built instrumentation data sheets
ix. As-built P&ID's for the plant
x. As-built detail process and control description as per EWS format
xi. As-built detail equipment control philosophy as per EWS format
xii. Network layout diagrams
xiii. SCADA alarm list
xiv. CD copy of all computer / PLC related / equipment parameter setting software programs
xv. Fault finding routines
xvi. Routine maintenance instructions, procedures and frequencies
xvii. Equipment and component specification sheets
xviii. A list of equipment and components including manufacturer, catalogue number and suppliers address, fax and telephone numbers
xix. Electrical Certificates of Compliance

Further, one (1) ring bound set of drawings relevant to a particular motor control centre shall be placed in a document holder compartment in the PLC compartment.

The drawings shall be provided in A4 format in a single page arrangement with each page laminated.

PS 7.4.2 Record (‘As-built’) Drawings

The Contractor shall provide ‘To-Scale’ record (as-built) detail drawings of all the relevant equipment. Such drawings shall be made available in an approved electronic format such as AutoCAD and PDF and shall be submitted to the Employer’s Agent prior to issue of the Taking Over Certificate.

The contract will not be accepted as complete until these have been supplied, complete and to the satisfaction of the Engineer.

PS 7.4.3 Standard Operating Procedures

The Contractor shall supply a Standard Operating Procedure for both the existing and the new works, conforming to ISO standards.

Findings from the HAZOP Study will be included and addressed in the SOPs.

PS 7.5 Inspection

At the end of the Trial Operation Period, an inspection shall be done by the Contractor and the Employer's Agent for the purpose of taking over the Works in terms of Clause 10 of the General Conditions of Contract.

PS 7.6 Guarantees and Warrantees

The Contractor shall guarantee all equipment and fittings supplied by him and installed under this contract for a period of at least twelve (12) months from date of issue of the Taking Over Certificate.

Should the plant and equipment be installed and commissioned a long time before the issue of the Taking Over Certificate, then the Contractor shall ensure that this milestone event is accounted for in the guarantee period by means of an extended guarantee to ensure compliance with the aforementioned requirements.

All supplied equipment

The cost for this extended guarantee (where required) is provided for under Dayworks Prime Cost items.

The guarantee shall include any latent defects in the plant, equipment, fittings and installation thereof and any labour or other costs inherent in repairing any defect and ensuring that the plant, equipment and fittings remain free of defects and in good working order to the satisfaction of the Engineer.

Fair wear and tear shall not be considered as requiring any action by the Contractor under the requirements of the contractual guarantee.

Provision, as required, shall be made by the contractor in the tendered rates, or elsewhere, for any additional costs incurred in providing this contractual guarantee.

PS 7.7 Mechanical, Electrical and Control and Instrumentation Schedules

The Contractor shall update the mechanical, electrical and control and instrumentation schedules and submit same to the Employer's Agent whenever any changes have been made.

PS 7.8 Chemical Supply

It is a specific requirement of this Contract for undertaking coagulation and flocculation tests using all the locally-available polyelectrolytes; identifying the most cost-effective polyelectrolyte that works effectively for Ogunjini WTW's particular water quality and then supplying one year's worth of said polyelectrolyte (supplied in 5 tonne loads as and when needed over the year).

Chemicals for coagulation of sludge in the dehydrator shall also be supplied as and when needed for one year after commissioning.

C3.2.2 PROJECT SPECIFICATIONS: WATER TREATMENT

TABLE OF CONTENTS

PS 8 WATER TREATMENT

PS 8.1 Review of Historical Data on Incoming Raw Water and Output Clear Water Quality

PS 8.1.1 Treated Volumes

The treated volume of clear water transferred to Ogunjini 1 Reservoir is metered on the WTW site. **Figure 1** below summarises the average throughput for each month from January 2014 through April 2016. There is no data available from November 2015 through January 2016 due to the flow meter being removed for repair work.

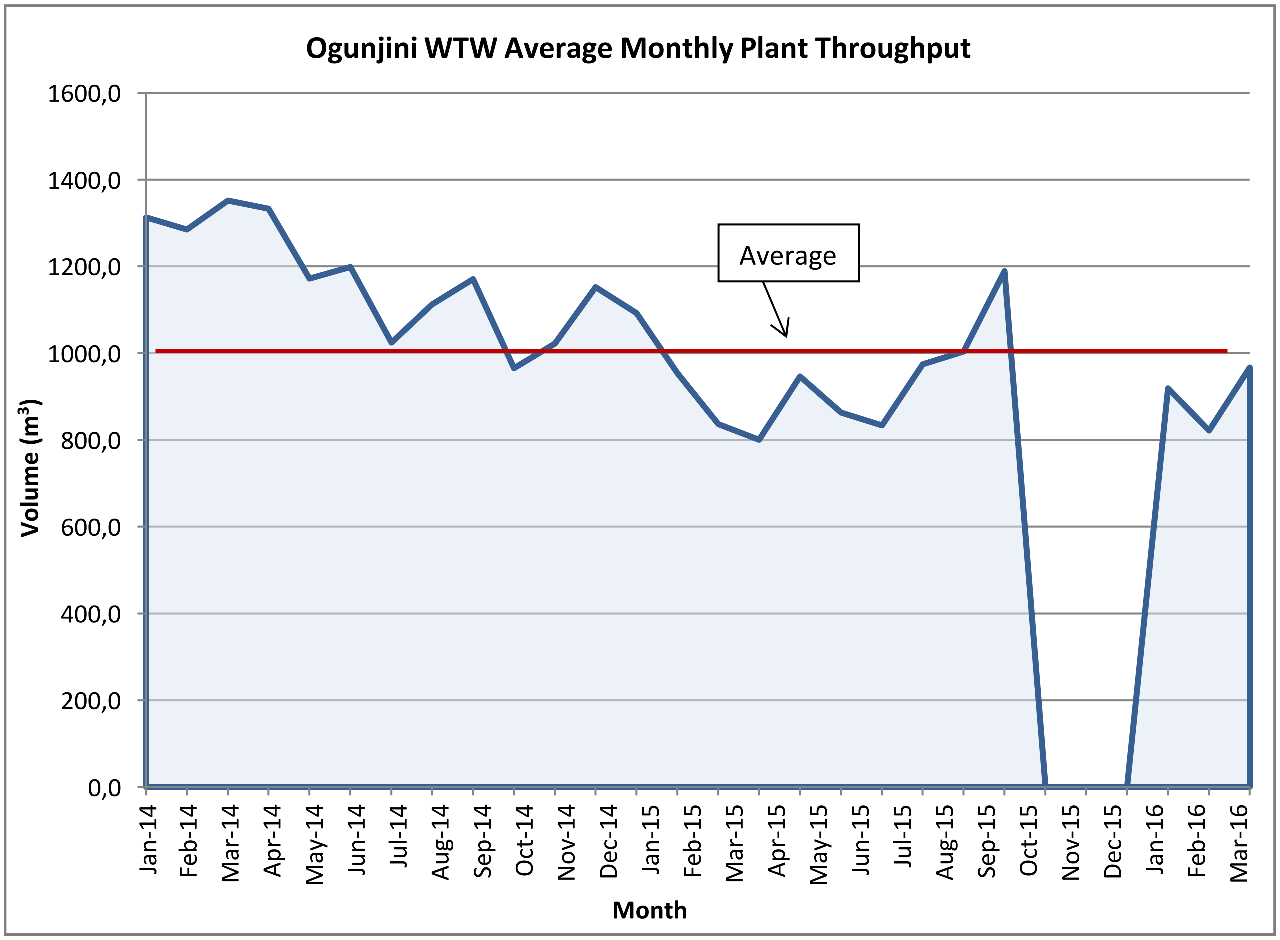


Figure 1: Average Monthly Throughout of Clear Water at Ogunjini WTW.

Over this period, the average throughput was approximately 1000 kl/day but peaking as high as 1600 kl/day on one occasion in 2014.

PS 8.1.2 Raw Water Turbidity

The raw water is abstracted directly from the Mdloti River, upstream of Hazelmere Dam and therefore has a highly variable settleable solids and colloidal load. Both settleable solids and colloidal content increases significantly in the rainy season.

Figure -2 overleaf summarises the monthly average raw water turbidity from 2014 through to 2016.

Over the month of October 2014, the turbidity peaked at 1000 NTU over a period of 3 consecutive days which had the effect of pushing the average turbidity for the month to over 200 NTU although, over half of this period, the turbidities were below 60 NTUs. The Works needs to be able to cope with highly turbid water over several days rather than stopping operations and drawing on storage while the readings are high.

In this particular instance, the final clear water was well within the required 1 NTU limit which indicates that such peaks are easily accommodated by the existing works.

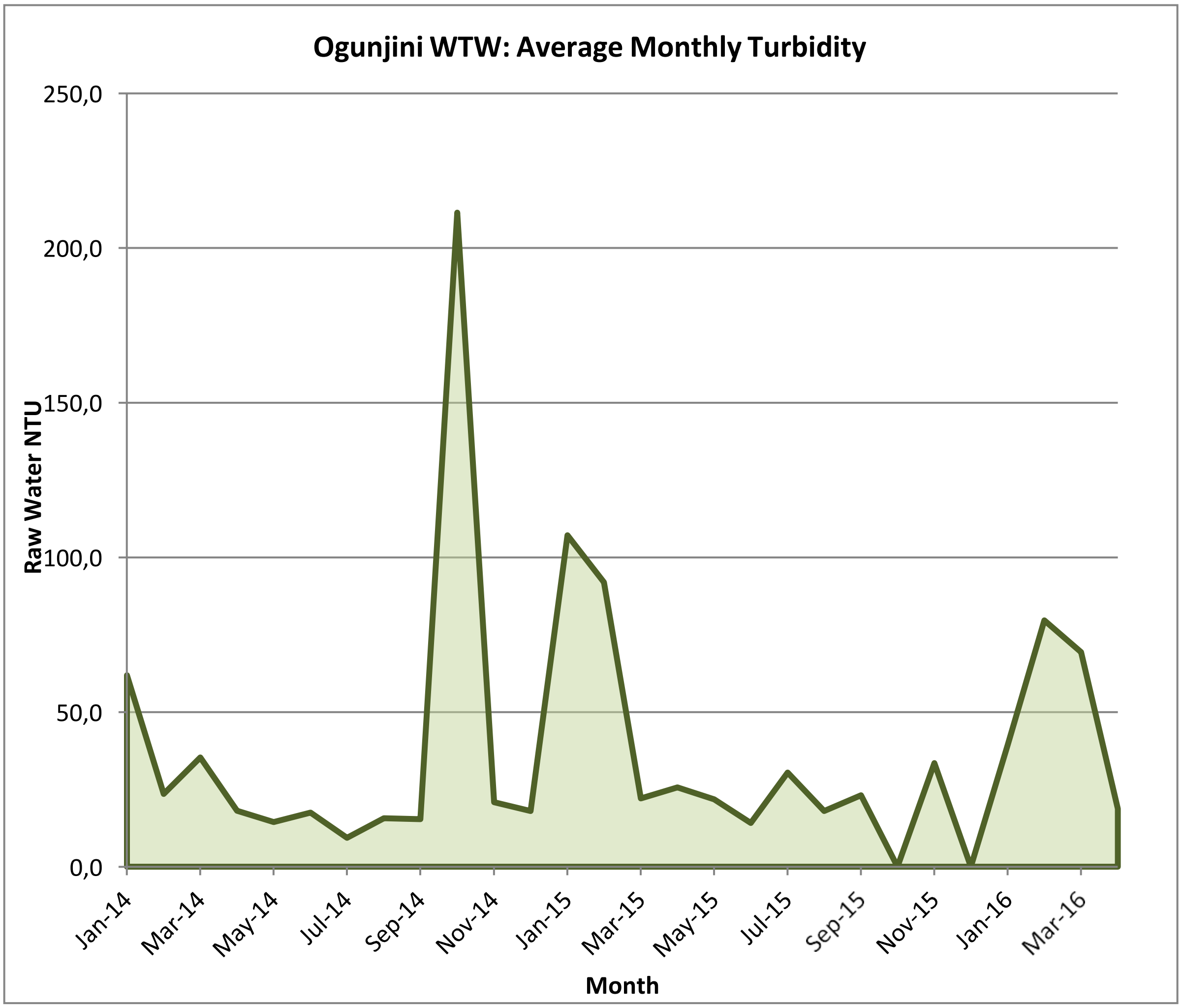


Figure 2: Summary of Monthly Average Raw Water Turbidity at Ogunjini WTW.

As can be expected with river abstraction, this WTW sees a large variation in the average raw water turbidity, with the summer months reflecting higher average turbidity levels.

The variation is further shown in **Figure 3** overleaf where for each calendar month, the maximum, the 75 percentile, the median, the 25 percentile and the minimum recorded turbidities are summarised.

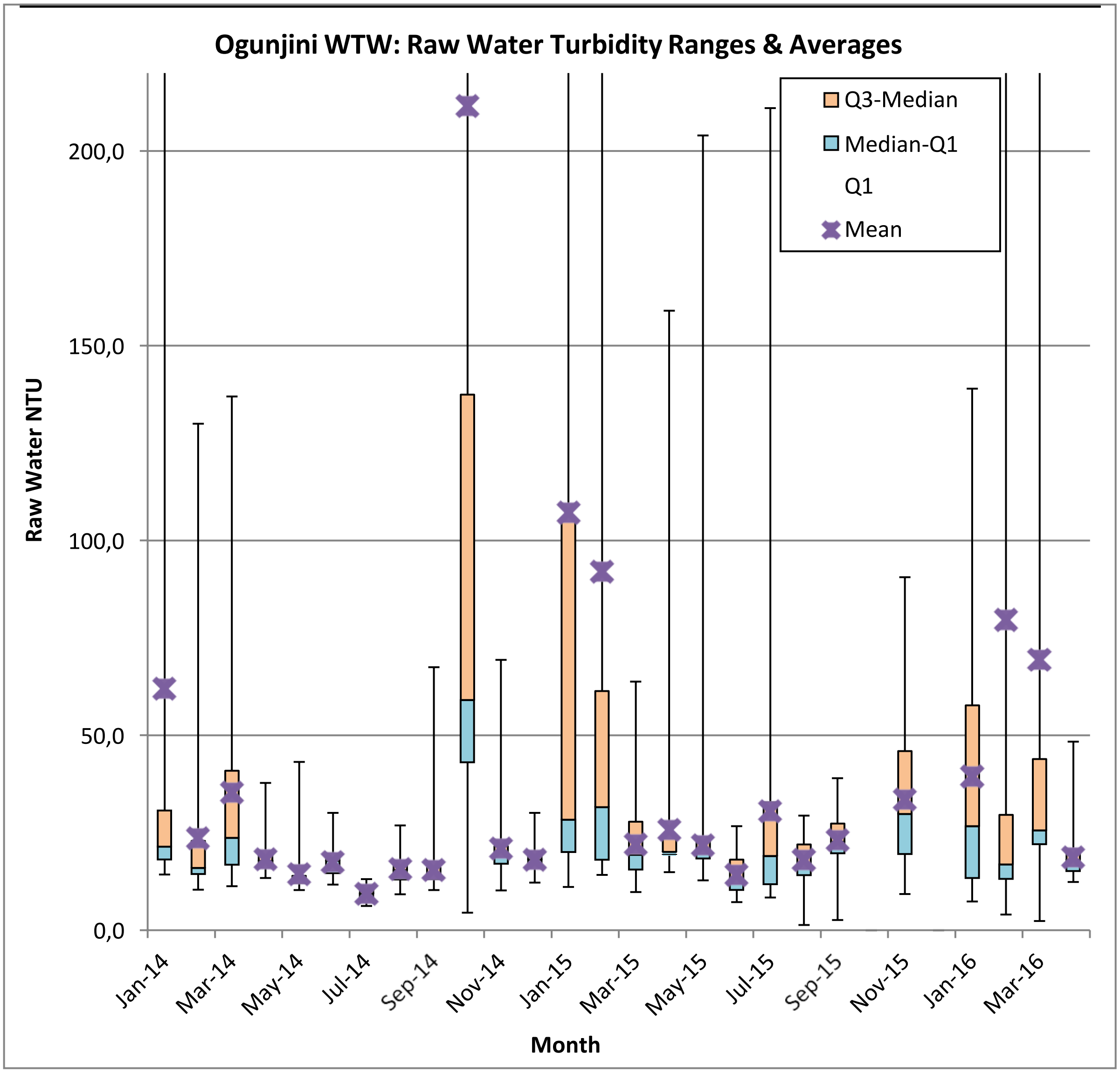


Figure 3: Summary of Monthly Raw Water TurbidityReadings at Ogunjini WTW.

PS 8.1.3 Raw Water Chemical Composition

There is no data available pertaining to the chemical composition of the raw water, though the physical, chemical, and biological composition of the treated water indicates that no advanced treatment processes are warranted.

PS 8.1.4 Clear (Treated) Water Turbidity

The available historical turbidity data (as per the SANS 241 determinants taken for compliance reports) of the Works' clear water output for each month is presented in **Figure** 4.

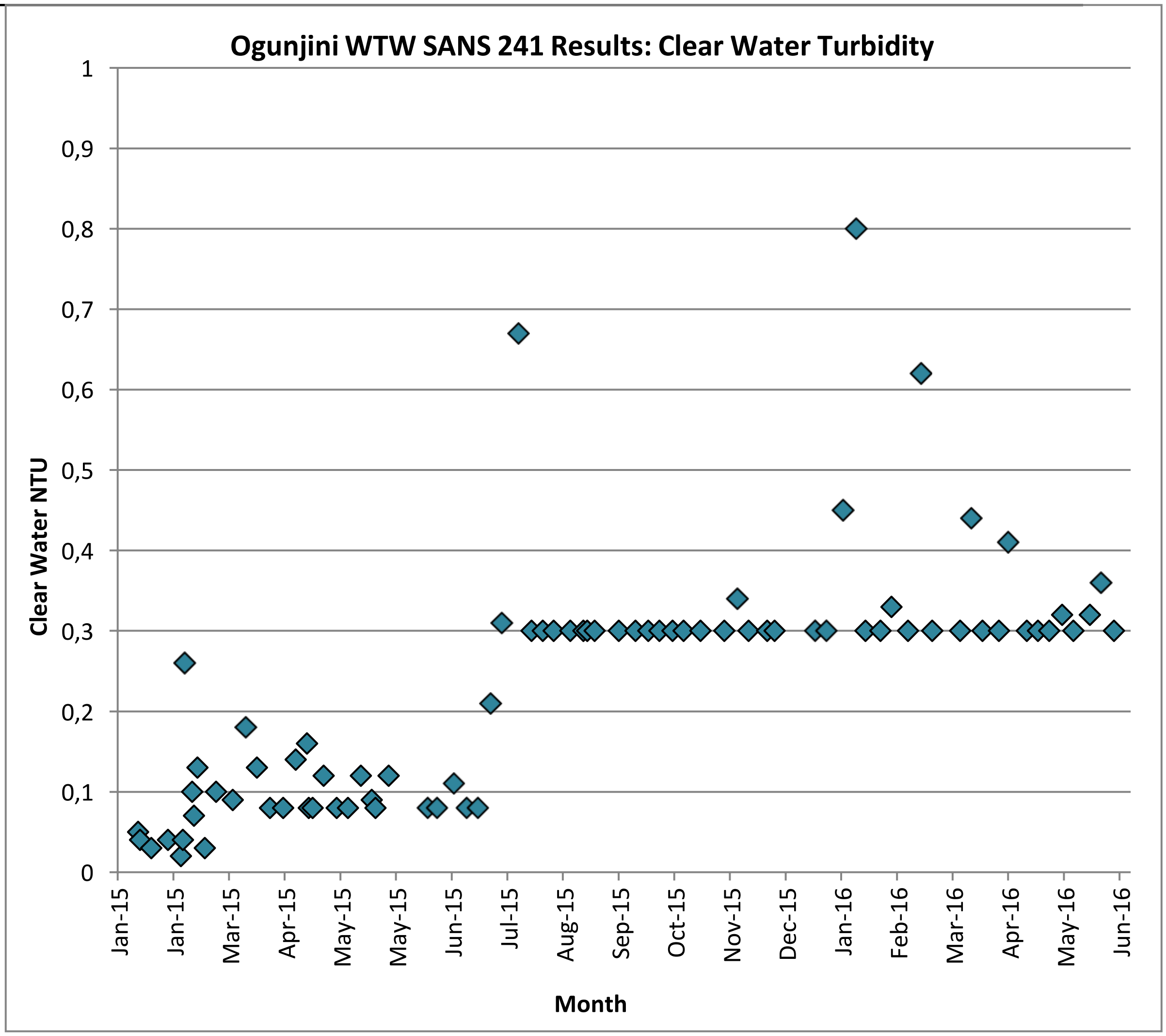


Figure 4: Summary of Clear Water Turbidity Samples taken at Ogunjini WTW

The turbidity readings of the existing plant clear water output reflect that the existing process is effective. For the limited period of readings available, it can be seen that the clear water turbidity never exceeded 1 NTU with almost all data points less than 0.5 NTU.

PS 8.1.5 Clear Water Chemical Composition

From a review of the available data on the full range of SANS 241 tested physical, chemical and biological determinants (January 2015 through June 2016), the following can be noted:

a. All physical and aesthetic determinants meet the standard limits

b. With the exception of residual chlorine and aluminium, there are limited results for other chemical macro and micro determinants; however:

   - Nitrate & nitrite and aluminium each had one sample exceeded the respective standard limits
   - Four out of 77 residual chlorine samples were slightly higher than 1.5 mg/l

- All other chemical determinants were well within the standard limits

c. There are limited results for chemical organic determinants, however:
   - The (limited number of) tests for trihalomethanes were all well below the 10 mg/l SANS 241 limit
   - There are limited readings of Total Organic Carbon (3 readings in period), though all were well below the 10 mg/l SANS 241 limit

d. 10% (of a total 77 samples) of total coliform measurements exceeded the 10 cfu/100ml limit, some reaching 80 cfu/100ml

e. 2.5 % (of a total 77 samples) of E. Coli measurements exceeded the 1 cfu/100ml limit, some reaching 80 cfu/100ml; however, half the samples taken had readings of zero

f. 10% (of a total 77 samples) of total organism measurements exceeded the 100 cfu/ml limit, with all these samples reaching 1000 cfu/ml

g. The measurements for Giardia and Cryptosporidium have zero readings.

The clear (treated) water quality is such that no advanced treatment processes are warranted (e.g. to reduce excessive iron, manganese, heavy metals, fluoride, organic carbon, cryptosporidium etc.).

The historical data of indicators for testing disinfection efficacy (E. Coli / total coliforms / total organisms counts) show that the clear water nearly always complies with SANS 214 with respect to biological quality.

PS 8.2 Existing Works

The below figure illustrates the site layout.

Figure Error! No text of specified style in document.**-5: Current Ogunjini WTW Site Layout**

PS 8.2.1 Raw Water Abstraction & Conveyance to Waterworks

Two previous attempts to provide a reliable run-of-river abstraction system have proved impractical and unworkable. The Works is therefore currently fed from a temporary system comprising 1 Duty and 1 Standby submersible pumps on the end of flexible rubber hoses laid unsecured directly in the river. This system is reliable but requires frequent manual re-positioning in the river and is vulnerable to vandalism, theft and floods. As confirmed by site investigation undertaken by the survey service provider, the rubber hoses are connected to a previously decommissioned 160mm diameter uPVC pipeline that extends to the raw water tanks.

The existing formal abstraction system comprises a Duty and Standby suction-lift arrangement in a concrete and brick tower where conventional end-suction pumps (installed above flood level) draw run-of-river water via two parallel stainless steel pipes arranged in the river to be submerged even at low flows. There are fixed strainers (5mm gap) on the pipe inlets and an industrial-type backwashable 'pot screen' on the suction side of the pumps. The existing mechanical and electrical equipment cannot be modified to improve operation, but the inlet pipework and abstraction tower can be re-used.

The raw water rising main from the dysfunctional pumpstation is a 160mm diameter HDPE (Class 12.5) pipe that runs along the eastern fence line to the two raw water balancing tanks.

PS 8.2.2 Raw Water Balancing Tanks

The raw water balancing tanks have a dual purpose; to provide a steady flow for the waterworks (while the river pumps switch on and off) and to settle-out some of the suspended solids.

The bigger raw water balancing tank is 14 x 6m x 2m water depth (168m^3) and the smaller (newer) tank is 9 x 6 x 2m water depth (108m^3) giving a combined storage capacity of 276 m^2 (retention time of about 6 hours at 1 Ml/d throughput).

There is no effective provision for flushing-out accumulated solids other than a scour offtake. Removing accumulated solids will therefore comprise draining the tank to the river and digging out the remaining mud and silt by hand.

PS 8.2.3 Waterworks Inflow Control, Chemical Dosing and flocculation

The inflow to the waterworks is manually regulated by means of an isolating valve from the raw water balancing tanks to the chemical dosing and flocculation facility. If the balancing tank is not kept full, the works inflow will vary with the changing water level in the balancing tank.

Coagulation is achieved by dosing the raw water with a cationic polyelectrolyte blend (Rheofloc 5537). The poly is dosed where the incoming water passes over a V-notch weir at the head of a flocculation channel.

A Streaming Flow Ion Detector (or 'Streaming Current Detector') measures the residual ion charge of the treated water at the end of the flocculation zone. This device was functional when the Works was inspected on 17th October 2016.

For optimum coagulation and flocculation, the polyelectrolyte should be flash-mixed into the full body of raw water (i.e. achieving full dispersion in a split second), then rapid-mixed to facilitate the formation of pin-sized floc, then gently mixed with declining intensity as the water flows through a floc forming zone.

The Ogunjini system flash-mixing and rapid mixing has too little intensity to be considered optimal. The mixing energy (expressed as water head loss rather than shear s^{-1}) is less than 300mm. At least 1m headloss is needed or mechanical energy added. The arrangement of the slow-mixing (flocculation) zone is adequate. At the time of visit, the floc formation was poor; but probably due mainly to the incoming raw water being relatively clean (it is easy to develop a strong, heavy floc where the water is dirty as there are more solids to form the body of the floc).

The flocculated water gravitates directly to the clarifiers. There is no obvious means of equally distributing the flow between the 4 clarifiers. It is presumed that the flows have been manually balanced at the time of construction by trial and error adjustments of the heights of the settled-water draw-off pipes.

The velocity in the above 100mm pipes to each clarifier is 0,37 m/s (at Works output flow of 1 Ml/d). This is low enough not to break up the floc, but also low enough for floc to settle inside the pipe. This does not seem to be causing any difficulties though.

PS 8.2.3.2 Clarifiers

There are four 'Dortmund' type deep-cone clarifiers whereby the incoming flocculated water is introduced near the bottom of the cone, the settled sludge is periodically manually drawn-off from the bottom of the cone (by means of a gravity pipe fitted with an isolating gate valve) and the settled (clear) water is drawn evenly off the top surface (by means of two perforated pipes). The latter gravitates the settled water to one of two flow division boxes which evenly divides the settled water among the slow sand filters.

Based on a typical design upflow rate of 1,0 m/h and a surface area of 10.6 m^2, the capacity of each unit is:

$10.6\, m^2\ x\ 1.0\ m/h\ =\ 10.6\ m^3/h\ =\ 254\ m^3/d$ less 2% for sludge wastage = 250 m^3/d.

The 4 clarifiers together can therefore produce a minimum of 1,0 Ml/d. If the chemical dosing and flocculation system is working well, it is possible to still achieve an acceptable output with an upflow rate of up to 1,5 m/h. The observed settled water turbidity indicates that these clarifiers are operating well.

The Operators at the WTW noted that sludge accumulated in the clarifiers is scoured to the river daily. Discharging sludge to the river is an unauthorised activity and is no longer authorised.

PS 8.2.3.3 Slow Sand Filters

There are five slow sand filters at the WTW. The inflow from the division boxes to each filter is uncontrolled except for an isolating valve. The water depth in each filter is controlled by adjustable telescopic valve in the clear water outlet chamber. This is designed to keep the surface of the sand submerged at all times under normal operation.

The standard design maximum filtration rate for slow sand filters in a sub-tropical environment is 150 mm/h (down through the sand).

The water depth increases as the surface becomes more clogged. If it gets too high, the telescopic outlet valve can be lowered accordingly. If the inflow is such that the above rate is exceeded, the surface biological purification process on top of the sand is compromised with the result that there will be little reduction in colloidal turbidity, colour, taste and odours. In addition, overloading the filters will also result in dirt penetrating deep into the sand and ultimately result in clogging.

Each unit is 6 by 15 m; giving a surface area of 90 m^2. It would be expected that four of the five filters are operational at any one time (to allow one to be offline for cleaning). Using the above criteria, each filter can pass a flow of:

$$90\, m^2\ x\ 0{,}15\, m/h = \ 13.5\, m^3/h\ =\ 324\, m^3/d$$

If all four on-line filters are not too clogged (i.e. starting to overflow even though the telescopic outlet valve is fully lowered), a maximum of 1300 kl/d production would be possible.

The usual practice for slow sand filters is to allow the biological growth to develop on the sand surface and periodically scrape-off most, but not all, of the growth clogging the top layer of sand. In this way, natural biological filtration can resume very quickly when the filter is re-commissioned. The cleaning of filters is a labour intensive process.

Currently, the small volume of solid waste generated when the surface of the filter bed is scraped clean is disposed of in the vicinity. Although this contains negligible amounts of polyelectrolyte (99% of which is removed with the clarifier sludge), this should, in future, be disposed of at a registered solid waste landfill site.

Although the Works as a whole is periodically overloaded, the clarifiers are working well so the slow sand filters do not tend to clog with dirt.

PS 8.2.4 Disinfection

The disinfection dosing facility is located in a building adjacent to the site office. There are 2 x 1000 litre batching tanks outside the building, each equipped with an 'Enviro-Cell' electrolytic sodium hypochlorite generators. There is a 1000 litre holding tank in a shallow chamber below ground level outside the building. At present, bags of salt (feedstock for the hypochlorite generators) are stored in the dosing building.

These generators are usually used to produce a sodium hypochlorite solution with a maximum free chlorine content of about 0,6% (i.e. 455 litres of solution contains about 2,7 kg of free chlorine). It takes 24h to make-up one batch. Unless very well maintained, the actual free chlorine delivery can decline over time.

The plant is therefore capable of producing up to about 4 kg free chlorine a day. At a typical free chlorine dosing rate of 1,5 mg/l, this is sufficient to disinfect about 2,6 Ml/d of potable water, but with no standby capacity. Standby capacity is to be provided by supplying a 3rd Enviro-Cell unit (held in reserve should one of the existing two units fail).

The hypochlorite solution is pumped (via chemical dosing pumps) to dosing points fitted to the two inlet pipes where they enter the clear water reservoir from the slow sand filters.

PS 8.2.5 Storage and Transfer

The clear water reservoir has a capacity of 650 Kl. This represents about 12h of on-site storage at the current design capacity.

The pump room is adjacent to the clear water reservoir and contains 2 No. horizontal multistage pumps. The existing staircase into the pump room is steep and difficult to navigate.

The clear water rising main is a combination of 150mm steel (welded) and 160mm mPVC. The clear water is pumped to Ogunjini 1 Reservoir located south of the site from where the water is reticulated to supply the area. The clear water may also be pumped directly to the Ogunjini Hospital Reservoir in instances where the Hospital is unable to receive water from the Ogunjini 2 Reservoir. The diversion of flow from Ogunjini 1 Reservoir to the Hospital Reservoir is currently a manual process.

PS 8.2.6 Buildings

The administration building, dosing/laboratory building, and disinfection building all require some modification and refurbishment.

PS 8.2.7 Site Constraints

There is limited space within the current site boundary. The new treatment units are to be sited within the current boundary. The hydraulic profile of the new processes need to take cognisance of the elevations of the existing system. The existing system hydraulic profile is very flat.

PS 8.3 Upgrading Details

PS 8.3.1 Overview

The upgraded Works shall have a nominal potable water output capacity of 2 Ml/d. The scope of work relating to the upgrade is summarised as follows:

Component	***Description***
Treated water demand	• Add 2 Ml/d capacity so that system can deliver a maximum peak daily demand of 3,0 Ml/d (nominal design capacity to increase from 1,0 Ml/d to 3,0 Ml/d)
Raw water abstraction and pumping	• Retain existing river intakes, but replace inlet strainers with non-clogging, non-restrictive system. • Replace pump with new self-priming unit drawing directly from suction pipework in the river. • All suspended solids to be removed at raw water balancing tank
Raw water pipeline	• Replace rising main (200mm HDPE)
Raw water balancing tanks	• Add hand-raked wedge-wire screen at existing inlet to tanks and upgrade flow division system between inlet tanks. • New tank outlets, core-drilled (200mm dia) 500mm off the floor.
Existing Works	• Add sensors for incoming raw water pH, turbidity and conductivity • Relocate dosing point to new in-line static flash mixer and add new flow regulating control valve and flow meter. • Floc channel will ***not*** be enlarged but refurbished. • Divert clarifier sludge to sludge holding tank for dehydrating and land disposal rather than river disposal. • Add flow meter to existing filtered water mains to clear water tank (Note: combine the two pipelines so can have one flow meter) • Add additional electrical hypochlorite generator as standby unit
New Works	• Provide pumped raw water feed, incl its own chemical dosing and mixing equipment • Install above-ground pre-fabricated clarifier and pressure sand filters (sized for 2 Ml/d capacity). • Provide new building for filter plant M&E equipment
Clear water reservoir	• Construct new 'SBS' type 500m^3 above-ground balancing reservoir (fed from new 2 Ml/d unit) and discharge to existing clear water reservoir via float control valve • Add baffle walls inside existing reservoir to provide better chlorine contact conditions
Clear water pipeline	• Replace existing rising main with new 200mm Class 25 mPVC pipeline
Clear water pumping system	• Replace existing pumps with larger units to satisfy the increased flow rate required. • Suction pipework needs to be replaced (new 200mm core-drill through reservoir wall) • An external access stairwell is needed (existing cat ladder too dangerous).
	•

Sludge handling and disposal	• Construct 9m dia x 3.8m deep sludge holding tank next to existing clarifiers.
Power supply	• Replace standby generator with 400 kVA unit and remove 100 kVA unit to EWS Stores.
Office buildings	• Complete refurbishment needed with various modifications.

PS 8.3.2 Raw Water Abstraction & Conveyance

The existing formal 150 mm diameter double-pipe river intake can be retained if the intake strainers are replaced:

RIVER INTAKE DETAILS	
Replacement Intake Size and Material	2No. DN150 304L schedule 10 stainless steel intakes 1300mm long bolted to existing suction pipes
Hole number and diameter	200 No x 25mm per intake (2 intakes)
Hole spacing	6 No around circumference @ 39mm c/c alternately staggered 66 rows along length @ 75mm c/c alternately staggered
Velocity through holes at pump flow	0.16 m/s at 31l/s pump rate
Velocity through existing suction pipework	0.87m/s at 30.9l/s pump flow

The existing pipework and pumps are to be removed and taken to Stores and replaced with a self-priming pump. A new 200mm diameter HDPE PN10 raw water rising main is required.

STATIC & DYNAMIC HEAD DATA FOR RAW WATER RISING MAIN	
Rising Main discharge elevation at raw water holding tanks	141.7 masl
Lowest operating river level at intakes	132.6 masl
River flood level at WTW boundary fence)	137.0 masl
Maximum static head (river level low)	9.1m
Minimum static head (flood at WTW boundary fence)	4.7m
Pump flow rate	30.9 l/s
Length of rising main	140m
Anticipated maximum dynamic head (Normal operating condition)	11.2m
Anticipated minimum dynamic head	6.8m

RAW WATER PUMP SUCTION CONDITIONS	
Minimum allowable river level at intakes (masl)	132.6
Pump centre line (approximately) (masl)	136.6
Suction lift (m)	4
Friction losses along suction pipework (m)	0.3
NPSH Available (m)	7.6

PS 8.3.3 Raw Water Settling & Holding Tanks

Modifications to the inlet box includes:

- Installing a horizontally mounted wedge wire screen (slot width 3mm) over the existing flow splitter box
- Provision of bunded concrete area next to screen
- Modification to weir crests with GMS rectangular plates.

Modifications to the raw water tanks includes:

- Core-drilled new outlets
- Diversion of the existing scour pipelines
- DN200 Schedule 10 304L Stainless Steel outlet pipes secured over the core-drilled holes and connected to a solvent-welded uPVC manifold to a new old and new works flow regulating and dosing point building.

PS 8.3.4 Flow Regulation to Old and New Works

OLD WORKS FLOW REGULATION		
Description: Continuous gravity flow to Flocculation Tank, manually adjusted once a day by Operator		
Flow control	Manually-actuated resilient seal gate valve (DN150)	
Design Flow	ℓ/s Ml/d	11.7 1.010
Max flow	ℓ/s Ml/d	14.0 (Design Flow + 20%) 1.212
Min flow	ℓ/s Ml/d	0 0

NEW WORKS FLOW REGULATION		
Description: Continuous pumped flow to Flocculation Tank, normally at 100% Design Capacity		
Flow control	Adjust motor speed on local VSD keypad	
Number of Pumps	No	2
Number on duty	No	1
Standby Pumps	No	1
Speed		VSD controlled in order to fine-tune or vary

NEW WORKS FLOW REGULATION		
Description: Continuous pumped flow to Flocculation Tank, normally at 100% Design Capacity		
		inflow
Type		End-suction dry-well pumps
Duty Point flow	m^3/day	2200
	ℓ/s	24.8
Duty Point Head	m	~8.0 to be confirmed by appointed Contractor
Max flow		Duty Point + % within allowable range for operation of pumps and VSD
Min flow		Duty Point - % within allowable range for operation of pumps and VSD

A new brick building with concrete slab roof will house the following:

- DN 150 Flow regulating valve (resilient seal gate valve with handwheel), DN150 diaphragm control valve ('Bermad' or similar for shutting-off the flow in the event that the clear water reservoirs are all full), polyelectrolyte dosing point, flash mixer and flow meter to Old Works (flow meter readout unit wall-mounted next to flow-regulating valve for ease of reference)

- 1 Duty & 1 Standby Raw Water Pumps, polyelectrolyte dosing point, in-line flash mixer and flow meter to New Works (flow meter readout unit wall-mounted next to VSD keypad)

Small-bore polypropylene pipework will deliver polyelectrolyte from the existing dosing building to the new dosing points in the abovementioned building.

PS 8.3.5 Chemical Dosing Equipment (SPEC CD: CHEMICAL DOSING EQUIPMENT)

The design, materials of construction, operation and testing of the equipment to be provided for flocculation and clarification shall generally comply with Particular Specification SPEC CD: CHEMICAL DOSING EQUIPMENT except where amended below.

POLYELECTROLYTE HOLDING TANKS		
Item	**Capacity**	**Description & Design Criteria**
Bulk Tank	5000ℓ	**Position:** Housed outdoors in a position accessible by delivery tanker. Mounted on concrete pedestal with $5m^3$ bund under. Base elevation to allow gravity-flow to Dosing Equipment Building. Delivery tanker to discharge (via its own hose) directly into top of bulk tank. Bulk tank and bund to be protected from the rain by overhead lean-to steel shelter. GMS steps to be provided for access for delivery operator to insert hose into top of tank **Material of construction and capacity:** Fibreglass designed for

POLYELECTROLYTE HOLDING TANKS		
Item	**Capacity**	**Description & Design Criteria**
		SG of 1,6 and of sufficient capacity to receive a 5 tonne delivery when still at least 30% full. Must have UV-stabilised opaque walls with translucent vertical strip for visual indication of liquid level.
Dilution Ratio		1 part poly to ***max*** 3 parts clean water (depends on particular poly; can be used undiluted or 1:2 or 1:3 dilution)
Assumed max design dosing rate of poly		20 mg/l at 20% Works hydraulic overload: 2 500m^3/d x 20mg/l per day = 50kg/d.
2 No. Day Tanks (alternating use; 1 on line, I for batching diluted poly) Each tank to be fitted with small motorised stirrer and service water supply	250ℓ	**Capacity:** 48h of storage = 100kg/d = 63 litres @ SG of 1.6 Required Capacity at 1:3 dilution (worst case) = 63 litres poly + 189 litres water = 252 litres (say 250 litres) **Position:** On pedestals inside existing chemical dosing building. **Material of construction and capacity:** Fibreglass or polypropylene designed for SG of 1,6 and of sufficient capacity to dose worst-case raw water at WTW design flow over at least 48h. Must be translucent for visual indication of liquid level. **Mixing:** Stirrer to be fixed-mounted on wall-mounted bracket and have low-revving, low shear blades suitable for high-viscosity long-chain polymer polyelectrolyte (ie requires reducing gearbox or VSD or fixed digital frequency reduction for motor).

SCD UNIT (STREAMING CURRENT DETECTOR or ION-CHARGE ANALYSER)	
Parameter	**Description**
Number of Units	***Old Works:*** 1 Duty (replace existing SCD and progressive cavity pump for sampling flow). Housed in existing dosing building ***New Works:*** 1 Duty housed next to flocculation zone
Output signal	4 – 20 mA analogue signal to dosing pump controller
Type	Ion charge analyser with 2 litre sampling pot
Sampling flow	**Position:** ***Old Works:*** New sampling pump drawing from 2nd last baffle on existing flocculation channel and discharging back at end of flocculating channel (ie after coagulation) (neutralisation of colloid charges by poly) ***New Works:*** Gravity flow drawing from end of coagulation zone of coagulation & flocculation tank and discharging to sludge draw-off system
	Sampling rate: ***Old Works:*** Progressive-cavity sampling pump 6 litres/min ***New Works:*** Manually regulated gravity flow to about 6 litres/min

POLY DOSING PUMPS	
Parameter	**Description**
Number of Pumps	1 Duty & 1 Standby for old works (replace existing) 1 Duty & 1 Standby for new works All housed in existing chemical dosing building
Pumped liquid	Diluted or undiluted polyelectrolyte
Type	Solenoid actuated reciprocating diaphragm with built-in controller for proportional dosing according to SCD 4-20mA analogue signal (residual ion charge of dosed raw water)
Dosing Rate (widest operational Range)	Min: 0.1 l/h (2.4 litres over 24h)
	Max: 4.2 l/h (100 litres over 24h)
Dosing Point	***Old Works:*** Immediately after flow regulating valve and immediately upstream of in-line static flash mixer ***New Works:*** Immediately after flow regulating pump and immediately upstream of in-line static flash mixer
Flash Mixer (one for Old Works & one for New Works)	In-line baffled static flash mixer designed for max 1.25Ml/d (14.4l/s) steady flow and approx.. 500mm head-loss as mixing energy at 12l/s. Flash mixer to be easily removable from the manifold and easy to dismantle for cleaning.

PS 8.3.6 Flocculation and Clarification (OLD WORKS)

Submerged ultrasonic sludge blanket probes will be retro-fitted to all 4 old clarifiers. This will assist the Operator determine when to let some of the accumulated sludge out and how much (need to retain some accumulated sludge for optimum floc growth and settling of incoming dosed raw water). No other modifications are required.

PS 8.3.7 Slow Sand Filtration & Filtered Water Conveyance

SLOW SAND FILTERS – OLD WORKS	
Parameter	**Criteria**
Sand	Well-washed natural river silica sand
Sand Grading	Effective size of 0.15 – 0.35 mm and a uniformity coefficient of 1.5 – 2 (coeff up to 3 is acceptable if 2 difficult to achieve)
Cleanliness	Free from clay, dust, organic matter. Sand shall not originate from, and be stored at, places where there are visible signs or history of contamination by sewage or other pollutants.
Metal	< 0.1% w/w of iron, manganese or aluminium

COAGULATION & FLOCCULATION – OLD WORKS	
Parameter	**Criteria**
Coagulation	Time for neutralisation of colloidal charges after flash mixing: MIN: 30 seconds MAX : 2 minutes
Existing chamber coagulation zone	0.55m wide x 1.5m long x 0,8m deep = 0.66m^3 Time for rapid mixing for coagulation: Max Flow: 50.5m^3/h = 47 seconds OK Design Flow: 42.1m^3/h = 56 seconds OK 50% Design Flow:21 m^3/h = 113 seconds OK CONCLUSION: No need for modification
Flocculation	Typical time for formation of floc large enough to settle: MIN: 10 minutes MAX : 20 minutes
Ideal Process for old works	Baffled channel after coagulation zone should produce pin-head size floc only as will otherwise break-up in the turbulence of conveying to each of 4 conical clarifiers. Formation of settleable floc should occur in sludge zone (lower half) of clarifiers.
Actual floc time in existing channel	1.5m wide x 2.5m long x 0.8m deep = 3m^3 Max Flow: 50.5m^3/h = 3.6 minutes OK Design Flow: 42.1m^3/h = 4.2 minutes OK 50% Design Flow:21 m^3/h = 8.4 minutes not ideal, but less turbulence in conveyance to clarifiers CONCLUSION: No need for modification

The sand needs to be removed and replaced with washed natural fine river (or pit sand) in accordance with the grading criteria below.

Replacement of the telescopic outlet valve assembly is required.

The 2 No. parallel filtered water pipelines require metering on a joined portion of pipeline.

PS 8.3.8 Flocculation and Clarification (SPEC CL: MODULAR CLARIFIERS)

The design, materials of construction, operation and testing of the equipment to be provided for flocculation and clarification shall generally comply with Particular Specification SPEC CL: MODULAR CLARIFIERS except where modified below.

The concept design allows for 1 modular unit. The offered arrangement shall fit in the space available (see layout drawings). Any cost of creating a larger footprint than that allowed on the drawings shall be included in the tendered rates for clarifier equipment.

No prescriptive parameters should be specified in the tender document other than stating that:

- The Contractor's design shall be based on the use of a single organic polyelectrolyte for coagulation and flocculation
- The Contractor's design shall ensure that the floc is fully-developed by the time the water enters the settling zone of the clarifier.
- An eye-wash station will be specified next to the poly dosing area.

MODULAR (PREFABRICATED) CLARIFIER UNIT		
Parameter	**Unit**	**Description**
Number of Units	No	2
Type of Technology	-	Inclined lamella-tube upflow clarifier
Duty cycle	hours/day	Continuous with steady flow
Suspended Solids Removal (typical)	%	95%
Design inflow rate/unit *(incl recycle water)*	Mℓ/d m^3/h	2.6 (24h/day) 108
Hydraulic peak inflow rate	Mℓ/d m^3/h	2.0 83.3
Hydraulic loading upflow rate at Design inflow rate	m/hour	Max 4.5
Sludge blanket level probe (This will assist the Operator monitor level of sludge accumulation and to automate desludging if desired)		Submerged ultrasonic sludge blanket probe to be installed below lamella plates No other modifications are required.
Desludging underflow (intermittent bursts)		Once a day (or more if necessary)
Desludge valves (both manual and actuated *in parallel*)		Each internal sludge hopper must have its own drain pipe and desludge valves
Weir loading at Design inflow rate	m^3/hour per m weir	Not more than 2.0 and evenly distributed (important for lamella pack clarifiers which are close to the surface)
Detention time at Design inflow Flocculation Zone	min	15

Detention time at Design inflow Settling Zone)	min	120
Material of construction		304L stainless

MODULAR (PREFABRICATED) CLARIFIER UNIT		
Parameter	**Unit**	**Description**
(main body of tank)		304LSS with stainless steel fittings and built-in pipework.
Access to top-of-tank		Access ladder and walkway the full length of the tank shall be provided

The clarifier units shall be fabricated from either 304L SS. Epoxy coated mild steel will not be accepted.

A settled water balancing tank between the clarifiers and the pressure filters is required:

SETTLED WATER BALANCING TANK	
Parameter	**Criteria**
Balancing storage between steady clarifier output and filtration and stop-start filter system	Minimum volume of storage required is largest of the following: a) Sufficient water for one backwash run b) Min 15 mins cycle time when inflow from clarifier is half the fixed filter feed rate
Volume for 1 backwash water run	Based on: a) Fixed filter (=backwash) rate of 50m^3/h b) 10 mins backwash c) Only 50% inflow (= 25m^3/h) from clarifier Net outflow of 25m^3/h for 10 mins **= 4m^3**
Volume for 15 mins cycle time (worst case when 7,5 mins tank filling when pump off and 7,5 mins emptying when pump on)	Based on: a) Fixed filter (=backwash) rate of 50m^3/h b) Only 50% inflow (= 25m3/h) from clarifier Net outflow for 7.5 mins at 25m^3/h **= 3.1m^3**
Adopted Balancing Tank capacity	**5m^3 (TBA)**

PS 8.3.9 Filtration (SPEC PF: PRESSURE FILTERS)

The design, materials of construction, operation and testing of the equipment to be provided for filtration shall generally comply with Particular Specification SPEC PF: PRESSURE FILTERS except where amended below.

Filtration will take place through 4 pressure filters operating at a fixed 83.3m^3/h and utilizing the filter feed pump to also act as backwash pump (filtrate from three on-line filters is redirected to the filter being backwashed; ie backwash flow is 4x design filter flow rate). The reduction of turbidity will be maximised through the pressure filters by limiting the filter bed loading to not more than 6m^3 per m^2 bed area per hour. This is considered prudent for a municipal waterworks (which needs to be robust and therefore designed on more conservative principles). The lower loading is also necessary to avoid the need to add a flocculation aide such as bentonite during periods of relatively clean raw water (when the raw water is clean, floc formation is otherwise very poor, but will still be trapped in the filters if the filter loading rate is low enough). Further specifications are detailed below:

PRESSURE FILTERS		
Parameter	**Unit**	**Description**
Number of Filters	No	4
Type	-	Pressure sand filter
Material of filter tank		304LSS
Influent Control	-	Common inlet manifold with electrically-actuated quarter-turn isolating ball valves.
Filter feed Rate (fixed)	m^3/h	83.3 (20.8 per filter unit)
Filtration loading at Design Inflow	m/hour	6.0
Filtration loading with three units on-line and one unit off-line for backwashing	m/hour	8.0
Design flow rate for all 4 filters	Mℓ/d	2.6 over 24h
Area of sand bed each filter	m^2	2.08
Filter nozzles		Min 50 nozzles per m^2 (= ~141mm c/c spacing)
		Slot width: 0,2mm
Filter media and depth		Gravel support layer around nozzles, with min 800mm deep bed of 0.9mm nominal grain size quarzitic sand (uniformity co-efficient less than 1,4)
Losses to backwash (10min backwash/day each)	% inflow	3.2 % (33.3m^3/1033m^3)
Air scour loading rate at 33kPa, 25°C	m/hour	30
Backwash water loading rate through sand bed	m/hour	24
Backwash flow rate	m^3/h & l/s	50 / 13.9 (using filtered water from the other three filters)
Duration of the backwash cycle	minutes	10
Backwash water volume from the backwashing of one filter	m^3	8.33
Design frequency of backwashing	days	Once a day (but possible to backwash several times a day if necessary)
Access for replacing sand		Flanged ports in the side of the pressure filter above and below the filter floor nozzles must be large enough to replace the sand and filter nozzles

FILTER FEED PUMPS		
Parameter	**Unit**	**Description**
Number of Pumps	No	2 (1 Duty, 1 Standby)
Type		End-suction or multi-stage centrifugal
Duty Point Flow	m^3/hour	83.3
	ℓ/s	23.1
Duty Point Head	m head of water	~15m (Contractor to confirm)

Reciprocating air compressors shall be Atlas Copco or Ingersoll Rand.

AIR BLOWERS		
Parameter	**Unit**	**Description**
Number of Blowers	No	2 (1 Duty; 1 Standby)
Type		Belt-driven Roots (rotary lobes positive displacement) inside acoustic hood
Duty point flow	m^3/hour @ 0.033 Bar & 25°C	62

The Filter Plant Building is to house the air blowers, filter pumps and MCC.

PS 8.3.10 Disinfection: Hypochlorite Dosing

The current system is reliable and safe to operate. The current batching units (2 No 'Enviro-cell' electrolytic units which converts salt water to sodium hypochlorite and hydrogen) each generate up to 455 litres of solution containing 0.6% free chlorine over 24h (2.75kg free chlorine per 455 litre batch). One batch is sufficient to disinfect up to 1.8 Ml /d of filtered water (assuming a dosage rate of 1.5 mg/l free chlorine). The following is required:

- 2 No. additional 'Enviro-cell' unit (allowance made for replacing the existing units with new units)
- 1 No. additional 500 litre batching tank
- 1 No. additional 500 litre holding tank (to be cross-connected at the bottom to the existing holding tank)
- Replacement of the 2 dosing pumps with new units
- An eye-wash station next to the batching tank area.

Achieving 1.5mg/l free chlorine per litre of filtered water (at 0,6% free chlorine concentration) translates to, at full design capacity, an intermittent dosing rate of sodium hypochlorite solution of up to 14l/h for the new works and a continuous rate of up to 12,5l/h for the old works.

DISINFECTION	
Parameter	**Criteria**
Required free chlorine dosing rate per litre of filtered water	1.5mg/l (=1.5g/m^3)
Free chlorine concentration of Envirocell batched sodium hypochlorite solution	0,6% by mass (= 6kg free chlorine per 1000 litres solution)
Required mass of free chlorine per day at Design Works Output (2000m^3/d)	= 2000m^3 x 1.5g/m^3 = 3kg per day
Total volume of batched sodium hypochlorite solution required per day **at Design Capacity** (2 Ml/d)	= 3kg / 6kg/m^3 = 500 litres/day
Total volume of batched sodium hypochlorite solution required per day at **Max Hydraulic Capacity** (2,4 Ml/d)	= 600 litres/day
Min required Holding Tank capacity	**48h capacity = 1200 litres**
Batching details (24h process from mixing 11kg of salt into 455 litres of potable water)	Need approx. 3 batches every 2 days (ie 2 batches per day on alternate days)
No of Envirocell units required	**2 Duty + 1 Standby**
Salt required on site	30 day supply = 45 No x 11kg pre-weighed bags OR 10 No. 50kg bags for on-site weighing batches
To assist with dissolving the salt, a hand-held high pressure water 'lance' (tapping off the rising main) is held inside the batching tank and directed over the undissolved salt on the floor of the tank until the required 455 litres has been added. To aid with rapid dissolving, the salt plus about 40 litres of water should be added the day before the lance is used (ie, with 3 tanks, 3 batches every two days can be made)	

HYPOCHORITE DOSING PUMPS	
Parameter	**Description**
Number of Pumps	1 Duty & 1 Standby for old works (replace existing) 1 Duty & 1 Standby for new works All housed in existing hypochlorite dosing building
Pumped liquid	0,6% free chlorine sodium hypochlorite solution directly from holding tank
Type	Solenoid actuated reciprocating diaphragm with built-in controller for proportional dosing according to flow meter 4-20mA analogue signal
Dosing Rate (Expected Range)	Min: 1,5 l/h (30 litres over 20h)
	Max: 15 l/h (300 litres over 20h)
Dosing Point	At head of existing clear water reservoir converted to chlorine contact tank

The existing pipework from dosing pumps to dosing point is adequate 'as is' for both old and new works (separate dosing pumps discharging into single existing line).

PS 8.3.11 Clear water storage

Due to space constraints, the biggest practical reservoir that can be constructed alongside and above the existing clear water reservoir is a 8.87m diameter, 8.35m high “SBS”-type ‘zincalume’ tank (capacity = 516 m^3). This is fed only from the new works.

CLEAR WATER STORAGE & BALANCING TANK	
Type	SBS ‘Zincalume’ reservoir with plastic liner
Dimensions	8.87m dia x 8.35m high = 516m^3
TWL	145.6 masl
BWL	masl
Inlet	DN150 free discharge at TWL
Outlet	DN200 to chlorine contact tank
Overflow	DN150 to chlorine contact tank

The existing clear water reservoir will no longer act as balancing storage between intermittent clear water pump operation and steady Works inflow, but is to remain full at all times and act as a chlorine contact tank. Retro-fitting 3 rows of baffles along the length of the tank is required to create ‘plug flow’ conditions.

The tank parameters, once modified, will be as follows:

CHLORINE CONTACT TANK	
Tank dimensions	13.4m long x 6.0m wide x 1.8 m water depth
Tank operational volume	144 m^3
Nominal chlorine contact time at 2,0 Ml/d works output	100 minutes (30 minutes is minimum required)
Worst-case chlorine contact time (clear water pumps running for more than 1,5h)	77 minutes
Floor level	135.19 masl
Roof soffit level	137.80 masl
Overflow weir level	136.89 masl
Elevation of Operational Water Level (300mm below overflow)	136.59 masl
Max flow required for equilibrium float valve (to keep chlorine contact tank topped-up from new balancing storage tank)	Full rate of clear water pumps (111m^3/h = 30,9 l/s); ie no contribution from old works for whatever reason.
Size equilibrium float valve required for above max flow	DN100
Typical range of water level for equilibrium float valve from fully-closed to fully-open	550mm Note: position of valve to be such that valve is shut at Overflow Level – 300mm
Centre-line of new cored inlet for equilibrium valve	254mm above valve-shut elevation (ie 44mm below overflow weir level)

PS 8.3.12 Clear Water High lift Pumping System

2 No. vertical multistage pumps (1 Duty 1 Standby) are to replace the existing horizontal multistage units. The suction and delivery pipework will be upgraded.

A new 200mm diameter mPVC Class 25 rising main between the WTW and Ogunjini 1 Reservoir is required. The rising main between Ogunjini 1 Reservoir and the Hospital Reservoir will not be replaced.

In order for the rising main beyond the high point to not empty into Ogunjini1 Reservoir every time the pump stops, a pressure-sustaining diaphragm control valve will be installed at the Ogunjini 1 Reservoir inlet. This will be fitted with two pilot controls to provide two alternative backpressure settings (a higher backpressure is required to push water through to the Hospital Reservoir).

PRESSURE SUSTAINING DIAPHRAGM CONTROL VALVE AT OGUNJINI 1 RESERVOIR	
Parameter	**Description**
Elevation of Ogunjini 1 Resv Bottom Water Level (BWL):	286.1 masl
Elevation of High Point on Rising Main:	276.8 masl
Difference in elevation:	9.3m
Pressure Sustaining required to keep Rising Main full when not pumping:	286.1+2-276.8 = **11.3m** above Ogunjini 1 Resv BWL
Elevation of Hospital Reservoir TWL:	295 masl
Friction in Ogunjini-to-Hospital Reservoir pipeline at 20l/s:	4m head
Elevation of rising main Hydraulic Grade Line at Ogunjini1 Reservoir control valve required to push water to Hospital Reservoir:	295 masl + 4m = 299 masl
Pressure Sustaining required to deliver to Hosp Resv:	299masl – 276.8masl =**22.2 m** above Ogunjini 1 Resv BWL
Control Valve details: **Size:** DN150 **Type:** V-port double-chamber (Bermad or similar)	

When pumping to Ogunjini 1 Reservoir, the static head depends on the setting of the pressure-sustaining valve at Ogunjini 1 Reservoir. When pumping to Ogunjini 1 Reservoir, the static head depends on the water level in the chlorine contact tank and the water level in the Hospital Reservoir.

STATIC HEAD FOR CLEAR WATER PUMPS	
Chlorine Contact Tank full (TWL) – normal operating condition	136.59 masl
Elevation of high point on pipeline	285.1 masl
HGL elevation (maintained by Pressure Sustaining Control Valve at Ogunjini1 Reservoir): Flow to Ogunjini 1 only	288 masl
HGL elevation (maintained by Pressure Sustaining Control Valve at Ogunjini1 Reservoir): Flow to Hospital & Ogunjini 1	~299 masl
Static head on clear water pumps – Normal operating condition for pump design duty	151.4m
Static head on clear water pumps – Flow to Hospital & Ogunjini 1 Reservoirs	~162.4m

The design duty has been determined as follows for the normal operating condition:

CLEAR WATER PUMP DUTY POINT		
Description	**Pumping to Ogunjini 1 Reservoir**	**Pumping to Hospital Reservoir**
Design flow for Duty Point	125 m^3/hr = 34.7 l/s	Depends on increase in pumping head
Velocity	1.3 m/s	
Darcy-Weisbach friction loss	10.1 m	
Minor losses	1.4 m	
Normal static head (from above)	151.4 m	
Total dynamic pumping head (Duty Point Head)	Max = 162.9 m **Selected Duty Point: 163m**	

The pump intakes will be submerged at all times (minimum submergence of chlorine contact tank outlets set to prevent vortex formation and air entrainment).

A new DN100 in-line electro-magnetic flow meter in a new chamber downstream of the pumps will be installed on the new Rising Main.

To improve access to the pump room, a conventional reinforced concrete staircase will be constructed on the outside of the building with an access doorway cut into the wall at pump room level.

PS 8.3.13 Sludge Handling

Waste sludge from the existing and new clarifiers will drain to a new central pump-sump constructed alongside the existing works central sludge drainage manhole. From here, sludge is pumped to a new above round reinforced concrete sludge holding tank.

SLUDGE COLLECTION PUMP SUMP	
Max instantaneous sludge inflow to pump-sump (= max rate of discharge from new clarifier)	16.7 l/s
Design Pump Rate (= max instantaneous inflow)	17 l/s
Volume of live storage required (max 6 pump starts per hour): shortest cycling time is when inflow = 50% of pumped outflow where sump has net inflow for 5 minutes (pump off) and net outflow for 5 minutes (pump on)	8.5 l/s over 5 mins = 2,5m^3
Internal pump sump plan area (2m x 2m sump)	4m^2
Live storage depth (2.5m^3/4m^2)	0.625m
Additional depth below 'Pump-Off' level to accommodate submersible dewatering (transfer) pump	0.3m (depending on pump selected)
Ground Level at Collection Sump	138.2 masl
IL of incoming sludge drainage pipelines	136.0 masl
Required IL of pump-sump to avoid backing-up drainage pipeline (- 1m above)	135.0 masl
Depth of sludge collecting pump sump below GL	3.2m

SLUDGE TRANSFER PUMP & RISING MAIN		
Number of Pumps	2 No. (1 installed in sump; 1 in storage on-site)	
Type	Submersible centrifugal pump on duck-foot bend & guide rails with 100mm GMS riser pipe	
Pumping Head	BWL of live storage in pump sump: TWL of Sludge Holding Tank: Max Static Head: Friction head (nominal) allow	135.3 masl 141.3m 6m 1m
Duty Point	17 l/s @7m 61m^3/h @ 7m	
Absorbed power at Duty Point (assume 50% efficiency)	2.3kW	
Motor size	3kW	
Rising Main Details	110 HDPE PN6 Velocity at Duty Point:	 2.1m/s

The sludge tank is to be 9m in diameter and have an effective sludge depth of 3m. A mixer is required to keep the sludge in suspension, homogenous and of consistent dry solids content.

SLUDGE HOLDING TANK & MIXER DETAILS	
Type of tank	Open-topped circular reinforced concrete with flat bottom (but with local sump in floor for emptying completely with dehydrator feed pump)
Internal Diameter	9m
Max depth of liquid sludge	3.0m
Freeboard above TWL	0.5m
No of Mixers	1 No. vertical shaft mixer with motor and gearbox on concrete platform 0.5m above TWL
Type of stirrer	Low-shear blades (3 No.) with input power just high enough to re-suspend any settled sludge (ie re-suspend sludge after mixer has been off for a prolonged period)
Stirrer diameter & speed	1.5m dia 54 rpm
Motor size & speed	7.5kW 1450rpm
Minimum depth of liquid in tank for stirrer to be submerged and stable	1.5m

PS 8.5 General Mechanical Requirements (SPEC MG)

The Works shall comply with SPEC MG for all water treatment and pumping equipment.

PS 8.6 General Pumping (SPEC GP)

PS 8.5.1 General

All pumps shall generally comply with SPEC GP for all pumping equipment except where in conflict with requirements given below.

PS 8.5.2 Pump type

Pumps offered for the various components of the works shall be as set out in the relevant clauses above.

PS 8.5.3 Impeller material

Multistage pumps shall have stainless steel impellers. Low-lift pump impellers shall be cast in bronze.

PS 8.5.4 Variable Speed pumps

Where variable speed pumps are required, the pump characteristic curves submitted for approval shall include a range of curves for different speeds and which indicate the maximum and minimum speeds possible.

PS 8.7 Valves (SPEC LK)

The Works shall comply with SPEC LK for all valves used in this contract where applicable.

PS 8.8 General Corrosion Protection (SPEC CP)

The Works shall comply with SPEC CP regarding corrosion protection.

PS 8.7.1 Corrosion Protection Systems

Corrosion protection systems for the plant shall be as follows:

Item	Material	Corrosion Protection System
Pumps: Internally Externally	Manufacturers standard Manufacturers standard	Manufacturers standard Manufacturers standard
Motors	Manufacturers standard	Manufacturers standard
Piping: Inside buildings and between components of new plant	Low Carbon Steel	FBE to Manufacturers Standard
Buried interlinking pipelines and new clear water rising main	HDPE / uPVC – as indicated on tender drawings	None
Puddlepipes	Low Carbon Steel	FBE to Manufacturers Standard
Valves	Manufacturers standard	FBE to Manufacturers Standard
Slip on couplings	Low Carbon steel	FBE or Two-Pack Epoxy
Check valves & valves	Manufacturers standard	FBE to Manufacturers Standard
Filters	Stainless Steel 304	None
Clarifiers	Stainless Steel 304 Or GRP	None
Nuts, bolts & washers: Nuts, bolts and washers Anchor bolts	316 stainless steel 316 stainless steel	None None
Switchpanels	Low Carbon Steel	Two pack epoxy

PS 8.9 Spares

The Contractor shall provide the following spares:

- Sufficient filter nozzles for 1 filter module
- Sufficient filter media in durable 20kg bags for 1 filter module
- Special lubricating oil for reciprocating air compressor crankcases in 5 litre containers
- Drive belt sets for reciprocating air compressors

- SCD sensor replacement unit in protective packaging (as standby held in stores)
- Drive belts for river abstraction pumps.

.

C3.2.3 CONTROL PHILOSOPHY

TABLE OF CONTENTS

PS 9 PROCESS & CONTROL PHILOSOPHY

PS 9.1 Overview of Process Flow

Figure 3-1 and Figure 3-2 show the process flow and mass balance for the WTW, respectively.

Figure 3-1: Process Flow Diagram

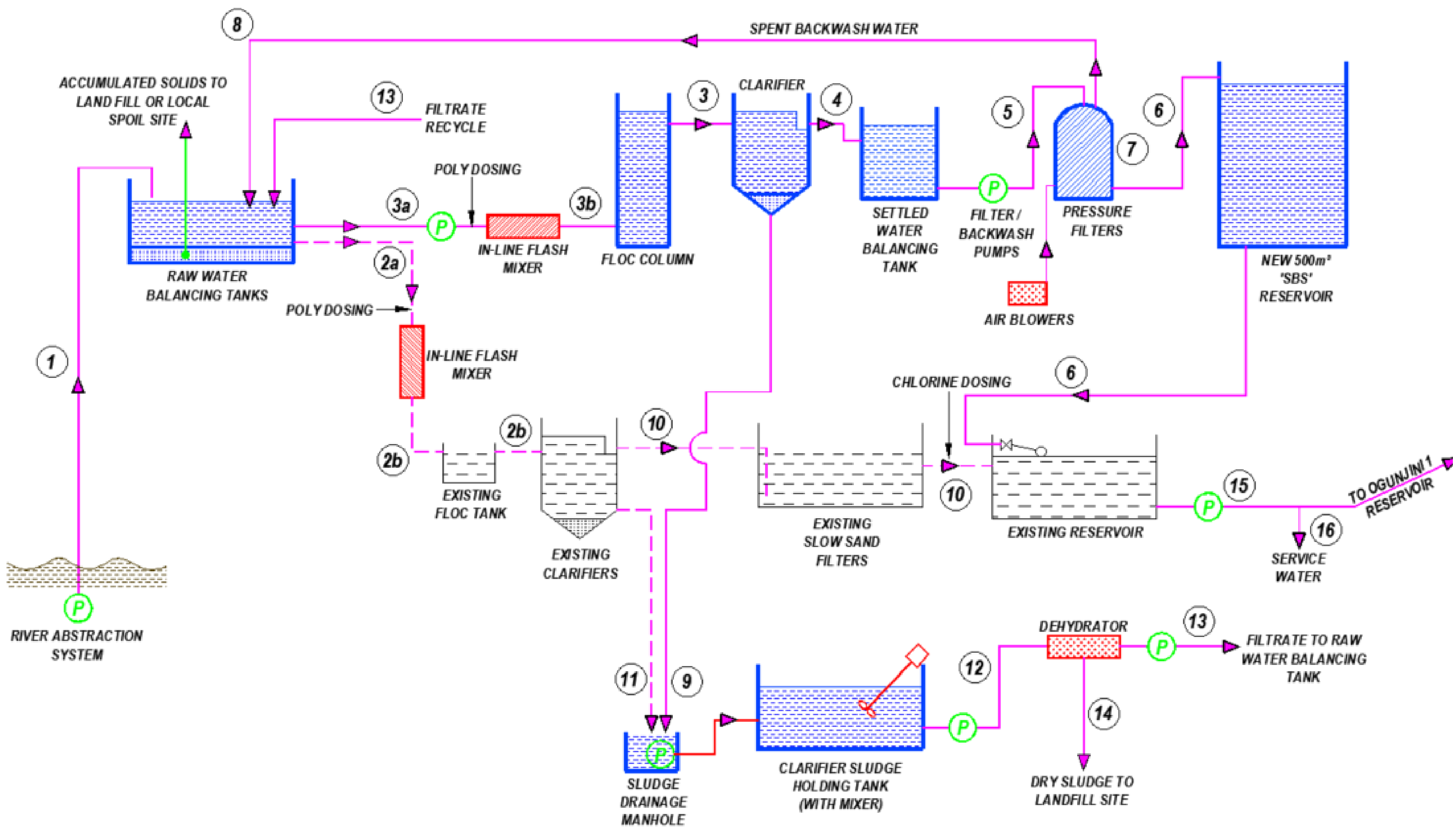


Figure 3-2: Mass Balance.

PIPE NUMBER	1		2a/b		3a/b		4		5		6		7		8		9	
	RIVER ABSTR		OLD WKS RAW INFLOW (incl RECYCLE water)		NEW WKS RAW INFLOW (incl RECYCLE water)		NEW WKS SETTLED WATER OUT to BAL TANK		NEW WKS FILTER FEED from BAL TANK		NEW WKS FILTERS to CHLORINE CONTACT TANK		NEW WKS BACKWASH FEED WATER		NEW WKS SPENT BWASH WATER to RAW WATER BAL TANK		NEW WKS DESLUDGE to SLUDGE TANK	
	Descr/Qnty	Unit	Descr/Qnty	Unit	Descr/Qnty	Unit	Descr/Qnty	Unit	Descr/Qn	Unit	Descr/Qn	Unit	Descr/Qn	Unit	Descr/Qn	Unit	Descr/Qn	Unit
DESIGN CAPACITY	18h/d pumping		continuous gravity flow		24h/d pumped flow		continuous gravity flow		Design output over 20h/d		Varies (equilib float valve keeps Chlr Tank full)		Typically 10mins/d x 4 filters @ 24m/h loading		as per 7		Typically 10mins/d, max 1% of raw inflow	
	2000	m3/d	1010	m3/d	1043	m3/d	1033	m3/d	1033	m3/d	1000	m3/d	33.33	m3/d	33.3	m3/d	10.0	m3/d ave
DESIGN FLOW RATE	111	m3/h	42.1	m3/h	43.5	m3/h	43.1	m3/h	50.0	m3/h	50.0	m3/h	50	m3/h	50	m3/h		
	30.9	l/s	11.7	l/s	12.1	l/s	12.0	l/s	13.9	l/s	13.9	l/s	13.9	l/s	13.9	l/s	16.7	l/s
MAX HYDR CAPACITY	24h/d pumping		120% design rate		Clear water output + backwash vol + sludge vol over 24h		Fixed fllter feed rate over 24h		24h pumping		24h pumping less B'Wash		can bwash more than 1x per day					
	2667	m3/d	1212	m3/d	1210	m3/d	1200	m3/d	1200	m3/d	1167	m3/d					16.7	l/s

PIPE NUMBER	10		11		12		13		14		15		16		17		18	
	OLD WKS SETTLED WATER OUT to SLOW FILTERS		OLD WKS DESLUDGE to SLUDGE TANK		SLUDGE TANK to DEHYDRATOR		DEHYDRATOR RECYCLE to RAW WATER TANK		DRY SLUDGE OUT		CLEAR WATER OUT to OGUNJINI 1 RESV		SERVICE WATER		SERVICE WATER to DEHYDRATOR		SERVICE WATER for GENERAL USE	
	Descr/Qnty	Unit	Descr/Qnty	Unit	Descr/Qnty	Unit	Descr/Qnty	Unit	Descr/Qn	Unit	Descr/Qn	Unit	Descr/Qn	Unit	Descr/Qn	Unit	Descr/Qn	Unit
DESIGN CAPACITY	continuous gravity flow		~10mins/d each tank, max 1% of raw inflow		Dehydrator design rate (normally < 8h/d)		pump rate = 2x dehydr rate		12% dry solids		18h/d pumping		tap from rising main		dehydr needs 200l/h service water		ablutions, rinsing etc	
	1000	m3/d	10	m3/d ave	20	m3/d	22	m3/d	0.200	m3/d	2000	m3/d	2.6	m3/d	1.6	m3/d	1	m3/d
DESIGN FLOW RATE	42	m3/h			3	m3/h	6	m3/h			111	m3/h			0.0154	m3/h		
	11.6	l/s	4.2	l/s	0.833	l/s	1.7	l/s			30.9	l/s	0.6	l/s	0.056	l/s	0.5	l/s
MAX HYDR CAPACITY	120% design rate				24h/d operation		24h/d operation		24h/d operation		24h/d operation		no limit				no limit	
	1200	m3/d	4.2	l/s	72	m3/d	144	m3/d			2667	m3/d						

The existing and new works will effectively operate completely independently from each other in terms of chemical dosing, flocculation, clarification and filtration. They have a common raw water supply, chlorination system, clear water delivery system and sludge handling system.

The new works will run on a continuous basis producing a daily volume of 1,0 Ml of potable water (whatever the consumer demand) and the existing works will make good the daily difference between overall consumer demand and the new works output.

Both works will operate continuously and will only shut-down under particular alarm conditions.

There is no liquid waste stream (eg clarifier sludge, clarifier sludge filtrate or filter spent backwash water) discharged to the river. Clarifier sludge is to be dehydrated (and removed as a solid) and clarifier sludge filtrate and filter spent backwash water are to be recycled back to the head of works.

The control of the waterworks process comprises the following (working backwards from Ogunjini 1 Reservoir):

- The Ogunjini Waterworks supplies water to Ogunjini 1 reservoir and, if necessary, can also bypass the latter in favour of pumping (at little higher head) to Hospital Reservoir. A pumping system drawing from Ogunjini 1 Reservoir transfers water to other reservoirs higher up the area of supply.

- The control system for the high lift clear water pumps at the waterworks is designed to keep Ogunjini 1 Reservoir within 300mm of full at all times (ie system is demand driven).

- The EWS Water Networks Branch can remotely cause water to be diverted to the Hospital Reservoir as and when needed or can automate this through the SCADA. Details are given in the relevant section of this Report.

- As noted above, the waterworks operates on a continuous basis and at a steady flow.

- The difference between what is pumped to Ogunjini 1 Reservoir and what is produced by the waterworks is taken up in a new clear water balancing reservoir at the waterworks.

- The waterworks Operator reviews the state of the new balancing reservoir early in the morning (when it should be at its fullest having caught-up with the high daytime draw the previous day) and makes an adjustment to the raw water flowing into the waterworks accordingly.

- In order to minimise the use of the existing slow sand filters (and thereby minimise the need for labour-intensive cleaning), the new portion of the waterworks is to be operated at full capacity all the time (as noted above) with the old part of the Works making up the shortfall (ie always operating at less than its design capacity until such time as demand matches the overall waterworks capacity). The waterworks Operator thus adjusts the inflow to the old part of the works on a daily basis to balance supply and demand. The new works can, however, be operated at up to 117% of Design Output Capacity and down to about 60% of Design Capacity by adjusting the speed of the new works raw water feed pump (not the river abstraction pump).

- Should the waterworks output exceed the demand (balancing tank reaching close to overflow point), the old and/or new works is temporarily shut-off until the balancing tank drops below 80% full (details given in the following sections).

PS 9.2 Raw Water Abstraction System

Due to space constraints in the existing river abstraction tower (and due to the risk of the pump motor being flooded in a long return period flood) only one pump can be installed. In lieu of a fitted and operational standby unit, a spare pump and motor and drive belts will be kept in storage in one of the waterworks buildings. Replacing either the motor or the pump or the drive belts only or all components is a simple procedure which can be carried out by EWS Mechanical and Electrical operations staff.

The raw water abstraction system is designed to pump water from two existing suction pipes in the river to a wedge-wire screen at the two existing raw water holding tanks. The screened raw water drops into a 60:40 ratio flow-splitter box below which, in turn, drains to the holding tanks (the one tank is 1.5x the volume of the other). The two tanks can be individually isolated for sediment removal by manually closing the relevant inlet sluice-gate and opening the tank drain valve. With one tank isolated, the full incoming flow to the division box overflows to the other tank.

The raw water balancing tanks must be kept to within about 300mm of being full at all times so that the gravity feed to the existing works remains steady and the residence time for solids settling is maximised. The control of the river water abstraction pump is therefore demand-driven; ie the pump starts when the water level in the balancing tanks fall below a preset level (about 300mm below full) and switches-off when the tank reaches full level. With a pre-set of 300mm, the pump will not cycle more than 3 times an hour under the shortest cycling time situation (shortest cycling time situation occurs when water works demand is half that of the raw water abstraction flow rate).

The raw water pump shall therefore be automatically controlled by a central PLC linked to ultrasonic level sensors in the two raw water tanks. The water levels in the two tanks will, under normal operating conditions, always be the same (the two outlets are directly linked to each other). Each tank will occasionally need to be drained to remove accumulated silt and mud in which case the PLC shall select for the higher of the two tank levels for river abstraction pump control (ie the tank remaining in service).

The raw water pump is a self-priming unit. The self-priming feature does not require any additional instrumentation or control equipment; it happens automatically when the pump switches on. As it can take several minutes to self-prime if the water has somehow drained-out since the last pump cycle (normally it will remain fully-primed), the motor protection timer for electric motor underload should be longer than the typical self-priming time (the actual details of which are to be confirmed at commissioning).

The suction side of the pump has no instrumentation or sensors as normally is operating at sub-atmospheric pressure. If the river is very low, the inlet can potentially suck air. There is also a small possibility that the inlets become clogged with, say, plastic bags in the river (although the inlet holes are generously-sized and spread-out to minimise inlet velocities, hence propensity to 'suck-in' debris drifting past). To protect the pump from such blockages and/or sucking air, the central PLC will shut down the pump and send an alarm signal if the flow meter shows a reduction of flow of more than 20% for a period exceeding a pre-set time limit (default value: 2 minutes to complete initial priming stage).

The control of the river pumps is not directly linked to the alarm conditions requiring shutting down the works because the pump will automatically shut itself off when the existing and new works no longer draw water and the raw water tanks fill to pump shut-off level.

The installed pump can be operated under Manual Mode. This mode is for testing / commissioning / emergency purposes only.

When 'Auto' mode is selected, the PLC executes all functions, including start and stop, alarms and trips. The HMI must display that the system is in Auto Mode.

The river abstraction Duty Pump has the standard electrical motor protection trips. The current underload timer needs to match or exceed the low flow pre-set time limit for the pump priming stage mentioned above.
It should be noted that separate electronic timers are required for tripping on motor

overload and underload conditions; if the river abstraction system starts from empty, it can take several minutes for the pump to self-prime. An overload condition needs to trip within a few seconds to prevent overheating the motor wiring.

PS 9.3 Regulating Raw Water Inflow to Existing and New Works

The new part of the waterworks will be fed from a Variable Speed Drive (VSD) controlled Duty Pump drawing from the existing raw water balancing tanks (the receiving flocculation tank Top Water Level is a few meters higher than the raw water balancing tanks). The pump speed is manually-set (using flow meter read-out display next to VSD) to deliver a steady full design capacity of the new works (however if desired by the Operator, the speed may be adjusted within a range which is to be within the allowable range of the VSD).

The existing works is at a lower elevation to the balancing tanks, so can remain gravity-fed. The raw water inflow to the latter will be manually adjusted by means of a gate valve once or twice a day to suit the abovementioned shortfall. **Note:** It would be too complex to try and automate this and, at the same time, maintain steady-state conditions in the clarifiers (which is necessary for optimal performance). To determine the daily output required, it is necessary for the Operator to make a judgement call based on many factors such as change in weather, change of demand patterns, the need to catch-up on storage levels etc.

The raw water feed pump to the new works and the manual flow regulating valve to the existing works are both situated inside a new small building (together with their respective flow meter readouts) next to the raw water holding tanks.

In addition to the manually-actuated gate valve feeding the existing works, a non-modulating normally-open diaphragm valve (fitted in-line downstream of the above) will allow the inflow to the existing works to be shut-off automatically in the event of an alarm being triggered (see alarm conditions below). This will be fitted with a solenoid control such that, if the solenoid valve is energised, the diaphragm valve shuts off the flow. When the solenoid valve de-energises, the valve slowly opens-up fully again. The same alarm conditions will also stop the Duty feed pump to the new works.

The raw water inflow to both the new and existing works will be shut-off under the following alarm events:

- Under-dosing of sodium hypochlorite in the clear water being pumped to Ogunjini 1 Reservoir: a residual chlorine measuring instrument mounted on the clear water pump delivery manifold triggers an alarm if the chlorine residual drops below a preset valve (default value: 0,2mg/l). The raw water inflow is only cut-off if the alarm is not reset within a pre-set time of it being triggered (default value: 30 minutes). If the raw water inflow is cut-off in this manner, it will be necessary for the Operator to reset the alarm before the raw water flow will resume.

- The new clear water balancing reservoir at the WTW reaches a predetermined level (100% full) (i.e. works throughput exceeds demand OR clear water high lift pumps not operating and reservoir is about to overflow to waste). Note: The existing clear water reservoir is (under normal operating conditions) kept topped-up at all times by means of an equilibrium float valve fed from the abovementioned balancing reservoir (which is at a higher elevation). The raw water inflow is shut-down immediately this alarm is triggered and flow will only resume when the water level in the balancing reservoir drops to below 80% full.

- The turbidity reading of the pumped clear water going to Ogunjini 1 Reservoir exceeds 1 NTU measured by a turbidity analyser mounted on the clear water pump delivery manifold. The raw water inflow is only cut-off if the alarm is not reset within a pre-set time of it being triggered (default value: 30 minutes). If the raw water inflow is cut-off in this manner, it will be necessary for the Operator to reset the alarm before the raw water flow will resume.

- The water levels in the raw water balancing tanks fall below a pre-set minimum level (activated by float switches in each tank; ***both*** need to be activated).

- The Works Operator hits the emergency stop button next to the new works raw water feed pump or actions this from his/her SCADA.

There is also a turbidity meter on the new works clear water pipeline. An alarm will be triggered if the turbidity rises above 1 NTU. The new works raw water feed duty pump is only cut-off if the turbidity reading remains above 1NTU and/or alarm is not reset within a pre-set time of it being triggered (default value: 30 minutes). If the raw water inflow is cut-off in this manner, it will be necessary for the Operator to reset the alarm before the raw water flow will resume. There is no corresponding turbidity reading of the filtered water from the existing works ('break-through' of dirt through the slow sand filters cannot happen; they are inclined to clog-up under poor settled water conditions rather).

Raw water monitoring-only instrumentation:

- Incoming raw water flow meter positioned on the raw water rising main from the abstraction works (TAG RW-FIT-01).

- Turbidity meter on raw water inlet to both works (drawing from new outlet pipe from raw water balancing tanks before it splits between new and existing feed lines)(TAG RW-AIT-02).
- pH (drawing from same point as above) (TAG RW-AIT-01).
- Conductivity (drawing from same point as above) (TAG RW-AIT-03)
- Two flow meters on the raw water feeds to the existing and new works (both meters housed in or near the raw water feed room next to the raw water balancing tanks) (TAGs OW-FIT-02 & NW-FIT-04).

Raw water control & monitoring instrumentation:

- Ultrasonic water level sensors on both existing raw water holding tanks (TAGs RW-LIT-01 & RW-LIT-02).
- Raw water feed pump to new works cut-out on low level alarm in both raw water holding tanks.
- Covered in Section 1.11:
    - Ultrasonic water level sensor on new waterworks clear water storage & balancing reservoir (TAG –CL-LIT-04).

Telemetry outputs to the Control Room (and signal to local SCADA) include but are not limited to:

- Status of river water abstraction pump (Auto / Manual / off / run / specific trip info / run hours).
- River abstraction raw water instantaneous flow and totalizer.
- Water levels in raw water holding tanks.
- Status of new works raw water feed pumps (Auto / Manual / off / run / specific trip info / run hours).
- Raw water instantaneous flow and totalizer: Feed to new works.
- Raw water instantaneous flow and totalizer: Feed to existing works.
- Alarm mode if raw water is shut off to both existing and new water works (showing which of the above-mentioned conditions has been triggered).
- Alarm mode if trip time-out on the river abstraction motor underload protection (indicating river abstraction pump failure to prime).

Outputs to local SCADA only:

- pH
- Conductivity
- Raw water turbidity.

PS 9.4 Chemical Dosing System

Chemical dosing for flocculation and coagulation for both the old works and new works will be separately automated using a Streaming-flow Current (or ion) Detector

(SCD) which, electronically linked to the chemical dosing pumps, automatically adjusts for changes in flow and turbidity. Flash-mixing shall be achieved by dosing immediately upstream of in-line flash mixing devices.

The existing works already has a SCD dosing control unit. This will be replaced with a new unit (TAG OW-AIT-04); complete with new progressive-cavity (self-priming fixed-flow) sampling pump. The sampling point for the SCD will remain at the very end of the flocculation channel (ie allowing sufficient time from dosing point for raw water colloidal charges to be neutralised by the polyelectrolyte).

The new works SCD unit will draw from the outlet of the flocculation tower. The sampling water will drain from the SCD unit to the clarifier sludge draining system (no sampling pump needed as per old works). The rate of sampling flow will be regulated manually by means of a ball-valve on the tapping off the flocculation tower.

Both old and new SCD charge signals shall be linked to the PLC for monitoring purposes (remote and on-site alarm to be activated if one of the charge signal starts climbing, this would indicate a failure of the respective chemical dosing system).

The chemical dosing pumps will draw from one of two Day Tanks (small tanks which each holds approximately three days' worth of polyelectrolyte). One tank is for preparing a diluted poly solution while the other is in use. These are manually filled in turn from a bulk tank outside. The latter is sized to hold 150% of the smallest tanker delivery weight (1,5 tonnes).

A load cell under the Day Tank will provide the signal. The trigger will be a pre-set weight (tank weight falls below the 10% full weight).

The Day Tank will serve both existing and new works (they have separate dosing pumps, but they are in the same building).

The following conditions shall also generate an on-site visual alarm and remote SCADA monitoring alarm:

- Low level of polyelectrolyte left in the Day Tank (i.e. about to run-out).

A flashing red light mounted on the outside of the polyelectrolyte dosing room is to be activated if any of the above alarm conditions are triggered.

Chemical dosing monitoring and control instrumentation:

- Weight of polyelectrolyte in dosing tank

- SCD charge reading (existing works)
- SCD charge reading (new works)

Telemetry outputs to the Control Room (and signal to local SCADA) include but are not limited to:

- Alarm mode if low level of poly is detected
- Alarm mode if either SCD charge moves outside pre-set parameters.

Outputs to local SCADA only:

- Weight of poly Day Tank
- SCD charge operating status and charge readings (both)
- Dosing pump rate (new and existing)

PS 9.5 Old and New Clarifiers

Submerged ultrasonic sludge blanket probes will be included in both the old and new clarifiers. These instruments will be used for monitoring purposes and will not be used to control any part of the treatment process.

The desludging valves on the new clarifier sludge concentrating hoppers are each manually operated where the operator watches the outflow (discharges to an open box) and closes the quarter-turn ball valves when most of the settled sludge has passed (i.e. when colour suddenly changes from dark to light). Actuated valves will be included in parallel and activated by daily timer, should the operator select automatic operation. The sludge drains to a pump sump near the old clarifiers (see below).

The existing clarifiers will operate as before (Operator manually operates new ball valve on each tank to draw down excessive sludge only; he/she needs to retain some sludge for maintaining a sludge blanket through which the incoming flow passes). The existing drainage pipework will be retained and the final collection manhole (where the sludge currently drains to the river) will be modified to act as a pump sump to transfer the sludge into an above-ground sludge holding tank (the latter would be too deep if directly collecting the gravity-flow sludge drainage).

A single small submersible dewatering pump (which has its own attached on/off float switches for automatic operation) suspended on a chain and with a DN50 rubber hose with quick-release coupling will transfer the incoming sludge into an above-ground sludge holding tank. A spare pump (with its own rubber hose and cable) will be kept in storage on site. A separate float switch in the pump sump will warn the Operator (and Pinetown Control Room) if the sludge level gets too high (eg pump failure for whatever reason).

Sludge Pump Sump monitoring instrumentation:

- Float switch to trigger High Level Alarm (flashing red light at Waterworks) (TAG SD–LIT-13)

Telemetry outputs to the Control Room (and signal to local SCADA) include but are not limited to:

- Alarm condition. Alarm to automatically reset once float switch no longer registers high level (pump working).

PS 9.6 Pressure Filters

The Contractor is responsible for the design of an automated modular pressure filter system such that filter feed pumps, drawing from a settled water balancing tank, operate at a fixed rate of 50m^3/h and shut down when the water level in the balancing tank is too low and switch on again when full. There will be 4 No filter units (i.e. 12.5m^3/h each under normal operating mode).

The filtered water is delivered directly to the new clear water reservoir inlet under normal operating mode. To backwash a filter, the flow from the other three filters is diverted from the clear water reservoir directly through the filter being backwashed, with the spent backwash water pushing through directly to the raw water holding tanks inlet splitter box for recycling (the flow to the new clear water balancing reservoir being temporarily suspended).

The backwashing sequence with its associated opening and closing of valves and switching pumps and blowers on and off (air scour followed by water backwash) will all be PLC controlled. Electrically-actuated quarter-turn ball valves (being more reliable and robust than butterfly valves) will be specified.

Normally, the PLC will be in Full Auto mode where backwashing of all 4 filters (in sequence) is either initiated by:

- A predefined pressure drop across the filter beds being exceeded (Note: with a common inlet and outlet manifold, the pressure drop will be the same for each filter unit; irrespective of whether or not it is clogged); or

- By timer (typically all 4 filters backwashed one a day irrespective of headloss).

Backwashing of each filter will require that there is sufficient water in the settled water balancing tank before each wash cycle is initiated (to prevent backwashing being interrupted before the cycle is complete).

One PLC will fulfil all existing and new works controlling functions (including the clear water pumps).

Through the HMI, Semi Auto mode can be selected where the Operator can manually initiate backwashing any particular filter (the sequencing of backwashing and returning to service still being automated).

If fully manual mode is preferred (or for testing and commissioning), the operator can push a sequence of buttons through the HMI to open/close valves and start/stop pumps and air blower.

Pressure Filter monitoring and control instrumentation:

- Differential pressure across the bank of 4 pressure filters (TAG NW-PdIT-01).
- Settled water flow meter on suction side of filter feed pumps (TAG NW-FIT-05)
- Filtered water flow meter on rising main to new clear water reservoir (TAG NW-FIT-07)
- Turbidity meter on filtered water rising main to new clear water balancing reservoir (TAG NW-AT-07).
- Spent backwash water flow meter on rising main to balancing tank at raw water screen / splitter inlet to raw water tanks (TAG NW-FIT-06).

Telemetry outputs to the Control Room (and signal to local SCADA) include but are not limited to:

- Filtered water turbidity (with alarm activation and shutting down incoming new works raw water feed pump if exceeds 1 NTU for longer than a preset time – default is 30 mins).
- Filtered water to clear water balancing reservoir instantaneous flow and totalizer.
- Backwash water to head-of-works balancing tank instantaneous flow and totalizer.
- Status of filter feed pumps and air blowers (Auto / Manual / off / run / specific trip info / run hours).

Outputs to local SCADA only:.

- Record of backwashing each filter (time of sequence being initiated can be downloaded or viewed).

PS 9.7 Disinfection

Although there are two independent water treatment processes, there will be only one chlorine dosing point. The current dosing point is a 32mm PVC pipe through the clear water reservoir wall next to 2 x DN200 inlet pipes from slow sand filters. This position will be retained and the discharge from the new clear water balancing reservoir will be added next to it. Baffle walls will be added inside the reservoir to convert it into a plug-flow chlorine contact tank (necessary for more effective sterilisation). The incoming water from the new and old system and the incoming sodium hypochlorite solution will all come together in a new mixing compartment at the head of the chlorine contact channel.

The sodium hypochlorite solution needs to be dosed in direct proportion to the filtered water inflow to the head of the chlorine contact tank to achieve a constant concentration of free chlorine in the filtered water of about 1,5mg/l.

The old works discharges at a continuous (24h/d), steady rate into the chlorine

contact tank but the new works inflow (from the new clear water balancing tank into the chlorine contact tank via a float control valve) will be variable according to whether the clear water high lift pumps are operating or not (the latter depends on the water levels in Ogunjini and Hospital Reservoirs).

Two separate sets of sodium hypochlorite dosing pumps are therefore required:

- one duty proportional dosing pump linked to a flow meter on the old works filtered water; and
- a separate duty proportional dosing pump linked to a flow meter on the new works balancing reservoir outlet pipe to the chlorine contact tank.

Both duty pumps will pump into the existing single dosing pipeline to the dosing point. Both sets will have a standby pump installed. Should one or both flow meters be out-of-order for whatever reason, the Operator can manually set a particular dosing flow on one or both duty dosing pumps. In this mode, however, the residual chlorine concentration being pumped away will vary and a higher mg/l dosage will have to be applied to maintain a minimum residual level.

Achieving 1.5mg/l free chlorine per litre of filtered water (dosing with hypochlorite at 0,6% free chlorine concentration) translates to, at full design capacity, an intermittent dosing rate of sodium hypochlorite solution of up to 14l/h for the new works and a continuous rate of up to 12,5l/h for the old works.

The proportional rate will be manually adjusted from day-to-day to achieve the required chlorine residual in the outgoing water. The dosing rate (as mg of free chlorine per litre) is to be determined by trial and error until the desired free chlorine level in the water pumped to Reservoir Ogunjini 1 is achieved (default value: Not less than 0,8mg/l).

A residual chlorine analyser (drawing from delivery side of high lift clear water pumps and housed on the wall in the room above the clear water pump room with return flow draining back into the chlorine contact tank) to provide feedback for the above. It is not proposed to automate the dosing rate to achieve a desired residual as the time-lag

between changing the dosage rate and sensing the result of the change is too long. It is not proposed to sample the free chlorine content at the point of dosing as this would require either a dangling probe (which is not suitable for free chlorine measurement) or a sampling pump to bring the sample above ground to a flow cell analyser (unnecessary complexity; the correct residual chlorine at the exit is the critical parameter).
A simple 'on-off' PVC float-switch in the bulk hypo holding tank will activate an alarm condition at a pre-set low solution level (representing imminent failure to disinfect).

The following conditions shall generate an on-site visual alarm and remote SCADA monitoring alarm:

- Low level of hypochlorite solution left in the disinfection dosing system (i.e. about to run-out). A plastic coated float switch in the tank provides the signal.
- Alarm if residual free chlorine concentration in clear water to consumers drops below a preset minimum level.

A flashing red light mounted on the outside of the hypochlorite dosing room is to be activated if any of the above alarm conditions are triggered.

Disinfection monitoring and control instrumentation:

- Free chlorine monitoring flow cell (which also monitors pH and temperature for correct reading) (TAG CL-AIT-11);
- Float switch in hypo bulk holding tank (TAG CL-LS-10)
- Run / Off lights for each of the two duty dosing pumps

Telemetry outputs to the Control Room (and signal to local SCADA) include but are not limited to:

- Free chlorine continuous monitoring of clear water pumped to Ogunjini 1 Reservoir.
- Alarm if level in hypo bulk tank activates low level float switch.
- Alarm if residual free chlorine concentration in clear water to consumers drops below a preset minimum level.

PS 9.8 Clarifier Waste Sludge Holding Tank

The dehydrating facility is only used intermittently as and when the Operator wishes to lower the level of accumulated sludge in the holding tank. This may be for several hours a day during periods of high river water turbidity (when lots of sludge is produced) or only a few hours on one day of the week when the river water is relatively clear.

The level in the sludge holding tank will be monitored by means of an ultrasonic level sensor (TAG SD-LIT-13). The Operator will also be able to look into the open-topped tank. An alarm is raised if the level reaches a pre-set nearly-full level (> 90% full).

The sludge holding tank is to be equipped with a vertical shaft stirrer suspended from a concrete platform above (this is to provide a consistent solids concentration for optimising the dehydrator polyelectrolyte dosing). The stirrer will run continuously while there is more than a minimum level of sludge in the holding tank. The stirrer can be set to Auto mode (automatically turns on when level of sludge – as determined by the ultrasonic level sensor – reaches a pre-set minimum 'high' and off again when the level drops to below a pre-set minimum 'low'. It can also be operated

manually in 'Manual' mode by push buttons if desired (for testing / commissioning purposes).

Sludge is pumped from the clarifier sludge holding tank to the dehydrator by means of a single small progressive-cavity pump (in a lean-to shelter against the outside wall of the holding tank. Being a progressive-cavity pump, the rate of flow is fixed no matter what the level in the sludge holding tank. The rate of flow is determined by the dehydrator unit design (the unit must operate at fixed flow rate). The pump is therefore hard-wired to the dehydrator unit so turns on / off with the dehydrator (see below).

Sludge holding tank monitoring instrumentation:

- Ultrasonic level sensor (TAG SD-LIT-13)

Outputs to telemetry remote monitoring include:

- Sludge holding tank balancing tank level
- Mixer status (on / off / trip / run hour meter)
- Sludge holding tank high level alarm (>90% full)

PS 9.9 Dehydration Facility

The dehydration system is manually activated by the Operator. It will have its own control panel (Contractor's design) situated at the dehydrating facility.

Filtrate from the dehydration process is drained to a 1m^3 sump beneath the unit. The sump is equipped with a submersible dewatering pump which transfers the filtrate to the raw water balancing tank inlet box. This operates entirely automatically by means of an on/off float switch physically attached to the pump. Like the pump transferring incoming sludge from the collection sump to the sludge holding tank, it will be suspended on a chain in the sump and linked to the rising main by means of a DN50 flexible hose with quick-release coupling. The submersible pump electrical cable (being of low motor power) will be fitted with a plug which plugs into an all-weather welding plug socket mounted above ground on the nearest wall. A spare pump (with its own rubber hose and cable) will be kept in storage on site. The filtrate will be monitored by means of a turbidity meter so that the Operator can be alerted should the dehydration system not be working optimally. If a pre-set turbidity is reached, the dehydrator unit will be turned-off. This will require manual resetting of the alarm once the Operator has determined what the problem is.

Positioning of the conveyor discharge head from over one collecting skip to another is a manual process (pivots at the conveyor inlet).
The dehydration equipment will automatically stop operating under the following

conditions:

- The sludge feed pump in the sludge holding tank switches off (tank empty).
- A fault condition develops anywhere within the dehydrator unit (Contractor's design).
- The filtrate turbidity exceeds a pre-set limit.

Dehydration monitoring instrumentation:

- Operation status of dehydrator facility (operating / off / trip / run hours)
- Flow meter for incoming sludge (TAG SD-FIT-10)
- Flow meter for outgoing filtrate (recycle to raw water balancing tanks) (TAG SD-FIT-11)
- Float switch – high (> 80% full) in filtrate recycle collection sump (alarm that recycle pump not working)
- Turbidity meter on filtrate delivery pipeline.

Telemetry outputs:

- Status of dehydrator (on / off / trip / run hours)
- Sludge pump inflow (instantaneous and totalizer)
- Filtrate transfer pumping (instantaneous and totalizer)
- Any alarm condition in dehydrator unit.
- Filtrate turbidity.

PS 9.10 High-Lift Clear Water Pumps

Ogunjini Reservoir 1 and the Hospital Reservoir must be kept as full as possible at all times (the former is the command reservoir for the supply area and the latter is the priority consumer). The control of the high lift pumps must therefore be demand-driven.

The Hospital Reservoir is slightly higher in elevation than Ogunjini 1 and currently is manually filled by EWS Operators by closing an isolation valve into Ogunjini 1. The new 200mm Rising Main to Ogunjini 1 will be fitted with a pressure-sustaining diaphragm control valve which, when a solenoid valve is remotely activated by a pre-set ‘start-filling’ level in the Hospital Reservoir, will cause the control valve to throttle the incoming pumped flow into Ogunjini 1 just sufficiently to increase the upstream pressure enough to push some of the pumped flow into Hospital Reservoir (not all the flow, as the pumps and Rising Main are being upgraded to a larger size than the 160mm extension to Hospital Reservoir can take). When the Hospital Reservoir is full, a remote signal to the solenoid valve will cause the valve to open fully to Ogunjini 1 again. The pressure-sustaining control valve will have a small-bore quarter-turn ball valve fitted to it for the Operator to manually do what the solenoid valve does to open fully or throttle the flow to Ogunjini 1.

The pump control back at Ogunjini WTW therefore needs to receive a signal from Ogunjini 1 Reservoir and shut-off the high lift Duty Pump when Ogunjini 1 Reservoir is full and restart when the water level has dropped by a pre-set value.

The drop in water level below a preset level at which the pumps must come on is such that the pumps do not cycle more than 6 times an hour with there being no demand on Reservoir 1.

The existing and new clear water storage reservoirs at the waterworks therefore act as balancing storage between steady works output and fluctuating demand and will eventually become depleted if the treatment works itself shuts down for any reason.

As noted under Section 1.2, to prevent the abovementioned waterworks reservoirs overflowing, the existing and new works will shut down if the water levels in the old and new reservoirs exceed their respective pre-set values (>90%).

There is 1 Duty and 1 Standby high lift clear water pump to transfer water to Ogunjini Reservoir 1.

In ‘Auto’ mode, the clear water pumps shall be controlled by the PLC as follows:

The Duty Pump will not start if:

- The existing waterworks clear water reservoir water level is below a preset low level.
- The motor statuses indicate a malfunction or circuit not in healthy condition.
- The telemetry signal from Ogunjini 1 Reservoir indicates that water level is above ‘Pump-On’ level (ie full or nearly full).
- A trip condition has not been reset by the Operator.

The Duty Pump will start if all the following conditions are all met:

- The Ogunjini 1 Reservoir level sensor indicates level has fallen below the pre-set (90%) level.
- The on-site lower clear water reservoir water level is above the pre-set minimum low level.
- The motor status has not indicated a malfunction.

The Duty Pump will stop if or when:

- The Ogunjini 1 Reservoir level sensor indicates when a specific high level has been reached (Reservoir full).
- The on-site lower clear water reservoir water level falls below the pre-set minimum low level.
- A Duty Pump fault trip condition develops.

An alarm will be triggered if:

- Any of the above 'Pump Off' conditions are triggered.
- Residual chlorine level falls below a pre-set minimum level for longer than a pre-set time-out period (30 minutes). This condition will not prevent the waterworks from operating. The Operator is to consult the Standard Operating Procedure to determine the process for bringing the required parameters back into range.
- Turbidity exceeds 1 NTU for longer than a pre-set time-out period (30 minutes). This condition will not prevent the waterworks from operating. The Operator is to consult the Standard Operating Procedure to determine the process for bringing the required parameters back into range.

Any one of the pumps can be operated under Manual Mode. This mode is for testing / commissioning / emergency purposes only. The control system must be hard-wired to prevent the possibility of both pumps operating together.

During normal operation, the Duty Pump is controlled by ultrasonic level sensors in Ogunjini 1 Reservoir and the lower clear water reservoir. The Duty Pump is protected from a low water level condition by means of a hard-wired float switch in the existing waterworks clear water reservoir.

The PLC executes all functions, including, start and stop sequences, interlocks, alarms and trips. All selector switches on field devices must be in Auto/PLC mode and the HMI must display that all systems are in Auto Mode.

This duty rotation will be based on numerical run cycle per pump, each pump will run for four operating cycles and the PLC will automatically change the duty cycle. This standby pump will be called to duty in the event of failure of the either of the duty pumps.

High Lift Clear Water monitoring instrumentation:

- Flow meter on clear water rising main to remote Ogunjini 1 Reservoir (TAG CL-FIT-09).
- Ultrasonic water level sensor in chlorine contact tank (TAG CL-LIT-05).
- Ultrasonic water level sensor in Ogunjini 1 Reservoir (TAG CL-LIT-09).
- Residual chlorine analyzer drawing from high lift pump manifold (TAG CL-AIT-11).

Outputs to telemetry remote monitoring include:

- Pump status (Auto / Manual / off / run / specific trip info / run hours)
- Clear water meter instantaneous flow and totalizer
- Operating mode.
- Reservoir 1 water level
- Existing waterworks reservoir level.
- Residual chlorine level
- Low level alarm in Existing waterworks reservoir
- Low residual chlorine alarm

C3.2.4 PROJECT SPECIFICATIONS: CONTROL AND INSTRUMENTATION

TABLE OF CONTENTS

PS 10 GENERAL

PS 10.1 Instrumentation

The Contractor shall refer to the attached instrumentation standards included with this Tender Package

The Contractor shall be guided by the Preferred Equipment List before selecting instrumentation to be used to operate the plant safely and correctly.

The Contractor shall utilise the typical instrument data sheets to prepare the detail data sheets for each instrument type and application. The data sheets shall be submitted for approval prior to procurement.

Where applicable, the Contractor shall supply sizing calculations.

The Preferred equipment list and the data sheets are included in this Tender Package.

The Contractor shall prepare an Instrument location diagram and installation hook-up drawings for each instrument for approval, prior to installation. The typical installation hook-up diagrams are included with this Tender Package.

All instrumentation and related equipment shall be installed in accordance with the manufacturer's instruction, the EWS Hook-Up and loop typical drawings and the specifications.

PS 10.2 Automation

The requirements for the PLC, HMIs and Networking equipment are covered in the section PLC, HMI and Network of this document.

PS 10.3 Electrical power supply to instruments.

Where Instruments require 240VAC power supplies, the contractor shall supply and install the power supply, complete with isolators/breakers as described in the Electrical specification document.

PS 10.4 Protection of Pump Sets

Standard protection for the electric motors forms part of the Electrical Scope, and is not addressed in this document. This refers to the winding temperatures, current draw etc. Electric motor protection signals are connected to the Electronic Motor Control devices within the MCC cubicles.

The centrifugal pumps are protected by low flow signals from the downstream flow meters. When a centrifugal pump is started, the low flow signal in the PLC is bypassed for a short period to allow the pump to achieve a steady discharge flow. The delay may be in the order of 30 seconds and should be adjusted during commissioning.

The progressive cavity pumps have an RTD temperature sensor installed in the stator of the pump. A high temperature shall be hard wired to the motor starter circuit in addition to being input into the PLC for display and trending on the SCADA and HMI.
There is a pressure switch installed immediately downstream on the pump discharge. The pressure switch shall be hard wired to the motor starter circuit in addition to being input into the PLC for status display and alarming on the SCADA and HMI.
When a progressive cavity pump is started, the low pressure signal in the PLC is bypassed for a short period to allow the pump to achieve a steady discharge pressure. The delay may be in the order of 30 seconds and should be adjusted during commissioning

In the event of a malfunction of the pressure switch, or any event resulting in a high pressure at the pump discharge, a piped pressure relief valve, installed by others, protects the pump from over-pressure.

PS 10.5 Numbering

Refer to the included Standard Specification for numbering systems for all equipment.

The Site Number for Ogunjini Water Treatment Works is 200.

Each Area MCC is numbered as shown below:

- MCC 1 is allocated to the main plant, and is located in the Clear Water Pump Station
- MCC 2 is allocated to the Filtration Plant, and is located in the Filtration Building
- MCC 3 is allocated to the Dehydrator

By way of example, the full tag number for a flow meter transmitter in the Old Works may be 200-01-FIT-03, but will generally be referred to as 01-FIT-03 when discussing the Ogunjini WTW.

Refer to the section PLC, HMI and Network for IP addressing of network connected equipment.

Refer to the P&ID and Instrument Index for suggested Instrument Tag Numbers.

PS 10.6 Panels, Cabinets and Enclosures.

The PLC Panel is attached to the MCC Panel. It is supplied by the Panel Supplier. Refer to the section PLC, HMI and Network for information on the PLC Panel

Field Instrumentation Cabinets:

Refer to the EWS Standard Cabinet GA included in this Tender Document for construction details.

The cabinet will typically contain two standard sized transmitters, complete with terminal rails for power and for signal, with surge protection as required.

When planning the layout in the cabinet, the Contractor shall ensure that access to instrumentation is not crowded, and that instrument covers and doors within the cabinet can be removed/opened without difficulty.

Drawings and General Arrangements of the cabinets shall be submitted to the Engineer prior to manufacture.

PS 11 RAW WATER FROM ABSTRACTION (P&ID 2/7)

PS 11.1 General

The Control Description will be found in the Detail Process Description. Reference shall be made to the Standard Specification documentation, including the Annexures and Drawings.

PS 11.2 Instrumentation and Installation.

a) Supply and install Magflow meter **01-FIT-01**. Install the transmitter in the standard instrumentation enclosure.

b) Supply and install a two-pair instrumentation cable from the magflow meter transmitter meter to the signal marshalling in the Clear Water Pump Station MCC.

c) Supply and install an ultrasonic level transmitter, complete with a level transducer, (**01-LIT-01**) in Raw Water Tank TNK-01.

d) Supply and install an ultrasonic level transmitter, complete with a level transducer, (**01-LIT-02**) in Raw Water Tank TNK-02.

e) Supply and install an Instrument Enclosure as detailed in this document. Install both **LIT-01** and **LIT-02** transmitters in the enclosure.

f) Supply and install a 2-pair instrumentation cable from the level meter terminals to the Raw Water Feed Pump Station MCC.

g) Supply and install an Instrument Junction Box (**01-JB-01)**. The enclosure shall be mounted in the Raw Water Pump Station. Supply and install terminal rails as required.

h) Supply and install a 12pr Instrumentation cable from 01-JB-01 to the signal marshalling in the Clear Water Pump Station.

i) Supply and install pH meter **01-AIT-01,** complete with sensor. Install the sensor in the bypass stream. Supply and install a 1pr cable from the analyser to 01-JB-01.

j) Supply and install turbidity meter **01-AIT-02**, complete with sensor. Install the sensor in the bypass stream. Supply and install a 1pr cable from the analyser to 01-JB-01.

k) Supply and install Conductivity meter **01-AIT-03**, complete with sensors. Install the sensor in the bypass stream. Supply and install a 1pr cable from the analyser to 01-JB-01.

l) Refer to the Standard specification for selection of the cable and installation of the cable. Note the requirements for cable glands, terminals, wire lugs and number ID.

PS 12 OLD WORKS (P&ID 3/7)

PS 12.1 Instrumentation and Installation.

a) Supply and install a cable junction box (**01-JB-02**) for installation in Lab & Dosing Building.

b) Supply and install a 12pr instrument cable from 01-JB-02 to the signal marshalling in the Clear Water Pump Station.

c) Supply and install an EWS standard local enclosure to house 2 level transmitters, (01-LIT-03 and 01-LIT-04) between CLA-02 and CLA-03, adhering to the installation specifications.

d) Supply and install a Dual Channel Level Transmitter (**01-LIT-03**), complete with submersible transducers (**LE-03a** and **LE-03b**) to measure a sludge blanket in Clarifiers CLA-01 and CLA-02.

e) Supply and install a Dual Channel Level Transmitter (**01-LIT-04**), complete with submersible transducers (**LE-04a** and **LE-04b**) to measure a sludge blanket in Clarifiers CLA-03 and CLA-04.

f) Supply and install a 4 pair Instrumentation cable between the level meter enclosure and the signal marshalling terminals in the marshalling panel 01-JB-02.

g) Supply and install a Streaming Current Detector (SCD), tag **01-AIT-04**, in the Lab and Dosing building. Note that this SCD requires a fast loop sample stream, with a small pump to drive the fast loop.

h) Supply and install a 1pr instrument cable from 01-AIT-04 to 01-JB-02.

i) Supply and install a magflow meter, **01-FIT-02.** Wall-mount the magflow transmitter in the Raw Water Pump Station.

j) Supply and install a 2 pair instrument cable between 01-FIT-02 and the termination rails in 01-JB-01 in the Raw Water Pump Station, for the analog and totalised signals

k) Supply and install an EWS standard local enclosure, adhering to the installation specifications The enclosure shall house 2 magflow meters, **01-FIT-03** and **01-FIT-08**.

l) Supply and install a 4pr cable between the enclosure and the signal marshalling in MCC-01 in the Clear Water Pump Station.

m) Supply and install the Magflow meter **01-FIT-03** in the local enclosure. For 01-FIT-8, refer to Clear Water and Chlorine System later in this document, and the P&ID 6/7.

n) Supply and install a cable junction box, **01-JB-03** in the Disinfection Building,

o) Supply and install three load cell weighing systems, to be installed for **TNK-03**, **TNK-04a** and **TNK-04b**. Mount the transmitters, **01-WIT-01**, **01-WIT-02, 01-WIT-03,** in the Disinfection Building

p) Supply and install instrument cables from each of the weighing transmitters to 01-JB-03.

PS 13 NEW WORKS (P&ID 4/7)

PS 13.1 Instrumentation and Installation

a) Supply and install a Magflow meter **(02-FIT-04)** in the Raw Water Pump Station.

b) Supply and install a 2pair Instrument cable from the flow meter to 01-JB-01.

c) Supply and install an instrument enclosure to EWS standards to house the SCD 02-AIT-06. There is a gravity drain so a sampling pump is not required.

d) Supply and install a SCD analyser (**02-AIT-06**) between the new flocculation tower (TNK 06) and the new clarifier (CLA-05).

e) Supply and install a 2pr instrument cable from 02-AIT-06 to the signal marshalling section in MCC-01.

f) Supply and install an EWS standard enclosure near CLA-05.

g) Supply and install a 4pr cable from the enclosure to the signal marshalling in MCC-02 in the Filtration Building.

h) Supply and install an ultrasonic level meter (**02-LIT-05**) in the clarifier (CLA-05), complete with submersible probe, suitable for determining a sludge blanket in the clarifier.

i) Install the Transmitter in the enclosure near CLA-05.

j) Supply and install an ultrasonic level meter (**02-LIT-06**) in the roof of the settled water tank (TNK-07).

k) Install the level transmitter in the enclosure with 02-LIT-05.

l) Supply and install electrically actuated ball valves beneath each hopper of the new clarifier. Two are shown, 02-XV-02a and 02-XV-02b, for two hoppers. The final number of valves will depend on the number of hoppers in the clarifier that the Tenderer offers. In order to make valid comparisons, quote on five valves for 5 hoppers.

m) Install 1pr instrumentation cables, one per ball valve, to the MCC-02 in the Filtration building. Quote on 5 cables for adjudication purposes.

n) Supply and install a magflow meter (**02-FIT-05**). Install the flow meter transmitter in the filter plant MCC room in the instrumentation section of the MCC panel.

o) Supply and install a 2pr instrument cable from 02-FIT-05 to MCC-03.

PS 14 FILTRATION (P&ID 5/7)

PS 14.1 Instrumentation and Installation.

a) Supply and install a magflow meter (**02-FIT-06**) in the Filtration building.

b) Supply and install a 2pr instrument cable from 02-FIT-06 to the signal marshalling in the MCC panel. Note that the pulse totaliser contact as well as the analog flow signal shall be connected to the marshalling terminals.

c) Supply and install a Pressure Differential transmitter (**02-PdIT-01**) at the filters, across the upper and lower headers.

d) Supply and install a 1pr instrumentation cable from the transmitter to the signal marshalling in the MCC panel.

e) Supply and install 16 electrically actuated ball valves in accordance with the Filter Supplier instruction.

f) Install 16 instrument cables, one to each actuated valve and the signal marshalling in the Filtration Building. The valves are numbered **from 02-XV-03 to 02-XV-18.**

PS 15 CLEAR WATER AND CHLORINE SYSTEM (P&ID 6/7)

PS 15.1 Instrumentation and Installation

a) Supply and install a standard EWS instrument enclosure at the new clear water reservoir (TNK-10).

b) Supply and install a magflow meter (**01-FIT-07**). Install the transmitter in the enclosure in point a) above.

c) Supply and install a turbidity analyser (**01-AIT-07**). Install the transmitter in the enclosure in point a) above.

d) Supply and install a 4pr instrument cable from the enclosure to the signal terminals in MCC 01.

e) Supply and install magflow meter (**01-FIT-08**) into the enclosure used for **01-FIT-03** (refer to PS93.1.m above)

f) Supply and install ultrasonic level meter **01-LIT-10**.

g) Mount the transducer for the clear water tank (TNK-10) on the roof of the tank.

h) Supply and install a 1pr instrument cable from the level transmitter to the signal marshalling terminals in the clear water pump station (MCC-01)

i) Supply and install the ultrasonic level meter, **01-LIT-09**. Mount the transmitter in the pump room at MCC-01.

j) Supply and install a 1pr instrument cable between the level transmitter and the signal terminals in MCC-01.

k) Supply and install a float switch, **01-LS-08**. The switch contact shall be hard wired to the control circuit of high lift clear water pumps, **PMP-007A&B.**

l) A bypass sample loop will be installed on the discharge from PMP-007A&B. Supply and install 4 analysers in the sample loop, Turbidity (**01-AIT-08**), pH (**01-AIT-09**), Chlorine (**01-AIT-11**) and Conductivity (**01-AIT-10**).

m) Mount the 4 analyser transmitters (AIT-08, AIT-09, AIT-10 and AI-11) in the clear water pump room.

n) Supply and install 1pr instrument cables, one from each analyser to the terminal rail in MCC-01.

o) Supply and install magflow meter **01-FIT-09**. Mount the transmitter in the Disinfection room.

p) Supply and install a 1 pr instrument cable to the signal terminal rail in the junction box in the Disinfection room.

q) Supply and install a low-level switch (**01-LS-12**) in the Hypochlorite tank (TNK-08)

r) Supply and install a 1pr instrument cable to the Junction Box 01-JB-03 in the Disinfection room.

PS 16 SLUDGE HYDRATOR (P&ID 7/7)

PS 16.1 Instrumentation and Installation

a) The sludge dehydrator is a packaged plant with propriety equipment. The Dehydrator supplier shall install the dehydrator and provide an interface with the selected PLC and network equipment and protocols.
Note that the MCC at the dehydrator will be MCC-03. The PLC IP address will be 10.200.3.1
In addition to the propriety instrumentation signals, the following instruments shall be included into the dehydrator PLC:
- 03-FIT-10
- 03-FIT-11
- 03-LSH-16

b) Supply and install a low-level switch (**01-LS-14**) in the sludge manhole.

c) Supply and install a 1pr instrument cable from the level switch to the instrumentation junction box in the Raw Water Pump Station.

d) Supply and install an ultrasonic level transmitter (**01-LIT-15**) and transducer.

e) Install the ultrasonic level transducer in the sludge holding tank.

f) Supply and install a 1pr instrument cable from the level meter transmitter to the Junction box in the raw water pump station.

PS 17 PLC, HMI AND NETWORK

PS 17.1 General

The Contractor shall use the EWS numbering system for all equipment. Refer to the numbering System document included in this Tender Package. In this instance:
10 is the IP address first group
200 is the ID for the Ogunjini Water Treatment Works.
03 is the Plant and MCC prefix for the Dehydrator equipment.

10.200.03.1 is the IP address for the PLC at the Dehydrator.

All drawings and General Arrangements shall be submitted to the Engineer prior to manufacture. Drawings include the System Architecture.

Refer to the detailed specification in GS1.23 of the standard MCC specification.

C3.2.5 PROJECT SPECIFICATIONS: ELECTRICAL

TABLE OF CONTENTS

PS 18 ELECTRICAL - GENERAL

PS 18.1 Introduction

This specification covers the electrical aspects of the Ogunjini water works upgrade.

This specification shall be read in conjunction with Particular Specification: EWS Standard Electrical Specification. If there are any discrepancies between this Project Specification and the EWS specification, the more onerous specification will take precedence, unless decided otherwise by the Employer's Agent.

This specification shall be also read in conjunction with the electrical drawings (refer to List of Drawings in C4.5).

PS 18.2 Scope of work

The contract includes the design, manufacture, supply, testing, delivery, rigging, commissioning, trial operation period, hand-over and maintenance during the Defects Liability Period of the following electrical work:

- Mains cable from the Eskom transformer to the main MCC Panel via the generator switchover panel (in the generator housing).
- MCC's for all equipment.
- All signal and power cabling between buildings and structures.
- Various sensing and monitoring instruments (flows, levels, turbidity, pH etc).
- Building DBs as described in the DB schematics and electrical drawings.
- Building lighting and small power points and minor appliances.
- Where required; decommissioning, stripping, removing and safely disposing of relevant existing electrical equipment to waste disposal site including obtaining of safety disposal certificate.

PS 19 MCC & INSTRUMENTATION

PS 19.1 General MCC and Instrumentation Requirements

The design, installation and commissioning of all MCC's and Instrumentation Works shall comply with SPEC EWS: STANDARD ELECTRICAL SPECIFICATIONS except where amended below.

PS 19.2 Detailed Scope of Work: MCC's

The detailed Scope of Work for the MCC's includes the following:

- Design to SANS 10142-1 & SANS 61439 a type tested MCC.
- Issue drawings and equipment lists for approval prior to construction that

include:
- General arrangement c/w dimensions of the MCC's
- Wiring diagrams showing the mains, control and PLC wiring
- Equipment lists of switchgear that reference to the wiring diagrams

- Manufacture of MCC's.
- Internal testing and quality control.
- Factory acceptance test at the manufacturer's facility with the Engineer.
- Delivery, offloading and rigging into position on site.
- Site acceptance test once the incoming and outgoing cables to and from the MCC's are connected.
- Routine test report and declaration of conformity to SANS 10142-1 & SANS 61439 including PLC/HMI programming, testing and commissioning.
- Panel must be designed for Type 2 co-ordination.

PS 19.3 Site specific supply

The supply to which the Main MCC is to be connected is 3 phase, 4 wire, 400/230V with a frequency of 50 Hz which could be either from a supply authority or on-site generator.

PS 19.4 Ratings and general requirements

- Voltage (nominal): 400V
- Voltage (operational): 400V
- Current: 750A
- Fault level: 36kA
- Frequency: 50Hz
- Insulation voltage: 1000V
- Impulse voltage: 8000V
- Overvoltage category: IV
- Level of contamination: 3
- IP rating: IP54
- Form of separation: 4a
- Maximum temperature: 45 degree Celsius
- Relative humidity: 85%
- Material: (2mm doors, 3mm mounting plates)
- Colour: Electric Orange
- Mounting: Floor standing
- Cable entry: Bottom
- Cable exit: Bottom
- Control voltage: 230V
- Instruments & PLC: 24V DC.

PS 19.5 Enclosure, busbars, wiring & labelling

Enclosure to be made up of modular construction fully type tested assembly.

All joints between enclosures to be fitted with purpose-made gaskets.

All doors to be earthed.

Particular attention shall be given to the ventilation of panels to prevent the build-up of excessive heat caused by internal heat generation. All necessary precautions shall be taken to ensure that the temperature of the air in any portion of the assembly does not rise more than 15°C above ambient air temperature.

Every board shall be fitted with a suitable gasket incorporated into the frame to ensure that the arrangement is in accordance with the required degree of protection. Sealing strips and gaskets shall be made of durable, non-hardening rubber, neoprene or other synthetic material, suitably fixed to the door to ensure that the seal does not become dislodged during normal operation.

The lock and door catch shall comprise of a combination unit. Door latching and de-latching operations shall be smooth and quick, whilst ensuring proper compression of the sealing gaskets. Repeated opening and closing of the hinged doors and operations of the door locks and catches shall not cause chipping or scratching of the painted surfaces or any other blemishes to the finished boards.

Lifting lugs shall be provided for floor standing enclosures and as needed for wall mounted enclosures.

The board shall have separate latches hinged or removable front cover secured to the board by means of suitable captive type screws or bolts. When the cover is removed/ opened, easy access to that compartments components and wiring shall be possible.

Due care shall be taken to ensure that the live side of the MAIN SWITCH is suitably protected so that no live conductors are exposed when the panel door is opened or the panel cover is removed.

The board shall be equipped with a set of 3 phase and neutral copper busbars. The 3 phase busbars shall be continuously rated for the full load of the incoming supply switch. The neutral shall be 100% of the phase busbars. Earth bar shall be rated to fault current and touch voltage and will be installed for the full length of the MCC.

Busbar rating shall be 2A/mm^2 up to 630A and 1.6A/mm^2 thereafter.

Busbar temperature shall not exceed a 40^o C temperature rise.

The busbars shall be adequately braced and supported. The busbars shall be covered with a sufficient number of layers of high quality insulating tape or heat shrinkable sleeving and finished in standard colours.

Busbars shall be suitable enclosed in a busbar chamber or behind a protective barrier for protection against inadvertent contact with "live" busbars with access panels removed.

Inter-connectors between the busbars and control units shall be by means of fully insulated, adequately rated conductors firmly bolted to the busbar and secured to the appropriate terminals of the control units using crimped-on terminal lugs. Solid flat conductors shall be used if the rating exceeds 400 A or if the fault current exceeds 25kA rating. No conductor of less than 16mm2 shall be used between busbars and control units. All conductors shall be suitably rated for the fault level.

All the outgoing connections of MCCB's greater than 400A 3 phase shall be done by means of copper bus bars, securely clamped using approved busbar clamping insulators, fixed to a robust metal section of adequate size, conveniently located in the rear of the distribution board to enable the incoming cables to be terminated in the back of the distribution board cubical behind each respective MCCB. This is to allow for the easy termination of the larger incoming cables, with sufficient clearance and space to enable the outgoing cables to be connected to their corresponding busbar terminals without difficulty or strain to the MCCB's. Each MCCB up to 250A shall be fitted with extended terminal complete with phase barriers as supplied by circuit breaker supplier.

A substantial earth terminal shall be firmly attached to the metal work of the distribution board and connected to an earth bar of cross sectional area not less than 50% of the phase bars, running the full length of the distribution board to which all earth conductors of the incoming and outgoing circuits shall be firmly connected.

The power and control wiring must be installed in PVC trunking by neatly arranged vertical and horizontal runs. Wire looms not in trunking must be strapped to rails and must be wrapped with spiral band to protect the conductors.

All control wiring must be numbered with Legrand Memocab, or similar, system.

Power wire: minimum 16mm^2 from busbars to starters
Up to 16mm^2 must be red/white/blue
Above 16mm^2 colour coded at ends with high quality heat shrink

Control wire: 1mm^2
220 Vac – Red
Neutral – Black
24V DC (+) – Grey (Marked +24Vdc)
24V DC (-) – Blue (Marked -24Vdc)
12V DC (+) – Yellow (Marked +12Vdc)
12V DC (-) – Blue (Marked -12Vdc)
Telemetry – Purple

Instrumentation earth must be provided in the PLC & Instrumentation sections.

All components must be labelled so that they can be clearly read in conjunction with the wiring diagrams.

The MCC shall be fitted with the following labels as needed in suitable positions:

- Live busbars
- Flash signs
- Main label (always required)
- Voltage rating
- Current rating
- Fault level and time
- IP rating
- Job number
- Reference number

- Date of manufacture
- Form of separation
- Fed from
- Each feeder/starter to be labelled

The MCC shall be supplied with a test certificate. This certificate shall include all items as indicated in Annexure 1 of SANS 1973–1.

The HMI shall comply with the following requirements:

- The HMI needs to show all process information, including at least the following items:
  - Pump status for each pump including, but not limited to:
    - Running / Stopped / Tripped,
    - Auto / Manual,
    - Duty / Standby,
    - Pump run hours,
    - Tele-override on / off
    - All trips
    - Alarm/trip history
  - Pressures,
  - PH levels,
  - Turbidity levels.
  - Chlorine concentration levels
- Set-points must be adjustable via the HMI
- User level access with password authentication to complete sensitive changes.

PS 19.6 MCC: Individual compartment description

Main Pump Station MCC Panel

<u>Incoming compartment</u>: (refer to typical drawing)

- 750A Fused MCCB with door-interlocked handle and shaft.
- Extended terminals on MCCB to accommodate 3 x 150mm2 copper cables.
- Polycarbonate shield over line side with warning label (“Live at all times – Isolate elsewhere”).
- 4P Class I surge protection complete with fuses as per manufacturer’s requirements.
- 4P Class II surge protection complete with fuses as per manufacturer’s requirements.
- Protection for small motors to be ABB UMC100, 24V intelligent starter.
- Phase failure relay with fuse protection.
- LED indication lights for phase ON indication (L1, L2 & L3).
- Control relays for interlocking starters and signal to PLC compartment.
- Power meter complete with dedicated fuses protection and current transformers.
- Power meter to have MODBUS RS45 port wired to PLC compartment.
- Engraved 125x25 label – Incomer.

<u>Feeder compartment</u>:

- MCCB’s as specified in SLD.

- Engraved 125x25 label – Feeders.
- Engraved label to identify each feeder.

<u>75kW Clear water pump no.1</u>**:** (refer to typical drawing)

- MCCB with door-interlocked handle and shaft.
- Line contactor (AC-3 rated).
- Soft starter – full three phase control with built-in bypass and torque control facility.
- Control equipment as per typical drawing.
- Provision for marshaling signals to PLC compartment.
- Engraved 125x25 label – CLEAR WATER PUMP NO.1.

<u>75kW Clear water pump no.2:</u> (refer to typical drawing)

- MCCB with door-interlocked handle and shaft.
- Line contactor (AC-3 rated).
- Soft starter – full three phase control with built-in bypass and torque control facility.
- Control equipment as per typical drawing.
- Provision for marshalling signals to PLC compartment.
- Engraved 125x25 label – CLEAR WATER PUMP NO.2.

<u>7.5kW Raw water pump no.1:</u> (refer to typical drawing)

- MCCB with door-interlocked handle and shaft.
- Line contactor (AC-3 rated).
- Soft starter – full three phase control with built-in bypass and torque control facility.
- Control equipment as per typical drawing.
- Provision for marshalling signals to PLC compartment.
- Engraved 125x25 label – RAW WATER PUMP NO.1.

Filter Building Room MCC Panel

<u>Incoming compartment</u>: (refer to typical drawing)

- 250A Fused MCCB with door-interlocked handle and shaft.
- Extended terminals on MCCB to accommodate 3 x 150mm2 copper cables.
- Polycarbonate shield over line side with warning label (“Live at all times – Isolate elsewhere”).
- 4P Class I surge protection complete with fuses as per manufacturer’s requirements.
- 4P Class II surge protection complete with fuses as per manufacturer’s requirements.
- Protection for small motors to be ABB UMC100, 24V intelligent starter.
- Phase failure relay with fuse protection.
- LED indication lights for phase ON indication (L1, L2 & L3).
- Control relays for interlocking starters and signal to PLC compartment.
- Power meter complete with dedicated fuses protection and current transformers.
- Power meter to have MODBUS RS45 port wired to PLC compartment.

- Engraved 125x25 label – Incomer.

7.5kW Filter pump no.1: (refer to typical drawing)

- MCCB with door-interlocked handle and shaft.
- Line contactor (AC-3 rated).
- VSD
- Control equipment as per typical drawing.
- Provision for marshalling signals to PLC compartment.
- Engraved 125x25 label – FILTER PUMP NO.1.

7.5kW Filter pump no.2: (refer to typical drawing)

- MCCB with door-interlocked handle and shaft.
- Line contactor (AC-3 rated).
- VSD
- Control equipment as per typical drawing.
- Provision for marshalling signals to PLC compartment.
- Engraved 125x25 label – FILTER PUMP NO.2.

15kW Filter blower no.1: (refer to typical drawing)

- MCCB with door-interlocked handle and shaft.
- Line contactor (AC-3 rated).
- Softstarter – full three phase control with built-in bypass and torque control facility.
- Control equipment as per typical drawing.
- Provision for marshalling signals to PLC compartment.
- Engraved 125x25 label – FILTER BLOWER NO.1.

15kW Filter blower no.2: (refer to typical drawing)

- MCCB with door-interlocked handle and shaft.
- Line contactor (AC-3 rated).
- Softstarter – full three phase control with built-in bypass and torque control facility.
- Control equipment as per typical drawing.
- Provision for marshalling signals to PLC compartment.
- Engraved 125x25 label – FILTER BLOWER NO.2.

Raw Water Feed Pump Station MCC Panel

Incoming compartment: (refer to typical drawing)

- 630A Fused MCCB with door-interlocked handle and shaft.
- Extended terminals on MCCB to accommodate 3 x 150mm2 copper cables.
- Polycarbonate shield over line side with warning label ("Live at all times – Isolate elsewhere").
- 4P Class I surge protection complete with fuses as per manufacturer's requirements.
- 4P Class II surge protection complete with fuses as per manufacturer's requirements.

- Protection for small motors to be ABB UMC100, 24V intelligent starter.
- Phase failure relay with fuse protection.
- LED indication lights for phase ON indication (L1, L2 & L3).
- Control relays for interlocking starters and signal to PLC compartment.
- Power meter complete with dedicated fuses protection and current transformers.
- Power meter to have MODBUS RS45 port wired to PLC compartment.
- Engraved 125x25 label – Incomer.

<u>3kW Raw Water pump no.1:</u> (refer to typical drawing)

- MCCB with door-interlocked handle and shaft.
- Line contactor (AC-3 rated).
- VSD
- Control equipment as per typical drawing.
- Provision for marshalling signals to PLC compartment.
- Engraved 125x25 label – Raw Water PUMP NO.1.

<u>3kW Raw Water pump no.2</u>: (refer to typical drawing)

- MCCB with door-interlocked handle and shaft.
- Line contactor (AC-3 rated).
- VSD
- Control equipment as per typical drawing.
- Provision for marshalling signals to PLC compartment.
- Engraved 125x25 label – Raw Water PUMP NO.2.

<u>PLC & Marshalling</u>:

- DP MCB supply to 24V DC power supply.
- Class II surge protection complete with fuses as per supplier's requirements.
- 20A 230V/24V DC power supply.
- PLC installation and wiring all inputs & outputs. Final I/O provisions to be determined by the manufacturer. A 20% spare capacity must be provided.
- HMI (15") installation and wiring required.
- Allow for marshalling of incomer and all starters to inputs and outputs of PLC.
- Allow for wiring of all field instruments to inputs and outputs of PLC.
- PLC marshalling to be completed by software via serial communications port. An RS-485 will thus be required.
- PLC shall allow for a spare port to facilitate PLC programming.
- Digital inputs will have fuse protection per starter.
- Digital outputs must have interposing relays per output.
- Analogue inputs and outputs must have individual fuse protection.

Although detailed in the Control Philosophy document, the following mode of operation will apply to the 2 High Lift Pumps:

- Duty rotation must be automatic (via the PLC).
- Standby pump must start automatically in the event of failure of the duty pump.
- Pump cycle must start automatically after a power failure.

<u>Field instruments to be catered for in the PLC compartment and interlocking of pumps</u>:

- No-flow monitoring with timers, LED indication lights and manual resets.
- Low level monitoring with pressure level transmitters with display units in MCC.
- High level monitoring with pressure level transmitters with display units in MCC.
- Low-low levels with level probe relays with LED indication lights and manual resets.
- Pressure monitoring with timers, LED indication lights and manual resets.
- All communication and analogue signals to have Moxa surge protection.

UPS and Backup Batteries

The UPS and battery charger as specified under Clause GS.1.18 in the standard specification shall be installed in this cubicle. The battery shall be installed in a separate cubicle close to the MCC.

Auto Control:

The panel shall be equipped as follows:

1 No. Control circuit HRC fuse
1 No. Neutral link

PS 19.7 FAT (Factory acceptance test)

A factory acceptance test shall be carried out at the manufacturer's facility.

The following will be required:

- Insulation test at 1000V of busbars and mains wiring.
- Current injection to maximum rating of incoming circuit breaker on busbars.
- Current injection on each starter's main circuit.
- IP rating confirmation.
- Verification that all components comply with specification.
- Full functionality test.
- Any other tests the client may consider necessary to establish that the MCC as a whole is functioning correctly and in accordance with the specification.
- Routine test report must be issued to the engineer on completion of the FAT.

The manufacturer shall give the engineer at least seven working day notice prior to FAT.

In the event any of the MCC's failing the test and having to be re-tested, at some future date, all expenses (including time, meals and travelling) incurred by the engineer in attending the second test will be to the manufacturer's account.

PS 19.8 SAT (Site Acceptance Test)

On completion of the electrical installation of the MCC's on-site, the following tests shall be carried out:

- All tests done during the FAT.
- Any other tests the client may consider necessary to establish that the MCC's as a whole are functioning correctly and in accordance with the specification, including programming, testing and commissioning of the PLC and HMI.

PS 19.9 Operating and Maintenance Manuals

The Contractor shall supply three complete comprehensive sets of operating and maintenance manuals complete with schematic control diagrams and complete spare parts list.

The above manuals are to be handed to the authorised representative on completion of the site acceptance test.

In addition a complete schematic diagram of the power and control circuitry is to be left inside the MCC PLC & marshalling compartment.

PS 19.10 Drawings

Within two weeks of the receipt of order the successful tenderer shall submit prints of each of the following drawings for approval:

- General arrangement of the MCC's.
- Wiring diagrams for the complete MCC's.

PS 19.11 Spare parts

Tenderers must give with their tender an assurance that spare parts for the equipment offered are readily available within the Republic of South Africa and to state where these are available.

A spare parts list must form part of the hand-over documentation.

PS 19.12 Guarantee

The tenderer shall guarantee the MCC's for a period of twelve months after first delivery of the MCC's. During the guarantee period the tenderer shall repair any defective material, equipment or workmanship (excepting proven, wilful or accidental damage, or fair wear and tear). These shall be made good with all possible speed at the tenderer's expense and to the satisfaction of the client.

When called upon by the client the tenderer shall make good on site and shall bear all expense incidental thereto including making good of work by others, arising out of removal or reinstallation of equipment. All work arising from the implementation of the guarantee of equipment shall be carried out at times which will not result in any undue inconvenience to users of the equipment or occupants of premises.

If any defects are not remedied within a reasonable time the client may proceed to do the work at the tenderer's risk and expense, but without prejudice to any other rights which the client may have against the tenderer.

The client reserves the right to demand the replacement or making good by the tenderer at his own expense of any part of the tender which is shown to have any latent defects or not to have complied with the specification, notwithstanding that such work has been taken over or that the guarantee period has expired.

Should any specified materials or equipment in the tenderer's opinion be of inferior quality, or be unsuitably employed, rated or loaded, the tenderer shall prior to the submission of his tender advise the engineer accordingly. His failure to do so shall mean that he guarantees the work including all materials or equipment as specified.

PS 20 STANDBY GENERATOR

PS 20.1 Introduction

The generating set shall comprise a diesel engine coupled to an alternator mounted on a common base, a set of starting batteries, automatic charging unit, interconnecting cables, a control panel housing the generator switchgear and generator controller and all necessary control gear.

PS 20.2 Detailed Scope of Work

The contract comprises of the manufacture, testing, delivery, rigging, commissioning and hand-over of the generating set (diesel engine coupled to an alternator mounted on a base mounted fuel tank).

This includes the items below and details further mentioned.

- 400kVA diesel generating set (diesel engine coupled complete with base tank, 1.6mm 3CR12 enclosure, generator controller, 4-pole change-over switch and related switchgear).
- Minimum 800 litre base mounted tank (or sufficient for 8 hours running if more than 800 litres) complete with all hoses and fuel level indicator.
- Drawings for approval prior to construction.
- Wiring diagrams indicating generator controller, switchgear and other auxiliary equipment for approval prior to construction.
- Factory acceptance test at the manufacturer's facility.
- Inspecting and liaising concerning concrete plinth provided with builder on site. Plinth and bund wall to be built to civil engineer specifications, using generator supplier recommendations.
- Delivery, offloading and rigging into position on site.
- Site acceptance test after delivery.

- First fill of diesel after site acceptance test.
- Routine test report and declaration of conformity to SANS 10142-1 & SANS 61439.

PS 20.3 Enclosure

The generating set must be installed in a sound attenuated 1.6mm 3CR12 canopy.

A 3CR12 duct shall be provided and installed between the radiator face and attenuated outlet opening to positively duct the hot expelled air out of the canopy. This will also function as a fire wall between the exhaust compartment and engine bay.

The enclosure including control panel must be powder coated Electric orange.

The enclosure must be weather proof and all joints must be bolted together (no pop-rivets will be accepted).

All joints must be filled with black silicone.

All bolts, nuts and hinges will be stainless steel.

All covers and doors must be fitted with neoprene gaskets.

All necessary safety and warning labels must be installed as per engineer's requirements.

PS 20.4 Rating & operational requirements

The rating of the diesel generating set shall be based on operation of the set when equipped with all necessary accessories such as radiator fan, air cleaners, lubricating oil pump, fuel transfer pump, fuel injection pump, water circulating pump and battery charging alternator.

The diesel generating set and its ancillary equipment shall normally operate as an automatic mains failure unit. It shall be capable of delivering its full rated output at any time and any ambient conditions likely to occur at the site.

The generator will be used to start (and run) various motors and other loads. It is the tenderers responsibility to familiarize himself/herself with the motor list and starting methods at time of tender. Should the tenderer feel that the 400kVA generator is not suitable for starting and running the motors and other loads, the tenderer shall offer a bigger generating set. The tenderer will not offer a smaller generating set. Should the tenderer choose to offer a 400kVA generating set, the Engineer will automatically assume that the motor list, starting and running currents of the motors and other loads have been considered. The starting, running of motors and other loads will be verified during the site acceptance test.

PS 20.5 Site specific supply

The system to which the generating set is to be connected is 3 phase, 4 wire, 400/230V with a frequency of 50 Hz.

PS 20.6 Diesel engine

The engine shall be of the multi cylinder, four stroke cycle, cold starting, direct injection, compression ignition type, suitable for operation on diesel fuel.

The engine shall be of the water cooled type and the cooling system shall be of sufficient capacity to cool the engine when the set is delivering its full rated load at the ambient site conditions.

The engine shall be equipped with a heavy duty type radiator complete with engine driven fan and centrifugal water circulating pump and a thermostat to maintain the engine at the manufacturer's recommended temperature level.

A thermostatically controlled immersion heater shall be provided and fitted in the engine cooling circuit to ensure easy starting of the engine at any ambient temperature.

The heater shall be so fitted that it can easily be withdrawn without having to drain the system. The heater shall be suitable for a 220 volt 50 Hz supply. The heater shall be supplied from a dedicated MCB in the control panel.

The engine speed shall not exceed 1 500 R.P.M. at normal full load conditions.

The engine shall be capable of satisfactory performance on a commercial grade of distilled petroleum fuel (commercial grade diesel fuel).

The engine shall be suitable for continuous running at the specified speed, delivering its rated output at the specified site conditions.

In addition the engine shall be capable of delivering 110 % load for one hour, after the set has been running at full load for a period of six hours and shall, after the overload period of one hour be capable of maintaining the rated output continuously without any undue mechanical strain, overheating, incomplete fuel combustion or other ill effects.

The engine shall have sufficient capacity to start up and shall within 15 seconds from mains failure, supply the full rated load at the specified voltages and frequency.

The engine shall be controlled by an electronic governor to maintain governed speed for 50 Hz operation.

The engine shall be provided with a forced feed lubricating system with a gear type lubricated oil pump for supplying oil under pressure to the main bearings, crank pin bearings, pistons, piston pins, timing gears, camshaft bearings, valve rocker mechanism and all other moving parts.

The engine shall be provided with one or more dry type air cleaners which shall provide positive air filtration.

The engine shall be fitted with an efficient stainless steel exhaust system. Flexible bellows shall be fitted between the exhaust outlet and the silencer. The flexible piping will not be used to form a bend or compensate for misalignment. The silencer and discharge piping shall be of the high efficient type and shall be suitably supported. The internal and external part of the exhaust pipe shall be suitably lagged.

The flywheel shall be designed to limit the cyclic irregularities within the required limits.

The engine shall be equipped with a 24 volt starting system of sufficient capacity to crank the engine at a speed, which will allow starting of the engine.

The starting equipment shall include a 24 volt D.C. starter motor engaging directly on the flywheel ring gear. A heavy duty battery charging alternator and maintenance free batteries shall be supplied.

The batteries shall be connected to the engine with suitably rated P.V.C. insulated flexible leads.

The batteries shall have sufficient capacity to provide three automatic attempts to start immediately followed by three manual attempts without any appreciable drop in voltage. The automatic attempts to start shall each be of not less than 10 seconds duration with 10 second intervals between and the manual attempts shall be based on the same cranking period.

A device shall be provided to limit the cranking time of each automatic attempt to start, to the 10 seconds specified above and to provide three automatic attempts after which the automatic starting mechanism will cut out until manually reset. The engine driven battery charging alternator shall have sufficient capacity to recharge the batteries back to normal starting requirements in not more than six hours.

A battery charging unit of the trickle charge type shall be provided to maintain the batteries at full capacity. The charging equipment shall be connected so that the battery is normally charged from the mains, but is also charged under mains failure conditions from the diesel generating set and if required via an inhibitor relay to prevent dual charging. The charging unit shall be incorporated in the diesel generator control cabinet.

PS 20.7 Alternator / AC Generator

The alternator / AC generator shall be a 400/230 volt, 3 phase, 4 wire 50 Hz machine rated 400kVA at no more than 0.8 power factor. The generator rating shall be applicable for continuous service application.

The alternator / AC generator shall be a revolving field type, coupled directly to the engine flywheel through a flexible disc for positive alignment. The alternator / AC generator housing shall bolt directly to the engine flywheel housing and shall be equipped with a heavy duty ball bearing support for the rotor. The motor shall be dynamically balanced up to 25 % over-speed.

The alternator / AC generator shall be of heavy duty compact design and insulation shall be Class H.

The alternator / AC generator field excitation shall be performed by a rotating exciter mounted on the generator motor shaft through a brushless rotating diode system. The voltage regulator shall be of the static-magnetic type with silicon diode control. It shall be mounted on the top or side of the generator and enclosed in a drip proof enclosure. A built in voltage adjusting rheostat shall provide 10 % voltage adjustment.

The alternator / AC generator shall be capable of continuously delivering the full rated load specified and of providing a 10 % overload for the period and in the manner specified for the engine.

The alternator / AC generator shall be self-regulated and shall incorporate an automatic voltage regulator.

The voltage regulation shall not exceed ±2,5% from no load to full load, including cold to hot variations at any power factor between 0,8 lagging and unity and inclusive of speed variations.

Upon application of full load at a power factor of 0,8 lagging the alternator voltage shall recover to within 2,5% of the steady state value within approximately 300 milliseconds.

Upon application of any load specified in transient, maximum voltage dip shall not exceed 20% of the nominal voltage when measured at the alternator terminals.

The alternator / AC generator stator windings shall be star connected with the star point brought out and connected to the neutral terminal in the terminal box on the generator to provide a 400/230V, 50Hz supply.

The terminal box shall be sized to suit the interconnecting cables between the alternator and canopy mounted control panel.

The alternator / AC generator shall be suitably suppressed against radio and television interference.

PS 20.8 Base / Fuel tank

A steel fabricated base-frame (incorporating the day fuel tank) with anti-vibration mounts. The day tank shall be an integral part of the base frame of the generator set. The tank shall have sufficient capacity to run the engine on full load for a minimum period of 8 hours between the engine-alternator combination and base shall be provided and must be able to be placed directly on the concrete slab. Notwithstanding the above, the minimum size shall be 800 litres.

The tank shall be fitted with a suitable filter, electronic gauge, removable inspection cover, drain and filler cap.

The set shall be supplied with a hand operated pump and suitable length of oil resistant hose. The hose shall be of the “push lock” type and shall be sufficient in length to extend for filling from 200 litre drums.

A tank mounted breather pipe shall be installed.

PS 20.9 Control Panel

A fully automatic change-over system must be provided to isolate main supply and connect standby set to the load in case of main failure. This procedure must be reversed on return of mains supply.

The switchgear for this system must be electrically and mechanically interlocked in a safe and fail-proof way to prevent the alternator from being switched onto mains and vice versa.

The control panel shall be of robust construction, totally enclosed and dust proof. Special attention shall be given to vermin proofing and dust sealing.

It shall be of folded 1,6 mm 3CR12 thick cold rolled sheet steel construction suitable for front entry through hinged doors. Internal chassis plates, circuit breaker pans and gland plates shall be provided.

All bus-bars and wiring shall be adequately rated and suitably supported, and control wiring shall be neatly laced and numbered with durable plastic ferrules, for easy tracing. Suitable terminals are to be provided for incoming and outgoing cables.

Busbars will be rated at 1.6A/mm^2. This will include the phase, neutral and earth busbars. Neutral and earth busbars will be of the same rating as the phase busbars.

Suitably sized holes shall be punched in the gland plates for the required number of cable terminations for both incoming and outgoing cables. The gland plate shall be suitably braced to prevent distortion after the cables are glanded thereto.

Tenderers must give an assurance with their tender that replacements for the equipment, switchgear and instruments used in the construction of the panel are readily available from stock held in the Republic of South Africa.

PS 20.10 Electrical Installation

All cables to and from the generating set panel must be supplied and installed by the Electrical contractor appointed to the project. It is assumed that the Electrical contractor may sub-contract the supply and installation of the generator. However, the Electrical contractor is at liberty to complete the generator supply and installation without using a sub-contractor, whilst meeting the requirements of this specification.

Allowance for correspondence and site meetings must be allowed for by the tenderer.

The tenderer shall ensure that the mains and generator phase rotations are identical before the site acceptance test and must be confirmed during the test.

PS 20.11 FAT (Factory acceptance test)

A factory acceptance test shall be carried out at the manufacturer's facility to establish that the diesel generating set and its ancillary equipment meets with the requirements of the specification.

The fuel required for the FAT must be allowed for in the tendered value.

The manufacturer must provide the required load for all the testing listed below. The cost of hiring load banks etc. to comply with the testing listed below must be included in the tendered value.

The manufacturer shall give the engineer at least seven working day notice prior to testing the generating set.

In the event of the generating set failing the test and having to be re-tested, at some future date, all expenses (including time, meals and travelling) incurred by the engineer in attending the second test will be to the manufacturer's account.

FAT must include the following:

- Simulate a mains failure to automatically start the generating set from cold to test its ability to attain full rated speed and voltage and assume the full load in the specified time of ten seconds.
- Run the generating set at full load per phase for a period of one hour.
- Immediately after the above specified run, without stopping the generating set, run it for a further hour at 110 % load per phase.
- Test the generating set with regards to voltage dip, voltage and frequency recovery, with a sudden application of various loads.
- Test and demonstrate (by simulation only where actual Conditions could damage the generating set and its ancillary equipment) the correct operation of the engine safety controls and alarms.
- Any other tests the client may consider necessary to establish that the diesel generator and its ancillary equipment as a whole is functioning correctly and in accordance with the specification.
- The manufacturer will have a dedicated test sheet for testing generating sets that must be completed during the FAT. This test sheet should include voltage, currents, frequency, temperatures, pressures etc.

PS 20.12 SAT (Site acceptance test)

The fuel required for the SAT must be allowed for in the tendered value. Further to this, the generating set shall be filled to 100% capacity after the SAT for hand-over. The cost for this must also be included in the tendered value.

On completion of the electrical installation of the generating set on site, the following tests shall be carried out:

- All tests done during the FAT.
- Any other tests the client may consider necessary to establish that the diesel generator and its ancillary equipment as a whole is functioning correctly and in accordance with the specification.

PS 20.13 Operating and maintenance manuals

The provisions of SPEC GM shall apply regarding provision of O&M Manuals.

In addition, a complete schematic diagram of the power and control circuitry is to be left inside the control panel.

PS 20.14 Drawings

Within one week of the receipt of order the successful tenderer shall submit prints of each of the following drawings for approval:

- General arrangement of the generating set switchboard front panel.
- Schematic of the complete electrical systems, including starter motor, battery and automatic battery charger.
- Dimensioned layout of the generating set in the canopy.

PS 20.15 Spare parts

Tenderers must give with their tender an assurance that spare parts for the plant offered by them as a whole are readily available within the Republic of South Africa and to state where these are available.

A spare parts list must form part of the hand-over documentation.

PS 20.16 Guarantee

The tenderer shall guarantee the generating set for a period of twelve months after first delivery of the plant. During the guarantee period the tenderer shall repair any defective material, equipment or workmanship (excepting proven, wilful or accidental damage, or fair wear and tear). These shall be made good with all possible speed at the tenderer’s expense and to the satisfaction of the client.

When called upon by the client the tenderer shall make good on site and shall bear all expense incidental thereto including making good of work by others, arising out of removal or reinstallation of equipment. All work arising from the implementation of the guarantee of equipment shall be carried out at times which will not result in any undue inconvenience to users of the equipment or occupants of premises.

If any defects are not remedied within a reasonable time the client may proceed to do the work at the tenderer’s risk and expense, but without prejudice to any other rights which the client may have against the tenderer.

The Employer reserves the right to demand the replacement or making good by the tenderer at his own expense of any part of the tender which is shown to have any latent defects or not to have complied with the specification, notwithstanding that such work has been taken over or that the guarantee period has expired.

Should any specified materials or equipment in the tenderer's opinion be of inferior quality, or be unsuitably employed, rated or loaded, the tenderer shall prior to the submission of his tender advise the engineer accordingly. His failure to do so shall mean that he guarantees the work including all materials or equipment as specified.

PS 21 MEASUREMENT & PAYMENT

PS 21.1 General

Electrical supply and installation and acceptance testing work shall be measured for payment in the units as indicated in the Bill of Quantities. The rates tendered shall cover all costs associated with the supplying and installing the billed item.

Payment for commissioning of the Works as a whole will be made in terms of the relevant clauses in SPEC MG : GENERAL MECHANICAL.

PS 21.2 Prime Cost Items

The following electrical items will be paid for as Prime Cost items with a percentage mark-up for Contractor's charges and profit (choice of unit to be the subject of discussions with the Employer and Engineer and agreed upon before purchase):

- The PLC controlling all process functions (including filter backwashing).

With the exception of the telemetry equipment, the cost of delivering to Site, installing, programming, wiring-up connections, testing, commissioning and maintenance over the Defects Liability Period etc shall be covered by other scheduled items.

C3.3: STANDARD SPECIFICATIONS

C3.3.1 AMENDMENTS TO SANS 1200

PSA GENERAL (SANS 1200 A)

PSA 2 Interpretations

PSA 2.2 Applicable edition of standards

Add at the beginning of SANS 1200 A, sub-clause 2.2:

"Unless a specific edition is specified (see the List of Applicable Specifications)"

PSA 2.3 Definitions

Add at the beginning of SANS 1200 A, sub-clause 2.3:

"The terms "ESCOM", "ESC" and "Electricity Supply Commission" shall mean "Eskom".

GCC: General Conditions of Contract (2015)"

PSA 2.4 (b) Abbreviations

Add the following to SANS 1200 A, sub-clause 2.4(b):

"Mod AASHTO: Modified AASHTO maximum dry density".

PSA 2.8.1 Principal

In the fourth line of SANS 1200 A, sub-clause 2.8.1, after the word "specification", **add**: "or in the measurement and payment clause of the standard specification, particular specification or project specification".

Add the following to SANS 1200 A, sub-clause 2.8.1:

"Items which are designated as provisional quantities or provisional sums in the Bill of Quantities are intended to provide for works, the need or extent of which shall be established by the Employer's Agent during construction. Work Scheduled as such shall only be undertaken on the written instruction of the Employer's Agent and, where applicable, shall be paid for at the tendered rate or in the absence of rates shall be valued in accordance with Clause 6.4 of the General Conditions of Contract.

The Bill of Quantities shall not be used for ordering purposes and no liability or responsibility shall be admitted by the Employer's Agent in respect of materials ordered or procured by the Contractor on the basis of the Bill of Quantities."

PSA 2.8.2 Preliminary and general section

Add the following to SANS 1200 A, sub-clause 2.8.2:

"In addition, the sum tendered shall cover all initial costs incurred in complying with the requirements of:

- Contract Specific Data _ C1.2
- Scope of Work_C3
- Site Information_C4

Facilities for the Contractor shall include all the costs of providing water for construction other than the water required for watertightness testing of water retaining structures. Water for such tests will be measured according to PSG 7.2.5 Testing watertight concrete.

The Contractor is to make his own arrangements with the eTHEKWINI MUNICIPALITY for water and sanitation connections."

Add the following new sub-clause to SANS 1200 A, sub-clause 2.8:

***PSA 2.8.3 Time-related items**

"The Contractor shall tender a lump sum in the Bill of Quantities to cover his time-related establishment costs. The amount tendered and paid shall be full compensation to the Contractor for:

i) The maintenance of his whole organization as established for this Contract.

ii) The maintenance of all insurances, indemnities and guarantees required in terms of the Conditions of Contract or Tender, where applicable.

iii) Compliance with all general conditions and requirements which are not specifically measured elsewhere for payment in these Contract Documents.

The Contractor shall tender a lump sum for the above mentioned items.

Payment of the lump sum shall be made monthly in compliance with the method laid down in Sub-clause 8.2.2 of SANS 1200:A. Provided that the total of the monthly amounts, so paid for the item, is not out of proportion to the value of the progress of the works as a whole.

The Contractor will not be paid Time-Related Preliminary and General Charges for any Special Non-Working Days, which shall be deemed to have been allowed for in his rates.

The payment to the Contractor for Time-Related Items shall be adjusted in accordance with the following formula in the event of the Contract being extended by means of a variation order:

$$\boxed{1 \text{ x } \frac{2}{3}}$$

Sum of Tendered amounts for Time Related Items (1)	x	Extension of Time authorised by <u>variation order (2)</u> Tender contract period (3)

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

The abovementioned adjustment of the payment for Time-Related Items shall be made in the Completion Payment Certificate and shall be the only payment for additional Time-Related costs, irrespective of the actual period required to complete

the Contract including its authorised extensions.

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

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

Where extension of time is approved, payment for time-related items shall only be applicable to working days as defined in the Contract."

PSA 3 Materials

PSA 3.1 Quality

Add the following to SANS 1200 A, sub-clause 3.1:

"Where a material to be used in this Contract is specified to comply with the requirements of an SANS Standard Specification, and such material is available with the official SANS mark, the material used shall bear the official mark.

The Contractor shall submit in good time, before any construction commences, to the Employer's Agent on site samples of all materials intended to be incorporated into the works. The samples shall be accompanied by results of tests undertaken by an approved independent laboratory on the samples in question on behalf of the Contractor and at his cost, before consideration by the Employer's Agent.

The Employer's Agent, during construction, will take independent samples from stockpiles of proposed construction materials on site and from the completed works. Approval will not be granted for samples delivered by the contractor directly to the Engineer's office. The Contractor shall be responsible for the cost of all failures on test samples and control testing.

All pipes, fittings and materials used in the Works, must bear the official standardisation mark of Standards South Africa where applicable. The mark on a pipe shall be visible from above after the pipe is laid.

Rubber articles, including pipe insertion or joint rings shall be stored in a suitable shed and kept away from sunlight, oil or grease.

Large items not normally stored in a building shall be neatly stacked or laid out on suitable cleared areas on the Site. Grass or vegetation shall not be allowed to grow long in the storage areas and the material shall be kept free of dust and mud and be protected from stormwater. Pipes shall be handled and stacked in accordance with the manufacturer's recommendations, special care being taken to avoid stacking to excessive heights and placing over hard objects. uPVC pipes shall be protected from direct sunlight by suitable covers.

Every precaution shall be taken to keep cement dry and prevent access of moisture to it from the time it leaves the place of manufacture until it is required for use on the Site. Cement is to be used on a first in/first out basis. Bags of cement which show any degree of hydration and setting shall be removed from the site of the Works and replaced at the Contractor's own expense. Any cement older than six weeks is to be removed from site.

Materials shall be handled with proper care at all times. Under no circumstances may materials be dropped from vehicles. Large pipes or large plant shall be lifted or lowered only by means of suitable hoisting equipment.

Where propriety materials are specified it is to indicate the quality or type of materials or articles required, and where the terms "or other approved" or "or approved equivalent" are used in connection with proprietary materials or articles, the Contractor is to supply with their tender the name of the manufacturer and supporting documentation that show that the materials or articles comply with the relevant specifications. It is understood that the approval shall be at the sole discretion of the Client and the Employer's Agent.

Irrespective of any approval granted/used by the Employer's Agent or the Employer, the Contractor shall be deemed responsible for all material quality use for construction and their specified performance."

PSA 4 Plant

PSA 4.2 Contractor's offices, stores and services

Add the following to SANS 1200 A, sub-clause 4.2:

"The suitable first aid services required in terms of Sub-clause 4.2 of SANS 1200 A shall include, inter alia, a First Aid cabinet fully equipped and maintained with at least the minimum contents as listed in Regulation 3 of the General Safety Regulations of the Occupational Health and Safety Act, 1993 (Act 85 of 1993), to deal with accidents and ailments which are likely to occur during the construction period."

PSA 5 Construction

PSA 5.1.1 Setting out of the works

Add the following to SANS 1200 A, sub-clause 5.1.1:

"The Contractor shall be fully responsible for the setting out of the works, and where labour intensive work is specified, for the setting out of the daily construction tasks.

The Contractor must, within two (2) weeks after the site has been handed over, ascertain the correctness of all pegs and bench marks. Any discrepancy shall immediately be reported in writing to the Employer's Agent. Any costs or subsequent costs arising from discrepancies which had not been reported to the Employer's Agent, within the aforementioned period, shall be the sole responsibility of the Contractor.

Before commencement of work, the Contractor is to liaise with the Employer's Agent to establish exactly the status of all boundary pegs adjacent to the Works. The position of all erf pegs found must be recorded on a layout print. If any pegs are missing, he shall immediately inform the Employer's Agent in writing.

On completion of the Contract the pegs that have been unavoidably disturbed will be replaced by the Employer. Pegs which have, in the opinion of the Employer's Agent, been disturbed due to the negligence of the Contractor will be replaced by a registered Land Surveyor at the Contractor's cost."

PSA 5.2 Watching, barricading, lighting

Add the following to SANS 1200 A, sub-clause 5.2:

"The Contractor shall employ competent watchmen to guard the Works both by day and night.

From the time any portion of the Works commences, until the Completion of the Works and the issue of the Certificate of Completion of the Works, the Contractor shall be responsible for protecting the property of the Employer and all persons having business on the Site from anything dangerous or likely to cause damage or injury. The Contractor shall take all practical precautions to avoid nuisance or inconvenience to the owners or occupier of properties near to the Site and to the public generally whilst carrying out the Works and shall at all times keep the Site clean and in a safety and satisfactory condition.

Temporary traffic signs shall be erected when work is being done within and adjacent to roadways. The number and layout of the traffic signs shall comply with the Site Manual entitled "Safety at Roadworks in Urban Areas", as published by the Department of Transport. Traffic signs shall have a yellow background with either a red or black border.

The Contractor shall control all access to the site, for authorised persons only, and to ensure that the approved conditions of the Health and Safety Management Plan is adhered to."

PSA 5.4 Protection of overhead and underground services

Add the following to SANS 1200 A, sub-clause 5.4:

"Before construction of the Works, or any phase of the Works, the Contractor shall contact all relevant parties and authority officials to establish the existence of existing services on site. The Contractor shall be responsible for obtaining all necessary wayleaves. No claims shall be lodged by the Contractor for delays in obtaining such wayleaves or permits.

Temporary and permanent alterations made to existing services by the Contractor will be measured and paid under the relevant scheduled items. The length of a service that is re-laid will be measured in its final position.

The sums or rates (as indicated in the Bill of Quantities) shall cover the cost of excavation and backfilling, lifting, recovery of the existing service, laying of the service in the new position, any other related work and materials such as new rubber ring seals, packing, etc., required to complete the alteration.

New material can be used to make up shortfalls resulting from a longer route, existing material damaged during recovery (beyond the control of the Contractor), and other additional work carried out by the Contractor in making permanent alterations. These new materials, for which no scheduled items apply for, will be measured and paid under "SCHEDULE OF DAYWORK RATES".

All additional work to locate and expose the existing service if the existing service is situated further than 2,0 m from the position indicated, (i.e., excluding the initial work within 2,0 m from the indicated position) will be measured and paid under "SCHEDULE OF DAYWORK".

The tendered rates shall further cover the cost of backfilling the excavation with selected material compacted to 90% AASHTO density, keeping the excavation safe and taking care that the services are not damaged in any way. No direct payment will be made for the protection of such services."

PSA 5.5 Dealing with water on works

Add the following to SANS 1200 A, sub-clause 5.4:

"The Contractor shall take all precautions to keep stormwater away from the excavations. He shall deal with all water inclusive of seepage and groundwater, such that construction is not hampered and shall supply and operate all necessary plant.

The cost of supplying and operating the equipment for dewatering of excavations and the controlling of stormwater, shall be covered by the tendered sums in the Bill of Quantities."

Add the following new sub-clause to SANS 1200 A, sub-clause 5.6:

***PSA 5.6.1 Environment management**

"Compliance with the Environment Management Plan of the approved Environmental Impact Assessment Report in terms of the Department of Environmental Affairs and Tourism regulations is a prerequisite for the Contractor.

The Contractor is to price the lump sum provision provided in the Preliminary and General Section of the Bill of Quantities to cover the Contractor's cost for compliance with the requirements of the Environment Management Plan. The cost of producing the Environmental Management Plan as well as training and appointing the necessary personnel to ensure compliance with the required regulations and specifications, shall be included in this lump sum.

A provision for a Time Related Item is made in the Preliminary and General Section of the Bill of Quantities. The amount submitted shall include full compensation for the provision of the training, plans, audits, assessments, administration, etc. and all other costs required for full compliance.

Fines issued for non-compliance will be deducted from these Provisional Sums, but are not limited to the value of the Provisional Sum stated."

PSA 5.7 Safety

Add the following to SANS 1200 A, sub-clause 5.7:

"Compliance with Occupational Health and Safety Act, 1993, the Construction Regulations, 2015, the Employer's Health and Safety Specification and the Construction Environmental Management Plan, is a prerequisite for the Contractor. The Contractor is to price the lump sum provision provided in the Preliminary and General Section of the Bill of Quantities, to cover the Contractor's cost for compliance with the requirements mentioned above. The cost of producing the Contractors Safety Management Plan and Risk Assessment as well as training and appointing the necessary personnel to ensure compliance with the required regulations and specifications, shall be included in this lump sum.

A provision for a Time Related Item is made in the Preliminary and General Section of the Bill of Quantities. The amount submitted shall include full compensation for the provision of the training, PPE's, plans, audits, assessments, administration, etc. and all other costs required for full compliance. Fines issued for non-compliance will be deducted from the above Provisional Sums, but are not limited to the value of the

Provisional Sum stated.

No separate item shall be allowed for in the Bill of Quantities for the accommodation of traffic. The Contractor's movement of construction activities is mainly between the site camp and the construction site which does not cross any municipal roads. In the event that the Contractor need to cross any municipal roads, he will ensure that he takes all necessary precautions for safety which will be deemed included in his rates."

Add the following new sub-clauses to SANS 1200 A, clause 5:

***PSA 5.9 Record drawing information**

"As the Works are progressing, the Contractor shall mark on a special set of drawings, all as-built details and submit the information to the Employer's Agent's Representative for approval on a monthly basis. No extra payment shall be made for preparation of these as-built plans.

The Certificate of Completion shall only be issued once all the as-built information has been received and verified by the Employer's Agent."

***PSA 5.10 Clearance of site on completion**

"The Contractor shall obtain, from each property owner listed in the Project Specification as being affected by the Works, a certificate to the effect that the property owner is satisfied with the standard of reinstatement of any fences, boundary walls or structures, compensation paid for loss or damage to stock, crops or property, material spoiled on their properties or any other condition affecting their properties as a result of the operations of the Contractor.

The Contractor shall further obtain a Clearance Certificate from each authority whose services have been affected or installed during the construction of the works.

All such certificates must be lodged with the Employer's Agent before the Certificate of Completion will be issued."

***PSA 5.11 Community Liaison Officer (CLO)**

"A provisional monthly rate has been included to allow for the salary of a person working full time as the Community Liaison Officer for the duration of the construction on this Contract. The rate also includes for costs such as transport, an office space, communication and any other requirement necessary. The Contractor shall ensure that the salary and other expenses such as payment to the Community Liaison Officer members are paid timeously and recorded. The CLO shall have a Matric (Grade 12) Certificate or equivalent and shall be fluent in English.

A separate item for overheads, charges and profit on the above item is applicable."

***PSA 5.14 ESKOM connection fee**

"A provisional sum has been included to allow for the ESKOM electrical connection at the required points in the works. The sum includes for all work to be carried out by ESKOM."

PSA 6 Tolerances

PSA 6.2 Degree of accuracy

Add the following to SANS 1200 A, sub-clause 6.2:

"The degree of accuracy shall be Degree II except for:

a) Smooth formwork which shall be Degree I."

PSA 7 Testing

PSA 7.1 Testing Principles

Add the following to SANS 1200 A, sub-clause 7.1:

"Every completed layer or section of the Works shall be subject to check testing by the Contractor. Whenever possible the check testing should be done in the presence of the Employer's Agent. Once the Contractor is satisfied with the standard of the Works, the Employer's Agent will be requested to perform acceptance testing for the particular section. When giving notice, the Contractor shall provide the Employer's Agent with the results of the check testing, thus indicating that the Work is to specification. The Employer's Agent shall be given 48 (forty-eight) hours' notice of when testing or inspections are required.

The Employer's Agent may from time to time carry out his own check tests on the work performed by the Contractor. Should these test result differ significantly from the data provided by the Contractor, the quality of the Contractor's control testing can be called into question. Upon such a discovery the Employer's Agent may order further check tests to be carried out on work already completed. All costs associated with such check tests shall be for the Contractor's account, and so shall the costs of any other check tests whose results do not comply with the specification.

Failure by the Contractor to notify the Employer's Agent or to provide the required information or, where specified, to perform the required test, will be grounds to exempt the Employer from payment for the associated work. This exemption is applicable to all subsequent work, which would be affected by the failure of the specific portion not tested.

The Employer's Agent will be under no obligation to the Contractor to perform acceptance tests. If the Employer's Agent elects not to perform a particular test after notification by the Contractor and is satisfied with results of the Contractor's check tests, the Contractor will be issued with a written instruction to proceed with the relevant works without the acceptance test being performed.

Nothing contained in this clause will relieve the Contractor of any responsibilities under the specifications or in any way limit the tests, which the Employer's Agent may call for or perform in terms of the specification.

The Employer reserves the right to recover cost from the Contractor in instances where the Employer's Agent is called to witness certain control tests, such as the pressure testing of a pipeline, and the results of such tests do not comply with the specifications."

PSA 7.2 Approved laboratories

Replace SANS 1200 A, sub-clause 7.2 with the following:

"Acceptance testing shall be done by a laboratory selected by the Employer's Agent. The Employer's Agent requires twenty-four hours' notice from the Contractor in order to perform the relevant acceptance test.

All acceptance testing by the Employer's Agent shall be paid by the Contractor. The costs of such tests which meet the specification requirements will be reimbursed to the Contractor in the monthly payment certificate. This payment shall consist of a billed amount plus the tendered mark-up.

A Provisional Sum has been provided in the Bill of Quantities to allow for the cost of such testing.

The Contractor shall make due allowance for testing procedures in the construction programme."

PSA 8 Measurement and payment

PSA 8.2.2 Time related items

Replace the contents of SANS 1200 A, sub-clause 8.2.2 with the following:

"Payment for time-related items will be effected as follows only after payment for the relevant fixed-charge item has been made: Subject to the provision of 8.2.3 and 8.2.4 payment will be made monthly in equal amounts, calculated by dividing the sum tendered for the item by the tendered contract period in months, multiplied by the months completed, provided always that the total of the monthly amounts so paid for the item is not out of proportion to the value of the progress of the works as a whole."

PSA 8.3 Scheduled fixed-charge and value-related items

SANS 1200 A, sub-clause 8.3 to include payment for:

PSA 2.2 Interpretations
PSA 2.8.1 Principle
PSA 2.8.2 Preliminary and general
PSA 3.1 Quality
PSA 5.1.1 Setting out of the works
PSA 5.2 Watching, barricading, lighting
PSA 5.4 Protection of overhead and underground services.
PSA 6.2 Degrees of accuracy

PSA 8.3.2 Establishment of facilities on thesite

PSA 8.3.2.1 Facilities for engineer

Add the following to SANS 1200 A, sub-clause 8.3.2.1:

a) Furnished office

"The office facilities for the Engineer will include the following:
- Separate Ablution Facilities
- Air conditioning (heating and cooling)

- Kettle and tea cups
- Desk
- Office Chair
- Filing Cabinet
- Drawing Rack
- Office for meetings to accommodate representatives from the Contractor, Employer, Employer's Agent and other relevant stakeholders."

b) Telephone

"The Contractor shall provide a cellular phone for the sole use of the Employer's Agent or his Representative."

d) Covered parking bay

"The Contractor shall also supply and maintain two corrugated iron covered carports with closed sides and gravelled floor for the sole use of the Employer's Agent's Representative and the Employer."

PSA 8.3.2.2 (a) Offices and storage sheds

Add the following to SANS 1200 A, sub-clause 8.3.2.2 (a):

"The tendered rate shall include payment for the site establishment for all temporary facilities required to undertake the work, as per PSA 4.2. The cost security to the site will be deemed as inclusive in the rates, and will not be measured separately."

PSA 8.3.2.2 (h) Dealing with water

Add the following to SANS 1200 A, sub-clause 8.3.2.2 (h):

"The tendered rate shall include payment for PSA 5.5."

PSA 8.3.3 Other fixed charge obligations

Add the following to SANS 1200 A, sub-clause 8.3.3:
"The rates are to include for the following:

*PSA 5.6.1 Environmental Management
PSA 5.7 Safety
*PSA 5.11 Community liaison officer
*PSA 5.12 Connection into existing sewers
*PSA 5.13 Relocation of existing services"

PSA 8.3.4 Removal of site establishment

Add the following to SANS 1200 A, sub-clause 8.3.4:

"The Tendered rate shall cover the cost of site removal of all temporary facilities required to undertake the work, as per PSA 4.2 and the rate shall include payment for *PSA 5.10."

PSA 8.4 Scheduled time-related items

Add the following to SANS 1200 A, sub-clause 8.4:

"The tenderer rates are to include for *PSA 2.8.3."

PSA 8.4.2.1 Facilities for the Engineer

Add the following to SANS 1200 A, sub-clause 8.4.2.1:

b) Telephone

"The Contractor shall provide a cellular phone for the sole use of the Employer's Agent or his Representative for the duration of the Contract."

d) Covered parking bay

"The Contractor shall also supply and maintain two corrugated iron covered carports with closed sides and gravelled floor for the sole use of the Employer's Agent's Representative and the Employer."

PSA 8.4.2.2 (a) Offices and storage sheds

SANS 1200 A, sub-clause 8.4.2.2 (a) to include payment for:

PSA 4.2 Contractor's offices, stores and services

PSA 8.4.2.2(h) Dealing with water

SANS 1200 A, sub-clause 8.4.2.2 (h) to include payment for:

PSA 5.5 Dealing with water on works

PSA 8.4.3 Supervision for duration of construction

SANS 1200 A, sub-clause 8.4.3 to include payment for:

*PSA 5.9 Record drawing information
PSA 6.2 Degrees of accuracy
PSA 7.1 Testing principals
PSA 3.1 Quality
PSA 5.1.1 Setting out of the works
PSA 5.2 Watching, barricading, lighting
PSA 5.4 Protection of overhead and underground services

PSA 8.4.5 Other time-rated obligations

SANS 1200 A, sub-clause 8.4.5 to include payment for:

*PSA 5.6.1 Environmental management
PSA 5.7 Safety
*PSA 5.11 Community liaison officer

PSA 8.5 Sums stated provisionally by engineer

Replace the second last sentence of SANS 1200 A, sub-clause 8.5 to read:

"The percentage rate for (b) (2) above shall cover the Contractor's overheads, charges and profit on the work covered by the sums provisionally stated for (b) (1) above. Payment will be made on the basis of the sums actually paid for such work, exclusive of VAT."

Add the following to SANS 1200 A, sub-clause 8.5 (b):

“The tendered rates are to include payment for PSA 7.2.”

PSA 8.6 Prime cost items

Replace the second last sentence of SANS 1200 A, sub-clause 8.6 to read:

"The percentage rate for (b) shall cover the Contractor's overheads, charges for taking delivery and profit on the supply of materials or goods covered by the sums stated in (a) above. Payment will be made on the basis of the sums actually paid for such materials or goods, exclusive of VAT."

PSA 8.7 Daywork

Add the following to SANS 1200 A, sub-clause 8.7:

“The rates submitted by the Tenderer in the relevant Bill of Quantities shall be applicable.

If a work item exists in the main tender the Employer’s Agent may decide to use it instead of resorting to Dayworks.

Provisional items for Daywork are scheduled as follows:

a) Labour at hourly rates for skilled, semi-skilled and unskilled labourers.

b) Material as a Provisional Sum inclusive of a percentage allowance on the net cost.

c) The Contractor's own plant as a Provisional Sum.

Tendered unit rates or unit rates that are agreed in terms of sub-clause 6.5.1.3 of the General Conditions of Contract for the Contractor's own plant used for Daywork shall cover the full cost of the use of such plant and shall, in addition, cover the cost of plant operators, consumable stores, fuel and maintenance.

The Contractor will be paid the actual net cost of plant hired by him for Daywork and in addition will be paid a percentage allowance on the net cost of such hire, which allowance will cover the Contractor's own overhead costs and profit.”

PSA 8.8.2 Accommodation of traffic

Add the following to SANS 1200 A, sub-clause 8.8.2:

“No separate item shall be allowed for in the Bill of Quantities for the accommodation of the contractor’s traffic. The Contractor’s movement of construction activities is mainly between the site camp and the construction site. In the event that the Contractor need to cross any municipal roads, he will ensure that he takes all necessary precautions for safety which will be deemed included in his rates."

Add the following new sub-clause to SANS 1200 A, clause 8:

***PSA 8.9 Environmental Control Officer (ECO)**

"A provisional sum of R17 000.00 per month must been provided, to pay the Environmental Control Officer (ECO) for undertaking the environmental audits of the site and work done. The Contractor is required to basically enter into a contract, with the ECO to provide this service. Payment will be made to the Contractor against this item on receipt of the ECO's monthly report.

The Contractor will be required to pay the ECO the sum in each certificate within 7 days of receipt of payment by the Employer. A penalty, equal to the amount due to the ECO, will be charged to the Contractor for failure to pay the ECO within 7 days of him receiving payment from the Employer. This penalty will be doubled to twice the amount due to the ECO, should the ECO not receive payment within 14 days of the Contractor receiving payment from the Employer. The penalty will not be reversed once payment to the ECO has been made."

PSAB ENGINEER'S OFFICE (SANS 1200 AB)

PSAB 3 MATERIALS

PSAB 3.1 Nameboards

Adjust the first sentence of the first paragraph of SANS 1200 AB, sub-clause 3.1 to read as follows:

Delete: "The standard board of the South African Institution of Civil Engineers" **and replace by:** "the standard nameboard of the eTHEKWINI MUNICIPALITY's Employer's Agent, all in accordance with standard drawing issued by the Employer's Agent."

Add the following the following to SANS 1200 AB, sub-clause 3.1:

"Two Employer's nameboards shall be erected within one month of the commencement of construction and shall be placed where ordered by the Employer's Agent. Any damage to this board shall be repaired within 14 days of a written instruction received from the Employer's Agent. The cost of the repair will be for the contractors account.

Erection of two Contractor's nameboards of maximum size 2.5 x 3 m will be allowed in the area of the Works, at positions approved by the Employer's Agent, who may at any time order their removal if any objections are received.

Sub-contractor's boards may be erected if sanctioned by the Employer's Agent. All nameboards shall be removed 14 days prior to the date of the Final Approval Certificate."

PSAB 3.2 Office building

Adjust the first sentence of the first paragraph of SANS 1200 AB, sub-clause 3.2 to read as follows:

"The Contractor shall supply, erect, maintain and service two offices with adequate lighting for the sole use of the Employer's Agent's Representative and the Employer."

The furniture stated in SANS 1200 AB, sub-clause 3.2, (a..... j) shall be replaced by the following items to be provided per site office:

a) One desk (1.5m x 0.9m) with at least one lockable drawer and 3 office chairs
b) One plans table (2 m long x 1 m wide x 0.9 m high) suitable for working with AO drawings plus one high stool.
c) One A0 plan rack and hangers to accommodate 30 drawings hanging vertically.
d) One lockable upright steel cabinet with three shelves or a lockable steel filing cabinet with four drawers
e) At least four metres of file/book shelving.
f) One noticeboard/pin-board of 2 m^2 size
g) One whiteboard of 2 m^2 size with 3 coloured markers and duster
h) Two independent power points, each supplied with a four plug extension cord
i) One suitable electrical heater/air conditioner
j) Adequate equipment and provisions for making tea or coffee.
k) One small electric refrigerator.
l) One small microwave oven.
m) An acceptable blind on each window.
n) A wash-hand basin inclusive of all necessary plumbing, soap and paper towels.

o) Acceptable lighting

Add the following to SANS 1200 AB, sub-clause 3.2:

"The Contractor shall also supply and maintain two corrugated iron covered carports with closed sides and gravelled floor for the sole use of the Employer's Agent's Representative and the Employer.

The Contractor shall also supply, maintain and service a boardroom for 20 m^2 minimum floor area able to seat 10 people for joint use by him, the Employer's Agent's Representative and the Employer. This room shall be equipped with adequate lighting, chairs, tables, a 2 m^2 noticeboard, a 2 m^2 whiteboard with stationary and air-conditioning."

PSAB 4 PLANT

PSAB 4.1 Telephone

Replace SANS 1200 AB, sub-clause 4.1 with the following:

"Mobile phone
The contractor will be required to supply the Employer's Agent's Representative with a new mobile phone inclusive of sim card as soon as the contract has commenced and pay for all calls made from this phone up to a maximum amount of R1500.00 per month.

Telephone, Fax and Mobile Network
The contractor shall supply a site telephone, fax, photocopier and a reliable ADSL facility for use by the Employer's Agents Representative for the duration of contract. The Contractor shall be responsible for the cost of all calls, installation, rental, supplies, maintenance, etc.

The ADSL facility may require a separate installation with modem from 8-ta, Space Stream or V-Sat.

Add the following new sub-clauses to SANS 1200 AB, clause 4:

***PSAB 4.2 Computer**

"A provisional sum of R36000.00 is to be allowed for the purchase of a computer, printer, scanner and copier, with required software for full functionality of all hardware, for the exclusive use of the Employer's Agent's Representative for the duration of the contract."

***PSAB 4.3 Survey equipment**

"The Contractor shall upon request provide the following survey equipment on the Site from commencement to the completion of the Works.

(a) 1 Employer's Agents level and levelling staff.
(b) 1 steel tape of 100 m length and measuring wheel.
(c) Wooden and steel pegs and hammers as required.

The equipment shall be provided for the exclusive use of the Employer's Agent's Representative. The Contractor shall keep the equipment continuously insured against any loss, damage or breakage, and he shall indemnify the Employer's Agent and the Employer against any claims in this regard. The Contractor shall also maintain the equipment in good working order throughout the Contract period.

The following additional equipment/service may be required from time to time by the Employer's Agent's Representative and shall be supplied by the Contractor when required. The equipment/service may be shared with the Employer's Agent's Representative.

(d) Two chainmen to assist with levelling and surveying;
(e) Theodolite and prism;
(f) Spray paint (selected colour)

Upon completion of the whole of the Works, ownership of the above equipment shall revert to the Contractor."

***PSAB 4.4 Site instruction books and daily site diary**

"The Employer's Agent shall supply a site instruction book for specific use on the Site. All instructions given by the Employer's Agent's Representative must be confirmed and countersigned by the Employer's Agent.

The Contractor shall supply a triplicate book for site correspondence and inspection requests to the Employer's Agent's Representative. Reasonable notice time shall be allowed prior to inspections. All inspections requests and approval/disapproval thereof shall be recorded by the Site staff in writing.

The Contractor in conjunction with the Employer's Agent must ensure that a suitable site quality record system is put in place to record that each section complies with the relative works specification.

The Contractor and the Employer's Agent shall keep a daily diary recording all the pertinent information and sign acceptance of each other's record on a daily basis. The daily record is to include weather conditions, any other factor that may affect the progress, labour on site, activity in progress, materials delivered, delays including reasons, site instructions received, plant on site and remarks pertaining to any other event on site."

PSAB 8 Measurement and payment

PSAB 8.2 Payment

SANS 1200 AB, sub-clause 8.2 to include payment for:

PSAB 3.1 Nameboards
PSAB 3.2 Office building
PSAB 4.1 Telephone
PSAB 4.2 Computer
PSAB 4.3 Survey equipment
PSAB 4.4 Site instruction book and daily site diary

Add the following new sub-clauses to SANS 1200 AB, clause 8:

***PSAB 8.3 Electronic equipment for the Employer's Agent**

"The Contractor will provide various items of electronic equipment for the exclusive use by the Employer's Agent and his site staff, to assist in the administration of the Contract, for the duration of construction. The equipment may include a digital camera(s), computer(s), software, printer(s), GPS, cellphones and related consumables.

The equipment shall remain the property of the Employer's Agent during the execution of the project, where after ownership will revert to the Employer. The Contractor shall have no obligation other than the payment in terms of PSAB 8 2."

***PSAB 8.4 Accommodation for the Employer's Agent's staff**

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

***PSAB 8.5 Environmental monitoring**

"The Contractor shall pay the monthly invoice and shall recover the same from the Employer under the relevant item in the Bill of Quantities.

The Contractor's overheads and profit on the above monthly payments will be paid at the tendered percentage mark-up on the payments made. "

PSC SITE CLEARANCE (SANS 1200 C – 1980 AS AMENDED 1982)

PSC 3 Materials

PSC 3.1 Disposal of material

Add the following to SANS 1200 C, sub-clause 3.1:

"Unless otherwise ordered by the Employer's Agent, the Contractor shall dispose of material resulting from clearing and demolition operations at a site to be determined by the Contractor. Such a site shall have the approval of the Employer's Agent, the Local Authority and the Environmental Officer. Payment for the clearing, loading, transport, dumping fees and any other requirement or costs incurred shall be included in the rate submitted."

PSC 5 Construction

PSC 5.1 Areas to be cleared and grubbed

Add the following to SANS 1200 C, sub-clause 5.1:

"All areas to be constructed on, inclusive of a two metre strip round the perimeter of each structure, shall be cleared and grubbed. A strip up to 1.5m wide on either side of the trench edges of the pipes shall be cleared and grubbed.

For the access and site roads the width of clearing shall only be sufficient for the construction of the road i.e. for the cut and fill operations and allowing for side slopes or as amended by the Employer's Agent.

No trees with a trunk girth of more than 1 m shall be removed without the written permission of the Employer's Agent."

PSC 5.2.3.2 Individualtrees

Delete the second sentence of SANS 1200 C, sub-clause 5.2.3.2 and substitute the following:

"The amount of the penalty payable by the Contractor for the removal or damage by him of a tree designated for preservation shall be R1000 for each tree having a girth of less than 1000mm and R2 000 for each tree having a girth of 1000mm or more."

PSC 5.4 Grubbing

In the fourth line of SANS 1200 C, sub-clause 5.4 delete: "200 mm" **and substitute:** "300mm"**.**

PSC 5.6 Conservation of topsoil

Add the following to SANS 1200 C, sub-clause 5.6:

"The topsoil up to a depth of 150 mm, if available and approved by the Employer's Agent, shall be removed from the above specified cleared areas and stockpiled not higher than 2m on approved sites for later reuse. Until required for spreading, the stockpiles of topsoil material shall be stabilized by watering or other approved means to limit dust pollution.

When in the opinion of the Employer’s Agent, there is an insufficient quantity of topsoil available as a result of the Contractor's failure to comply with the above, the Contractor shall import approved topsoil at his own cost.”

PSC 8 Measurement and payment

PSC 8.2.1 Clear and grub

Add the following to SANS 1200 C, sub-clause 8.2.1:

“The rate tendered for clearing and grubbing shall cover the cost of disposal of the material off the Site by approved means. Debris should be dealt with as per PSC 3.1, as amended.

The area to be cleared and grubbed will be measured by area and will include trees up to 1.0 m girth.

The rate tendered for will include payment for PSC 5.1, as amended.”

Add the following to SANS 1200 C, sub-clause 8.2.1:

“Unit: m^2”

PSC 8.2.5 Take down existing fences

Add the following to SANS 1200 C, sub-clause 8.2.5:

“Unit: m”

PSC 8.2.10 Remove topsoil to nominal depth of 150mm and stockpile

Add the following to SANS 1200 C, sub-clause 8.2.10:

“The rate tendered for the removal of in-situ topsoil shall also cover the cost of stabilizing and protecting the stockpiles of topsoil and include payment for PSC 5.6, as amended.

The rate shall also cover the cost of loading, hauling, spreading to a compacted thickness of 150 mm and making suitable provision to avoid the topsoil slipping down the slopes of embankments and cut-slopes, all to the approval of the Employer’s Agent.”

PSD EARTHWORKS (SANS 1200 D - 1988 as amended 1990)

PSD 2 Interpretations

PSD 2.3 Definitions

Delete the sentence ofSANS 1200 D, sub-clause 2.3 headed "Restricted excavation" and substitute:

"Restricted excavation - An excavation so restricted in area or width as to preclude removal of material by excavating machinery used for bulk excavation measured in terms of SANS 1200 D, sub-Clause 8.3.2. Restricted excavation may be carried out by smaller machinery or by hand, as selected by the Contractor. The extent of restricted excavation shall be as scheduled and/or shown on the drawings; all other excavation shall be regarded as bulk excavation."

PSD 3 Materials

PSD 3.1.2 Classes of excavation

Replace SANS 1200 D, sub-clauses 3.1.2 (a), (b) and (c) with the following:

"All material encountered in any excavations for any purpose including restricted excavations will be classified as follows:

1. Excavation in all materials, excluding hard rock. This category of excavation includes; excavation in all sandy and disturbed material; in clay; in undisturbed and weathered Shale (clay); Sandstone; Mudstone and in all rip-ablerock.

2. Excavation in hard rock will require the use of a hydraulic breaker or rock splitting. Areas deemed to require excavation in hardrock will be as agreed on site with the Employer's Agent.

Other earthworks

Non-plastic sandy material from excavations shall be used in the following order:

1. As selected granular material for pipe bedding.
2. As blanket and backfill to pipe trenches.
3. As backfill to structures.
4. As spoil stockpiled in selected areas indicated by the Employer's Agent.

The Contractor shall employ selective methods of excavation to obtain topsoil, and material suitable for backfill, embankments, pipe bedding, selected granular material, road construction and bulk earthworks platforms."

PSD 5 Construction

PSD 5.1.1.2 Safeguarding ofexcavations

Replace SANS 1200 D, sub-clause 5.1.1.2 by the following:

"Excavation rates are to include all the Contractor's costs required for full compliance of the Occupational, Health and Safety Act 2014.

This can include the provision of a shoring system, designed by the Contractor and signed off by a suitably qualified Professional Engineer, or the reduction of the slope of excavations to the safe angle as determined by a suitably qualified Professional Geotechnical Engineer employed by the Contractor."

PSD 5.1.1.3 Explosives

Delete the contents of SANS 1200 D, sub-clause 5.1.1.3 and replace with the following: "Explosives are not permitted."

PSD 5.1.2 Existing services

PSD 5.1.2.2 Detection, location and exposure

Add the following to SANS 1200 D, sub-clause 5.1.2.2:

"The Employer's Agent may order excavation by hand in order to search for and expose services. An item has been included in the Bill of Quantities to cover the cost of such work if so ordered by the Employer's Agent."

PSD 5.1.2.4 Negligence

Add the following to SANS 1200 D, sub-clause 5.1.2.4:

"Where a service is damaged because of the Contractor's negligence, he shall be liable for the costs involved in the repair of the service and any other costs consequent upon the interruption of the damaged service."

PSD 5.1.3 Stormwaterand groundwater

Add the following to SANS 1200 D, sub-clause 5.1.3:

"The Contractor shall provide, operate and maintain sufficient pumping equipment, pipes and other equipment on site as may be necessary to dispose of stormwater and groundwater for the proper execution of the Works."

PSD 5.1.4.1 Dustnuisance

Add the following to SANS 1200 D, sub-clause 5.1.4.1:

"The Contractor is responsible for dust control and is liable for all claims that may result from dust nuisance on all parts of the site and surrounding areas at all times, from the date of handing over of the Site, to the completion date of the Contract.

The Contractor shall plan the Works accordingly and shall use sufficient water or other methods to keep the level of dust to a minimum. This shall be done in consultation with the Employer's Agent and to the Employer's Agent's approval.

The contractor must make allowance for the above in the rates tendered for excavation."

PSD 5.1.4.3 Excavated material not to endanger or interfere

Add the following to SANS 1200 D, sub-clause 5.1.4.3:

"All surplus material and unsuitable material not required for backfilling shall be disposed of at suitable sites to be located by the Contractor. All such sites shall require the approval of the Employer's Agent and the Local Authority and community. No additional payment will be made for the transportation of such material.

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

PSD 5.2.2.1 (c) Excavation for general earthworks and for structures

Add the following to SANS 1200 D, sub-clause 5.2.2.1(c):

"The Contractor shall excavate to the net outlines of the structures plus an allowance for work space. Vertical concrete walls shall not be cast against excavated surfaces, except in the case of concrete encasement to pipes and footings for brick walls."

PSD 5.2.2.1 (e) Excavation for general earthworks and for structures

Add the following to SANS 1200 D, sub-clause 5.2.2.1(e):

"The Contractor shall inform the Employer's Agent, in writing, at least 14 days before commencing any work which will result in a change in the topography of the site, whether such work is for the permanent works or for temporary works which the Contractor intends to execute for his own convenience. Thereupon, before commencing the work, the Contractor shall take cross-sections of the original ground profiles or another approved method to determine the ground profiles of the entire area to be worked. In addition all rock and/or foundation levels shall be recorded as the work proceeds.

The information so obtained shall be permanently recorded on a drawing or drawings which shall each be signed by both the Contractor and the Employer's Agent. The Contractor shall then provide the Employer's Agent with a reproducible copy of each drawing to serve as a permanent record both for the purpose of determining the quantities of excavation and earthworks carried out in the construction of the permanent works and the extent to which temporary works shall be removed or temporary excavations shall be refilled upon completion of the

Works.

Where the Contractor excavates to dimensions in excess of those shown on the drawings or ordered by the Employer's Agent or if the material in the bottom of an excavation is loosened before concrete has been cast, or if there is any over-excavation, or any loose or disturbed soil it shall be removed and the over-excavation shall be replaced by mass concrete of prescribed mix Grade 15/20 mm.

Where blinding, mass or structural concrete is to be cast or where precast elements are to be placed on surfaces established by restricted excavation, the Contractor shall, in the case of rock surfaces, over excavate to 100 mm below the bottom of the structure and use mass concrete Grade 15/20 mm for bringing the level to the bottom of the blinding.

Excavations to final level, ready to receive a blinding layer or concrete footing, shall be completed not less than 24 hours before such layer or footing is cast.

The Contractor shall arrange for the inspection by the Employer's Agent or his Representative of all surfaces immediately before casting concrete."

PSD 5.2.2.3 Disposal

Add the following to SANS 1200 D, sub-clause 5.2.2.3:

"All excess excavated material not used for backfilling shall be disposed of at a site to be found by the Contractor and approved by the Employer's Agent. The spoil site shall be finished off at the completion of the works to the satisfaction of the Employer's Agent."

PSD 5.2.3.1 Embankments

Add the following to SANS 1200 D Sub-clause 5.2.3.1:

"The areas over which earth fills are to be constructed shall, after site clearance and removal of 150mm topsoil, be ripped to a depth of 150 mm and compacted to 90% of Mod AASHTO Density. Should the topsoil layer be in excess of 150mm the Contractor is to notify the Employer's Agent in writing and request a directive as to how to proceed.

The Contractor shall plan his operations and particularly his cut and fill operations in such a manner that all cut material may be used to the best advantage of the Employer. This would mean that no material shall be unnecessarily spoiled. The Contractor shall therefore not spoil any materials without the Employer's Agent's approval and without satisfying the Employer's Agent that this is necessary and that the most economical method of constructing the works is proposed.

Where the earthworks pattern is such that the selected materials cannot be placed directly in their appropriate positions the Employer's Agent may authorize their removal to temporary stockpiles.

Wherever practical, fill shall be placed in successive layers parallel to the final level of the platform, in depths not exceeding 300mm unless otherwise approved by the Employer's Agent.

The material to be used for the platform construction will be G7 minimum quality material.

Where filling is required on ground slopes greater than 1:10 the Contractor shall submit proposals for benching for approval by the Employer's Agent.

Fill in other applications shall be compacted to the densities specified in SANS 1200 D, sub-clause 5.2.3.1 and SANS 1200 DM, sub-clause 5.2.4.2 (100% for sand). Material shall be placed in such a way that adjacent layers at any stage of the operation do not differ in height by more than 300 mm."

PSD 5.2.3.2 Backfilling of trenches and backfilling or filling against structures

PSD 5.2.3.2 (a) General

Add the following to SANS 1200 D, sub-clause 5.2.3.2 (a):

"Backfill measured under the various items in the Bill of Quantities shall be compacted to a density as stipulated in the scheduled item.

Material for backfilling around structures must be selected so that no clay, boulders or rock is used for backfilling within 300 mm of the structure."

PSD 5.2.4.2 Topsoiling

Add the following to SANS 1200 D, sub-clause 5.2.4.2:

"Topsoil shall not be stockpiled higher than 2 m. Care shall be exercised to prevent the compaction of topsoil in any way especially by vehicles travelling over suchmaterial.

Topsoil shall be placed as directed in SANS 1200 D, sub-clause 5.2.4.2 on the faces of cut slopes and embankments and other flatter areas, as shown on the drawings or ordered by the Employer's Agent. The cut and embankment surface shall be raked or lightly scarified before laying of the topsoil to assist with adhesion between the surfaces.

Amend the last sentence of SANS 1200 D, sub-clause 5.2.4.2 to read:

"The final thickness of topsoil after light compaction shall be at least 100mm."

PSD 5.2.4.3 Grass or other vegetation

Add the following to SANS 1200 D, sub-clause 5.2.4.3:

"Grass using sods from the site shall be planted in all topsoiled areas or as directed by the Employer's Agent."

PSD 5.2.5.1 Freehaul

Add the following to SANS 1200 D, sub-clause 5.2.5.1:

"All movement of cut to fill material shall be regarded as freehaul. No overhaul will be paid.

In addition, all movement of topsoil, overburden soil or any other material within the boundary of the site and less than 5 km from the site boundary shall be regarded as free-haul."

PSD 7 Testing

PSD 7.2 Taking and testing of samples

Add the following to SANS 1200 D, sub-clause 7.2:

"The Contractor shall carry out sufficient process control checks (one test per five cubic metres of backfill) on the compaction of all backfill layers before calling the Employer's Agent to inspect the work completed. The frequency of testing shall be such that tests shall be carried out for every lift of backfill material starting from 300 mm. The costs of testing shall be deemed to be included in the rates for backfilling of the platform."

PSD 8 Measurement and payment

PSD 8.1 Basic Principals

Add the following new sub-clauses to SANS 1200 D, sub-clause 8.1:

***PSD 8.1.4 Recording of original ground profiles**

"The tendered rate for excavation shall cover the cost of recording the original ground profiles, rock and/or foundation levels, as applicable prior to commencement of any excavation, including stripping of topsoil. This is required to allow the Employer's Agent to check the Contractor's survey and adjust his design levels if necessary."

***PSD 8.1.5 Backfilling of over-excavation**

"Backfilling over-excavation with concrete as specified in PSD 5.2.2.1(e), as amended, will not be measured for payment unless the over-excavation is ordered by the Employer's Agent to remove unsuitable material, in which case the additional excavation will be measured and paid as excavation in all materials and the concrete will be measured by volume, all to the additional dimensions ordered by the Employer's Agent."

***PSD 8.1.6 Benching**

"The construction of benches shall be measured as "cut to fill" or cut to spoil as the case may be."

PSD 8.2 Computation ofquantities

Add the following to SANS 1200 D, sub-clause 8.2.1:

"The volume of excavated material will be measured from the net outline of the structures and the average depth of excavation unless otherwise approved by the Employer's Agent."

PSD 8.3 Scheduled items

PSD 8.3.2 Bulk excavation

Add the following to SANS 1200 D, sub-clause 8.3.2:

"Extra-over payment will be made for hard rock excavation provided the surface levels of the hard rock have been recorded on drawings signed by the Employer's Agent before it is excavated."

PSD 8.3.2(b) Extra-over for

Replace the contents of SANS 1200 D, sub-clause 8.3.2 (b) with the following:

"No extra-over payment will be made for excavation in material classified in terms of SANS 1200 D, sub-clause 3.1.2, as amended in PSD 3.1.2, as intermediate excavation. The tendered rate for excavation in all materials shall include for the cost of such excavation.

Extra-over item will be made for:

2) Material classified as "hard rock". Refer to PSD 3.1.2, as amended. Extra-over payment will be made for hard rock excavation provided the surface levels of the hard rock have been recorded on drawings signed by the Employer's Agent before it is excavated. Unit: m^3.
3) Boulder excavation which, for the purposes of measurement, will not be differentiated into Class A and Class B. Unit: m^3.
4) Hand Excavation. Unit: m^3
5) Supply, mix and place (by weight) 8% Ordinary Portland Cement to stabilise granular material. The OPC will be measured net by weight. The rate shall cover the cost of supply, mix and placing. Unit: kg.

Typically the volume required will be as follows:

Density of soil x percentage required:
= 1890kg/m^3 x 8%
= 151kg of cement per cubic metre of soil."

PSD 8.3.3 Restrictedexcavation

PSD 8.3.3(b) Extra-over for

Replace the contents of SANS 1200 D, sub-clause 8.3.3 (b) with the following:

"No extra-over payment will be made for excavation in material classified in terms of SANS 1200 D, sub-clause 3.1.2, as amended in PSD 3.1.2, as intermediate excavation. The tendered rate for excavation in all materials shall include for the cost of such excavation.

Extra-over item will be made for:

2) Material classified as "hard rock". Refer to PSD 3.1.2, as amended. Extra-over payment will be made for hard rock excavation provided the surface levels of the hard rock have been recorded on drawings signed by the Employer's Agent before it is excavated. Unit: m^3.
5) Boulder excavation which, for the purposes of measurement, will not be differentiated into Class A and Class B. Unit: m^3.
6) Hand Excavation. Unit: m^3
5) Supply, mix and place (by weight) 8% Ordinary Portland Cement to stabilise granular material. The OPC will be measured net by weight. The rate shall cover the cost of supply, mix and placing. Unit: kg.

Typically the volume required will be as follows:

Density of soil x percentage required:
= 1890kg/m^3 x 8%
= 151kg of cement per cubic metre of soil.”

PSD 8.3.10 Topsoiling

Add the following to SANS 1200 D, sub-clause 8.3.10:

“The topsoiling will be measured by surface area covered.

The rate for topsoiling shall include for PSD 5.2.4.2 and cover the cost of loading, hauling, spreading, compacting and making suitable provision to avoid the topsoil slipping down the slopes of embankments and cut-slopes, all to the approval of the Employer’s Agent.”

PSD 8.3.11 Grassing or other vegetation cover

Add the following to SANS 1200 D, sub-clause 8.3.11:

“Grass sods from the site shall be planted in all topsoiled areas or as directed by the Employer’s Agent. The rate shall include for PSD 5.2.4.3 and include purchase of the grass, levelling and shaping of the ground, fertilizing, planting, topdressing, watering, weeding and cutting the grass until an 80% coverage is achieved. Payment for grassing will be made on a pro rata basis to the coverage achieved.”

PSDB EARTHWORKS (PIPE TRENCHES) (SANS 1200 DB)

PSDB 3 Materials

PSDB 3.1 Classes of excavation

Add the following to SANS 1200 DB, sub-clause 3.1:

"The classification of material for excavation shall be as specified in PSD 3.1.2, as amended."

PSDB 3.6.1 Subbase and base

Replace SANS 1200 DB, sub-clause 3.6.1 with the following:

"Where trenches cross existing surfaced roads the following will apply:

a) The service (pipe, cable etc.) shall be laid on a bedding cradle, and covered with a fill blanket, as specified in SANS 1200 LB Bedding (Pipes) or in the Project Specification.

b) The remaining portion of the trench, from the top of the fill blanket to the underside of the road wearing layer, shall be filled with soilcrete (G4 gravel with 5% cement) compacted mechanically in 150mm layers to 98% of MOD. ASSHTO for a minimum total thickness of 300mm."

PSDB 3.7 Selection

Add the following to SANS 1200 DB, sub-clause 3.7:

"Notwithstanding SANS 1200 DB, sub-clause 3.7, in terms of which the Contractor has a choice regarding methods of selection, the Contractor is required to use selective methods of excavation. The Contractor shall selectively remove and keep separate the sandy material from unsuitable material and place it adjacent to the trench for reuse as backfill, selected fill, selected granular material or for other use as ordered by the Employer's Agent.

Material which, in terms of SANS 1200 D, sub-clause 6.2 or SANS 1200 LB, sub-clause 6.1, is too wet for immediate use in the trench (but which is otherwise suitable) will not be regarded as "unsuitable" material and, if so ordered by the Employer's Agent, the Contractor shall spread such material in a suitable area until it has dried sufficiently for later use. Should the material which is replaced in the trench become too wet again, due to the fact that the Contractor made insufficient provision for the handling and removal of groundwater in accordance with SANS 1200 A, sub-clause 5.5, the Contractor shall replace the material at his own cost with material which is, in the opinion of the Employer's Agent, suitable.

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

Unless otherwise ordered by the Employer's Agent, all excavated material shall be kept within the pipe servitude. The toe of the bank of excavated material shall be trimmed well back from the edge of the trench so as to leave a minimum

0.6 m clearance between the toe of the bank and the edge of the trench. The Contractor shall keep this strip clear of excavated material at all times.

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

PSDB 5 Construction

PSDB 5.1.2 Stormwater, seepage and dewatering excavations

PSDB 5.1.2.1 Throughout the works

Add the following to SANS 1200 DB, sub-clause 5.1.2.1:

"In addition to the Contractor's responsibilities for dealing with water, the Employer's Agent may order the Contractor to place a crushed stone bedding layer (minimum thickness 150 mm) on the trench bottom. Should the trench bottom conditions remain unstable due to the nature of the soil and the degree of saturation, the Employer's Agent may order the Contractor to install a filter fabric on the trench bottom prior to the provision of the stone layer.

Should the material in the trench bottom or the bedding material be of such a nature that it can penetrate the stone layer, the Employer's Agent may instruct the Contractor to enclose the stone layer completely within a geotextile filter blanket which shall comply with the requirements below, and shall have overlaps of at least 300 mm.

The Contractor will only be paid by providing and laying the stone bedding layer and filter fabric after receipt of a written order to do so from the Employer's Agent.

<u>Stone bedding in water-logged conditions:</u>

Where the use of a layer of crushed stone in the trench bottom has been authorized by the Employer's Agent, it will be measured by volume calculated according to length multiplied by the minimum base width and specified thickness. The tendered rate shall cover the cost of preparation of the trench bottom to accommodate the layer of stone, the supply and placing of the layer of stone over at least the specified width and all related activities in order to produce a stable platform.

<u>Geotextile filter fabric:</u>

Where the Employer's Agent has authorised the use of geotextile filter fabric, this shall be measured by area as: width x nett length, where the width shall be the full or half-width supplied by the manufacturer which conforms closest to 2 x the specified minimum base width plus 2 x height of bedding plus 300mm. The tendered rate shall include the cost of supply, placing and losses as a result of overlaps and over excavated trench widths.

The synthetic fibres of a geotextile blanket shall consist of at least 85% by mass of polypropylene, polyethylene, a polyester, a polyamide, or a copolymer of vinyl chloride and vinylidene-chloride, or any combination of these polymers, and shall contain such additives as are necessary to render the filaments resistant to the effects of ultra-violet radiation and heat. The amount of water absorbed by the geotextile after 24 hours soaking in water at 20°C shall be less than 1% by mass.

In addition to the requirements of SANS 1200 DK, sub-clause 3.1.3 the geotextile shall comply with the following:

Mass	:	150 g/m^2 (minimum)
Strength in all directions	:	6 kN/m (minimum) Equivalent
opening size (EOS)	:	105 micrometres (maximum)"

PSDB 5.4 Excavation

Add the following to SANS 1200 DB, sub-clause 5.4:

"The maximum allowable length of open pipe trench, at any given time during the execution of this Contract, shall not exceed:

a) 250 meters per section of the pipeline under construction and/or,
b) 500 meters in aggregate, for all sections of pipeline
c) At any time during the contract the aggregate length of completed sewer, without successful testing, will be restricted to 250 metres.

Please note that any portion of the pipeline being laid and backfilled, which has not been fully backfilled, is deemed to be an open pipe trench. Open trenches are to be regularly (at least once a day) checked in compliance with the OHS Act requirements by the Contractor's appointed construction Safety Officer."

PSDB 5.5 Trenchbottom

Add the following to SANS 1200 DB, sub-clause 5.5:

"Where the Contractor's method of working results in quagmire conditions in the trench bottom, the Contractor shall excavate and stabilize the trench at his own cost to the approval of the Employer's Agent."

PSDB 5.6.3 Disposal of soft excavation material

Replace SANS 1200 DB, sub-clause 5.6.3 with the following:

"All surplus material and unsuitable material not required for backfilling shall be disposed of at suitable sites to be located by the Contractor. All such sites shall require the approval of the Employer's Agent and the Local Authority and community. No additional payment will be made for the transportation of such material

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

PSDB 5.6.6 Completion of backfilling

Replace SANS 1200 DB, sub-clause 5.6.6 with the following:

"The contractor shall bring on to the site sufficient resources for pipe laying so that trenches do not remain open for longer than one week ahead or behind the pipe laying team."

PSDB 5.6.8 Transport for earthworks

Add the following to SANS 1200 DB, sub-clause 5.6.8:

"The transport of all earthworks, whether for imported or excavated material from site, shall be included in the tendered rates for the schedules items, and no payment will be made for overhaul."

PSDB 5.7.2 Areas subject to traffic loads

Add the following to SANS 1200 DB, sub-clause 5.7.2:

"All trenches will be considered to be subject to traffic loads and the backfill material and compaction in these trenches shall comply with the requirements of SANS 1200 DB, sub-clauses 3.5 (b) and 5.7.2."

PSDB 7 Testing

PSDB 7.1 Testing

Add the following to SANS 1200 DB, sub-clause 7.1:

"The Contractor is to allow in his rates a minimum of one compaction test per 50 meters for every completed layer of blanket and backfill."

PSDB 8 Measurement and payment

PSDB 8.3 Scheduled items

PSDB 8.3.2 Excavation

SANS 1200 DB, sub-clause 8.3.2 to include the following:

"The rates for excavation of trenches shall also cover the cost of selection as specified in PSDB 3.7, PSDB 5.4, PSDB 5.5, PSDB 5.6.3, PSDB 5.6.6, PSDB 5.6.8 and 7.1.

No extra-over payment will be made for excavation in material classified in terms of SANS 1200 D, sub-clause 3.1.2, as amended in PSD 3.1.2, as intermediate excavation. The tendered rate for excavation in all materials shall include for the cost of such excavation.

(b) Extra-over item will be made for:

2) Material classified as "hard rock". Refer to PSD 3.1.2, as amended. Extra-over payment will be made for hard rock excavation provided the surface levels of the hard rock have been recorded on drawings signed by the Employer's Agent before it is excavated. Unit: m^3.
3) Boulder excavation which, for the purposes of measurement, will not be differentiated into Class A and Class B. Unit: m^3.
4) Hand Excavation. Unit: m^3
5) Supply, mix and place (by weight) 8% Ordinary Portland Cement to stabilise granular material. The OPC will be measured net by weight. The rate shall cover the cost of supply, mix and placing. Unit: kg.

PSDB 8.3.6.1 Reinstate road surfaces

SANS 1200 DB, sub-clause 8.3.6.1 to include payment for:

PSDB 3.6.1 Subbase and base
PSDB 5.7.2 Areas subject to traffic loads

PSDB 8.3 Schedules items

Add the following new payment items to SANS 1200 DB, sub-clause 8.3:

***PSDB 8.3.8 Crushed stone bedding layer .... Unit: m^3**

"The rate shall include payment for PSDB 5.1.2.1."

***PSDB 8.3.9 Geofabric blanket ....Unit: m^2**

"The rate shall include payment for PSDB 5.1.2.1."

PSDK GABIONS AND PITCHING (SANS 1200DK)

PSDK 3 Materials

PSDK 3.1.2 Gabion basket/cage

Replace SANS 1200 DK, sub-clause 3.1.2 with the following:

"Gabion boxes shall consist of double twisted, hexagonal wire mesh with nominal opening of 80 mm, with 4,4 mm o/d wire frame and 2,7 mm o/d mesh wire. Complete with partitions/diaphragms (see SANS 1200 DK, sub-clause 2.3.2) at 1 m centres. All wire to be mild steel to SANS 1580 – 2010, zinc coated by hot-dip galvanizing to SANS 675 – 2011.

Mattresses shall consist of double twisted, hexagonal wire mesh with nominal opening of 80 mm, with 4.0 mm o/d wire frame and 2.5 mm o/d mesh wire. Complete with partitions/diaphragms (see SANS 1200 DK, sub-clause 2.3.2) at 1 m centres. All wire to be mild steel to SANS 1580 – 2010, zinc coated by hot dip galvanizing to SANS 675 – 2011."

PSDK 3.1.3 Geotextile material

Add the following to SANS 1200 DK, sub-clause 3.1.3:

"Filter fabric for groundwater drains shall be a non-woven continuous filament, needle punched, spun-bounded polyester geotextile having the following physical characteristics:

Mass per unit surface… .... 150 g/m^2 (min)
Porosity under 0,5 KPa 93%
Porosity under 200 KPa 82%
Normal permeability under 2 KPa .... 3 x 10 - 3 m/s
Normal permeability under 200 KPa .... 7 x 10 - 4 m/s
Normal through flow under constant head of 400mm…………………………270 ℓ $/m^2/s$

<u>Alternatively - for woven filter fabrics the following characteristics shall apply:</u>

Mass per unit area… .... 270 g/m^2
Water percolation .... 160 ℓ$/m^2/s$
Composition.................................... polypropylene tape and polyethylene monofil

The material shall be placed as directed and shall not be exposed to direct sunlight for prolonged period."

PSDK 5 Construction

PSDK 5.2.1 Preparations of the foundations and surface for bedding

Add the following to SANS 1200 DK, sub-clause 5.2.1:

"Where poor in-situ material is encountered below the concrete base, rock fill or 19 mm stone or a crusher-run or material complying with the requirements of SANS 1200 MF, sub-clause 3.3.3, shall be used as bedding material. Where concrete bases are not required for low height revetment, the bed for the gabion cages shall be constructed using similar quality crusher-run material, or on suitable in-situ material as directed by the Employer's Agent."

PSDK 7 Testing

Add the following new sub-clause to SANS 1200 DK, clause 7:

***PSDK 7.6 Concrete testing**

"The requirements of SANS 1200 GA shall apply to the testing of concrete used in the footings where applicable."

PSDK 8 Measurement and payment

PSDK 8.2.1 Surface preparation for bedding of gabions

SANS 1200 DK, sub-clause 8.2.1 to include payment for:

PSDK 5.2.1 Preparation of the foundations and surface for bedding
*PSDK 7.6 Concrete testing

PSDK 8.2.2 Gabions

SANS 1200 DK, sub-clause 8.2.2 to include payment for:

PSDK 3.1.2 Gabion basket/cage

PSDK 8.2.4 Geotextile

SANS 1200 DK, sub-clause 8.2.4 to include payment for:

PSDK 3.1.3 Geotextile material

PSDM EARTHWORKS (ROADS, SUBGRADE) SANS 1200 D

PSDM 3 Materials

PSDM 3.1 Classification for excavation purposes

Replace SANS 1200 DM, sub-clause 3.1 with the following:

"The Contractor may use any method he chooses to excavate any class of material but the chosen method of excavation shall not determine the classification of the excavation. The Employer's Agent will decide on the classification of the materials. In the first instance the classification will be based on inspection of the material to be excavated and on the criteria given in PSD 3.1.2, as amended."

PSDM 3.2.3 Selected layer

Add the following to SANS 1200 DM, sub-clause 3.2.3:

"The Contractor shall obtain selected sub-grade material from a source of his own choice. The unit rate tendered shall include all procurement related costs, including haulage. The selected layer shall be constructed of material and compacted as specified."

PSDM 5 Construction

PSDM 5.2.3.3 Treatment of roadbed

Substitute the first paragraph of SANS 1200 DM, sub-clause 5.2.3.3 (a) with the following:

"The roadbed shall be scarified to a depth of 150 mm, watered, shaped and compacted to 93% mad. AASHTO density (100% for sand), except where otherwise ordered by the Employer's Agent.

Where the existing subgrade material does not conform to the G7 specification as per the TRH 20, the Contractor is to notify the Employer's Agent and request approval for inclusion of a selected subgrade layer."

PSDM 5.2.8.1 Freehaul

Replace SANS 1200 DM, sub-clause 5.2.8.1 with the following:

"All movement of cut to fill and cut and spoil material on site shall be regarded as freehaul. In addition, all movement of topsoil, overburden soil or any other material within the boundary of the site shall be regarded as freehaul."

PSDM 7 Testing

PSDM 7.3 Routine inspection and testing

Add the following to SANS 1200 DM, sub-clause 7.3.2:

"No single test result which is below the specified density will be accepted.

The cost of all routine testing done by the Employer's Agent, and of which the results do not comply with the specified minimum requirement for the material, shall be borne by the Contractor and will be subtracted for the monthly payment certificates"

PSDM 8 Measurement and payment

PSDM 8.3.3 Treatment of roadbed

SANS 1200 DM, sub-clause 8.3.3 to include payment for:

PSDM 7.3 Routine inspection and testing
PSDM 5.2.3.3 Treatment of roadbed

PSDM 8.3.4 Cut to fill, borrow to fill

SANS 1200 DM, sub-clause 8.3.4 to include payment for:

PSDM 5.2.8.1 Freehaul

"No extra over payment will be made for excavation in material classified in terms of SANS 1200 D Sub clause 3.1.2 as intermediate excavation and boulder excavation Class A and B. The tendered rate for excavation in all materials shall include for the cost of such excavation. Rock quantities are to be measured and agreed with the Employers Agent prior to backfilling. In the event that backfilling has taken place before rock quantities have been agreed with the Employers Agent then no rock payment will be made."

PSDM 8.3.5 Selected layer

SANS 1200 DM, sub-clause 8.3.5 to include payment for:

PSDM 3.2.3 Selected layer

PSDM 8.3.6 Extra-over Items 8.3.4 and 8.3.5 for excavating and breaking down material in

Delete Item a) of SANS 1200 DM, sub-clause 8.3.6 and add the following:

"No payment shall be made for intermediate excavation. Excavation normally classified as Intermediate excavation shall be paid as per the rate for normal excavation (SANS 1200 DM, sub-clause 8.3.4 or 8.3.5 as appropriate)."

PSDM 8.3.7 Cut to spoil or stockpile from

Delete item b) of SANS 1200 DM, sub-clause 8.3.7 and add the following:

"No payment shall be made for intermediate excavation. Excavation normally classified as Intermediate excavation shall be paid as per the rate for soft excavation, SANS 1200 DM, sub-clause 8.3.7 (a)."

PSDM 8.3.12 Overhaul

SANS 1200 DM, sub-clause 8.3.12 to include payment for:

PSDM 5.2.8.1 Freehaul

PSDQ CONCRETE RETAINING BLOCK WALL (SPEC DQ)

PSDQ 1 Scope

This is a Particular Specification and covers the erection of gravity / composite / precast block retaining walls in terms of the latest amended edition of the SANS 508:2008. This specification covers the construction of a concrete retaining block system for the stabilization of the platform fill slopes and to provide protection of the platform during flooding conditions.

PSDQ 2 Interpretation

PSDQ 2.1 Supporting specification

In addition the specifications and requirements of the supplier of the Loffelstein CRB or similar approved units shall be adhered to. The block shall comply with the minimum specifications as stated in the table below and in the SANS 508:2008, and shall also be erected in accordance with the dimensions shown on the design drawings.

<u>21 day crushing strength of blocks:</u>

- Under full platen contact: Avg 13MPa with a minimum of 11MPa
- Under simulated in-situ point loading: 8 MPa (minimum)
- Coefficient of friction for interlocking sliding: 0,54 (Value at 95%)
- Block dimensional variations: Approx 3mm (length, width and height)
- Block mass variation: Not less than 95% of specified mas.

Tests and associated results, as conducted by an approved authority / laboratory, shall be made available to the Employer or his Agent for approval, e.g.:

- 21 day crushing strength (As specified above)
- Determination of the coefficient of friction for interlocking and sliding between blocks
- Representative pullout resistance (Block and geogrid connection test / Determination of pullout resistance of various block types)

PSDQ 3 Materials

PSDQ 3.1 Precast concrete units

Apart from the specification of concrete mentioned hereafter, all materials shall comply with SANS 508:2008 specifications. Concrete used for gravity retaining wall footings shall comply with the requirements of SANS 1200 G.

PSDQ 3.2 Concrete footing

Strip clearing for the retaining wall shall be carried out in accordance with SANS 1200 C. Concrete used for the foundation bases, where required, shall comply with SANS 1200 GA, as applicable, for strength concrete of Class 35/19.

PSDQ 3.3 Curing compound

The curing compound for the concrete foundations for Concrete Retaining Wall System shall be a white pigmented natural resin based liquid curing compound complying with ASTM C309-74.

PSDQ 3.4 Geotextile material

The applicable provisions specified in PSDQ 8.4 shall apply.

PSDQ 3.5 Bedding material

Where poor in-situ material is encountered below the concrete base, rock fill or 19 mm stone or a crusher-run or material complying with the requirements of SANS 1200 MF, sub-clause 3.3.3, shall be used as bedding material. Where concrete bases are not required for low height revetment, bases shall be constructed using similar quality crusher-run material, or on suitable in-situ material as directed by the Employer's Agent.

PSDQ 3.6 Block filling material

An approved granular soil material suitable for supporting plant growth shall be used for filling the blocks.

PSDQ 5 Construction

PSDQ 5.1 Footing foundation

The footings shall either be cast in-situ concrete or constructed from an approved crusher-run material or in-situ material as directed by the Employer's Agent or as shown on the drawings.

PSDQ 5.2 Placing and backfilling

Backfilling behind the blocks is to be placed in layers not exceeding 200mm and compacted to 93% MOD AASHTO.

PSDQ 6 Tolerances

PSDQ 6.1 Permissible deviations

The permissible deviation on the surface of the concrete footings shall be 3 mm on the flatness of the plan surface.

The completed retaining wall shall be true to the setting out line and blocks shall be installed horizontally with the use of a line and spirit level (3 blocks will be levelled simultaneously in length and in depth), unless otherwise stated. The height of the lower block above the final ground level shall not vary by more than 100 mm from that shown on the approved detail drawings.

PSDQ 7 Testing

PSDQ 7.1 Concrete

The requirements of SANS 1200 GA shall apply to the testing of concrete used in the footings where applicable.
The requirements of SANS 508-2008 shall apply to the concrete retaining blocks.

PSDQ 8 Measurement and payment

Various items shall be listed as given below. The tendered rates shall include full compensation for the necessary plant, labour and material to execute the works as listed, including the spoil of surplus material on site and control density testing.

PSDQ 8.1 **CRB Loffelstein blocks**

Sandstone CRB blocks .... Unit: m^2

The rate shall cover the cost of supplying, loading, transporting and off-loading, together with the cost of any additional trimming of the cut batter slopes, of laying the precast units to specified heights, of backfilling, and for the provision of approved granular soil and filling of the units, and all plant, equipment and labour to complete the wall.

Items will be provided for height increments of 2 m measured vertically from the top to the footing, or in the case of a perched condition, from the near side finished road level. Excavation for required cut batters will be paid under SANS 1200 DM.

PSDQ 8.2 **Bedding material**

Crusher-run material for bedding below concrete footings/G7 Material. ......Unit: m^3
Crusher-run material for wall footings material… .... Unit: m^3

The rate shall cover the cost of acquiring, regardless of distance, the required material from commercial sources, delivering and placing the material, compacting and finishing to the required tolerances.

The volume of gravel bedding material will be computed from the dimensions of the footings as shown on the drawing or as directed by the Employer's Agent.

PSDQ 8.3 **Supply concrete for footing**

Concrete Class 35/19… .... Unit: m^3

The rate shall cover the cost of the design of the concrete mix, the provision of concrete, mixing, testing, placing, compacting, forming of stop-ends and unforeseen construction joints, striking off or levelling as applicable, and curing and repairing where necessary. It shall also include for all excavation for the concrete footing and excavation for crusher-run bedding beneath the footings, and for disposal of the excavated material. The rate shall also include the steel reinforcement mesh as specified per drawing.

PSDQ 8.4 **Supply geotextile fabric (A2/U14)**

Geotextile Fabric (A2/U14) .... Unit: m^2

The rate shall cover the cost of supply, lay and bed into position as shown on the drawing.

PSDQ 8.5 **Fill behind retaining wall**

Use G7 material from stockpile and stabilize with 2% cement and place and compact in layers of 150mm to 93% MOD AASHTO density behind retaining wall blocks .... Unit: m^3

The rate shall cover the cost of supply, lay and bed into position as shown on the drawing.

PSG CONCRETE (STRUCTURAL) (SANS 1200 G)

PSG 2 Interpretations

PSG 2.4.2 Strength concrete

Add the following to SANS 1200 G, sub-clause 2.4.2:

"With the exception of mixes weaker than 15 MPa, all concrete for the Works shall be considered to be strength concrete.

Unless otherwise specified on the drawings or in the Bill of Quantities, all structural concrete shall be Grade 35 MPa/19.

Where blinding layers are specified, the concrete shall be grade 15 MPa/19 placed and finished off to the final level."

PSG 3 Materials

PSG 3.2 Cement

PSG 3.2.1 Applicable specifications

Add the following to SANS 1200 G, sub-clause 3.2.1:

"CEM1 42.5 as specified in SANS EN 197-1 common cements, a 75% CEM1 42.5 and 25% PFA blend or 50% slagment and 50% CEM1 shall be used as specified in the relevant sections of SANS 1491 and SANS EN 197-1. Any variations to these are subject to the Employer's Agent's approval.

For non-structural concrete CEMI 32.5 is acceptable."

PSG 3.2.3 Storage of cement

Add the following to SANS 1200 G, sub-clause 3.2.3:

"Cement shall be used in the order in which it is received (first in, first out basis).

Cement kept in storage for longer than 6 weeks shall be removed from site and not used in the Works.

Any cement that shows signs of hydration, such as the formation of lumps, may not be used and is to be immediately removed from site."

PSG 3.3 Water

Replace SANS 1200 G, sub-clause 3.3 with the following:

"Only potable quality water from an approved source may be used for mixing concrete. Water from a river or stream may only be used for curing."

PSG 3.4 Aggregates

PSG 3.4.1 Applicable Specification

Add the following to SANS 1200 G, sub-clause 3.4.1:

“The maximum aggregate size shall be 25 mm. Any aggregate may be used provided the free sodium alkali content in the concrete mix does not cause an alkali-aggregate reaction.

Coarse aggregate may be obtained from the nearest available commercial sources, and shall be subject to the Employer’s Agent’s approval.

Fine aggregate may be obtained from local sources subject to testing of its suitability by an approved laboratory and approval by the Employer’s Agent.

Aggregates shall be tested periodically for reactivity, the costs of which shall be deemed included in the rate tendered for concrete. A design mix will have to be made and the results submitted to the Employer’s Agent for approval before construction begins.

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

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

Aggregates for grouting

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

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

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

PSG 3.4.2 Use of plums

Replace SANS 1200 G sub-clause 3.4.2 with the following:

“The use of plums will not be permitted.”

PSG 3.5 Admixtures

Add the following Clause to Clause 3.5:

“The use of admixtures will be subject to the approval of the Employer’s Agent.

The information listed in SANS 1200 G, sub-clause 3.5.1 shall be provided.

In addition all water retaining structures will include the following admixture: Crystaline Waterproofing Additive (Zypex Admix C- 500 NF) added at the rate of 5kg per 1m3 of concrete during mixing, all to manufacturer's specification.

If two or more admixtures are to be used, the Contractor shall submit all necessary and available data for assessing the interaction and compatibility of the admixtures."

Add the following new sub-clauses to SANS 1200 G, sub-clause 3.5:

***PSG 3.5.3 Pulverized fly ash (PFA)**

***PSG 3.5.3.1 General**

"Concrete containing a percentage of FA shall be termed FA concrete. Pulverized fly ash (PFA) shall conform to the requirement of SANS 1491-2.

All concrete used shall consist of FA in the concrete unless otherwise shown on the drawings or ordered by the Employer's Agent.

FA concrete shall conform to the requirements of SANS 1200 G for concrete and the additional requirements specified below."

***PSG 3.5.3.2 Source and quality**

"Fly Ash shall be procured from an approved source and shall be of a consistent quality conforming to SANS 1491-2. In particular it shall be tested for and shall conform to the following:

a) the loss on ignition shall not exceed 5%
b) the percentage by mass retained on 45 micron screen shall not exceed 12.5%"

***PSG 3.5.3.3 Cementitious material**

"The cementitious material used for FA concrete shall consist of a mixture of between 75% and 80% by mass of ordinary Portland cement and of between 25% and 20% by mass of FA.

If instructed by the Employer's Agent, all concrete used for construction of water retaining structures shall contain a post surface treatment that waterproofs by crystallization (Xypex or similar approved) at a rate and application in accordance with manufacturer's recommendation. Reference made to PSG 5.5.8, Curing and protection."

***PSG 3.5.4 Crystalline waterproofing additive**

"The Contractor shall be responsible for furnishing all labour, materials, services and equipment necessary for the supply and installation of crystalline waterproofing additive to concrete structures as indicated on the drawings, and as specified herein. The crystalline waterproofing material shall be added to concrete during the mixing cycle, and shall be used in above and below grade walls and slabs including liquid retaining structures where enhanced chemical resistance is required.

The concrete waterproofing system shall be of the crystalline type that chemically controls and permanently fixes a non-soluble crystalline structure throughout the capillary voids of the set concrete. The system shall cause the set concrete to become sealed against the penetration of liquids from any direction, and shall protect the concrete from deterioration due to harsh environmental conditions.

Prior to installation of waterproofing, the Contractor shall conduct a meeting with the Employer's Agent's representative, concrete supplier, concrete placer and waterproofing manufacturer's representative to verify and review the project requirements for waterproofing as well as the manufacturer's product data including application instructions.

After this meeting, the Contractor shall obtain approval to install the crystalline waterproofing additive in writing from the product manufacturer, which written approval shall be given to the Employer's Agent's representative. This requirement shall not absolve the Contractor of his/her obligations in accordance with the contract and project requirements.

The admixture shall be added to the concrete mix at the time of batching. The Contractor shall obtain a completely homogeneous mixture by thoroughly blending the admixture with the concrete mix."

***PSG 3.9 Materials for movement joints**

***PSG 3.9.1 General**

"The various jointing materials, the manufacturers of the materials and the methods of application shall be as approved by the Employer's Agent. Materials shall be stored and protected to avoid damage, degradation, distortion or contamination.

The joint materials shall be resistant to ultraviolet light and to biological degradation."

***PSG 3.9.2 Waterstops**

"Waterstops shall be of approved manufacture and of the pattern and the material and widths scheduled and specified and shown on the drawings. They shall conform to Specifications CKS 388 or 389, for natural rubber or PVC respectively, and have the appropriate physical properties as set out below:

	PVC	Rubber
Tensile strength (@ 25oC)	12,2 MPa	20,7 MPa
Elongation at break (@ 25oC)	250%	500%
Hardness BS degrees (IRHD @ 25oC)	-	60 to 65 ^{o}
Softness (BS)	28 to 52 ^{o}	-

All intersections between waterstops shall be prepared by mitring and welding/vulcanising intersection pieces in the factory in accordance with the manufacturer's instructions and to approval of the Employer's Agent. Only straight lengths of waterstop may be field welded using the appropriate jigs and tools.

Where required, waterstops shall have eyelets so that they may be tied securely to the adjacent reinforce¬ment. "Rearguard"-type waterstops shall have flanges or cleats that grip effectively."

***PSG 3.9.3 Fillers**

"Closed cell expanded polyethylene fillers shall comply with the following:

Property	Unit	Value Test Method
Density	kg/m^3 110	DIN 53420
Compression Stress at compression strains of 10% 25% 50%	 kPa 175 kPa 210 kPa 340	 DIN 53577 DIN 53577 DIN 53577
Compression set after 24 hours recovery	% 14	
Tensile Strength	kPa 680	DIN 53571
Elongation at Break	% 49	DIN 53571
Max. water absorption after 24 hours by volume	% 0,1	ASTM C-177

Fillers shall be pre-cut to suit the application with a tear-out strip for forming the specified recess for the sealant. If so required the filler shall be glued into position with an approved epoxy glue."

***PSG 3.9.4 Bond breakers, primers and sealants**

"The bond breaker between the top of the blinding layer or dry packed mortar screed and the underside of the floor slab shall be either a double coat of a spray grade bitumen emulsion complying with SANS 309 applied at a rate of 1,0ℓ/m2 of net bitumen or a 250 micrometre polythene sheet complying with SANS 952, Type D.

Where bitumen impregnated resilient fibreboard is specified, it shall comply with American Federal Specification HH F 341a for Type 1, Class B.

The bond breaker (if specified) shall be self-adhesive PVC tape (or equal, approved material) with a width the same as the joint recess into which it is to be applied.

The primer, if required for the sealant, shall be fully compatible with the sealing compound that is to be used.

The elastomeric sealant shall be either a two-component polysulphide liquid polymer base complying with the requirements of SANS 110 or a polyethylene based polyurethane "pouring grade" for horizontal or near horizontal joints or "gun grade" for vertical/overhead joints and joints steeper than 1 in 10 to the horizontal. All elastomeric sealants shall comply with BS 4254 Type A1 and shall have a movement tolerance of 25%."

***PSG 3.10 Precast paving slabs**

"The paving slabs shall comply with the requirements of SANS 541, shall be as scheduled and with patterned surface, or equal approved. Samples of the types which the Contractor proposes to use shall be submitted for approval prior to construction.

The area to be paved shall be compacted to a minimum of 93% Mod AASSHTO density (100% for sand), trimmed and then treated with an approved weed killer, with care being taken to avoid contaminating surrounding areas. The paving slabs shall be laid on a sand bed approximately 25 mm thick, which shall be graded to the required levels and slopes as approved by the Employer's Agent. The joints between the slabs shall be 2 mm to 6 mm wide and shall be grouted with cement mortar. Gaps in the pattern of slabs shall be filled with Grade 15MPa/19 concrete and given a wood floated finish."

PSG 4 Plant

PSG 4.3 Mixing plant

PSG 4.3.1 General Requirement for Mixing Plant

Add the following to SANS 1200 G, sub-clause 4.3.1:

"Stand-by mixers of adequate capacity and with an independent power unit shall be maintained on site for immediate use in the event of breakdown of the regular mixers failure of the power supply."

PSG 4.4 Vibrators

Add the following to SANS 1200 G, sub-clause 4.4:

"Stand-by vibrators of adequate capacity and with an independent power unit shall be maintained on site for immediate use in the event of breakdown of the regular vibrator failure of the power supply.

Vibrators for in-situ concrete shall be of the internal or immersion type."

PSG 4.5 Formwork

PSG 4.5.3 Ties

Add the following to SANS 1200 G, sub-clause 4.5.3:

"The use of sleeves for formwork ties through the walls of water retaining structures will not be permitted. Ties, when cast in, shall have some form of positive anchorage to prevent any rotation when loosening formwork and some form of water bar to restrict seepage along the tie.

For watertight concrete structures the shutters shall be fastened using an approved imbedded fastening system.

A sample of the tie to be used must be submitted the Employer's Agent for approval prior to construction."

Add the following new sub-clause to SANS 1200 G, clause 4:

***PSG 4.6 Water-bath**

"A temperature-controlled water-bath with a capacity to cure two hundred cubes shall be provided on site. The water-bath shall be located under cover."

PSG 5 Construction

PSG 5.1 Reinforcing

PSG 5.1.2 Fixing

Add the following to SANS 1200 G, sub-clause 5.1.2:

"Fixing of reinforcing bars by welding and heating of bars will not be permitted.

Fixing blocks for the attachment of fixtures may be embedded in concrete provided that the strength or any other desirable feature (such as appearance of the member) is not, in the opinion of the Employer's Agent, impaired thereby.

Supports shall be of approved precast concrete blocks properly shaped to maintain position or proprietary supports of an approved type. Concrete blocks shall be adequately cured as specified. Wooden supports shall not be used nor shall bars be placed in succeeding layers of fresh concrete nor shall bars be adjusted during the placing of concrete. Tie-wire shall point away from the nearest formwork face.

Where clips, stools and other supports are not shown on the drawings and are structurally not required, the Contractor shall provide those supports he deems necessary to ensure the correct positioning of the reinforcement, to the satisfaction of the Employer's Agent. The cost of such steel, labour, and other fixing materials shall be inclusive in the rate for the scheduled reinforcement and no additional payment shall be made."

PSG 5.2 Formwork

PSG 5.2.1 Classification of finishes

Add the following to SANS 1200 G, sub-clause 5.2.1:

"Rough formwork, Degree of Accuracy III, may be used on the outside faces where the concrete is more than 500 mm below the final ground level. Smooth formwork, Degree of Accuracy II, will be used elsewhere. Where specified special finishes shall be to Degree of Accuracy I.

All concrete surfaces that will be exposed above the final ground levels shall have a special smooth finish to a Degree of Accuracy I. The formwork used shall be high-grade, unblemished and regular in size. Formwork ties shall be placed in a regular pattern. The special smooth finish shall be an off-shutter finish to the concrete such that no after treatment is required other than at the positions of formwork ties.

All honeycombing shall be repaired by cutting back to sound concrete and patching with a suitable epoxy mix to the approval of the Employer's Agent.

Concrete for manholes shall be finished with a steel float or against a steel shutter which has been cleaned and oiled before use."

PSG 5.2.2 Preparation offormwork

Add the following to SANS 1200 G, sub-clause 5.2.2:

"All exposed external angles in concrete work shall have 20 mm x 20 mm chamfers unless otherwise specified or ordered, but the top edge of a slab that is to receive an applied finish shall not be chamfered."

PSG 5.5 Concrete

PSG 5.5.1.1 General

Add the following to SANS 1200 G, sub-clause 5.5.1.1:

"Supervision:

The Contractor shall be responsible for ensuring that the erection of the concrete work is carried out under the supervision of a person with adequate knowledge of the mixing, transporting, placing and curing of concrete.

Programme and Plant:

Prior to carrying out any concrete work, the Contractor shall obtain the approval of the Employer's Agent in respect of:

a) Structural programme,
b) Concrete plant details,
c) Materials to be used in concrete,
d) Details of concrete,
e) Construction joints"

PSG 5.5.1.4 Chloride content

Add the following to SANS 1200 G, sub-clause 5.5.1.4:

"Efflorescence will not be acceptable on any exposed concrete surface"

PSG 5.5.1.5 Durability

Add the following to SANS 1200 G, sub-clause 5.5.1.5:

"The water/cement ratio, as specified in Table 5, but shall not exceeding 0.5."

PSG 5.5.1.6 Prescribed mix concrete

Add the following to SANS 1200 G, sub-clause 5.5.1.6:

"Notwithstanding the requirements of SANS 1200 G, sub-clause 5.5.1.6, samples of aggregates will not be made available by the Employer's Agent. The Contractor shall supply aggregates from commercial sources located by him, complying with the requirements of PSG 3.4.1, as amended, for the production of prescribed mix concrete.

<u>"No-fines" concrete:</u>

A nominal aggregate size of 19 mm shall be used in the manufacture of "no-fines" concrete.

No-fines concrete shall be laid under where specified and shall consist of coarse aggregate, cement and water only. No fine aggregate shall be used. Sandwiching or layering of pours will not be permitted. The Contractor shall cast to the profile depth in one pour.

The mixing of the cement and water paste shall have the consistency of paint capable of coating each coarse aggregate particle uniformly and sufficiently to form a small fillet at all the contact points of each stone in the aggregate.

Between 24 and 48 hours after the no-fines layer has been laid it shall be covered with 1:4 cement: sand mortar layer 20 mm thick. The mix shall be comparatively dry to ensure that it does not penetrate and block the cavities in the no-fines concrete. The surface shall be steel floated to form a plane surface.

The mortar skim shall be cured in the same manner as concrete for a period of not less than 2 days."

PSG 5.5.1.7 Strength concrete

Add the following to SANS 1200 G, sub-clause 5.5.1.7:

"The concrete mix design for strength concrete must be prepared in an approved laboratory and the results of actual test mixes must be submitted for approval together with 7-day and 28-day strength test results. Special attention is drawn to the fact that the concrete mix must provide a very dense and impervious concrete.

The Contractor shall submit details of the proposed concrete aggregates and design mix to the Employer's Agent for approval, after which he shall be required to make a trial mix and obtain cube test results to validate the proposed mix. Only after receipt of satisfactory cube test results, the Contractor shall be permitted to use the mix in the construction of water retaining structures. The cost of designing and proving the proposed concrete mix shall be deemed to be included in the tendered rates.

The Employer's Agent may call for revised mix designs at any stage during the Contract.

Any mix for use in a water retaining structure shall have a water/cement ratio not exceeding 0,5. A cement content not less than 325 kg/m^3 and not more than 450 kg/m^3 shall be used and the proportions of the various aggregates shall be such as to produce a density of at least 2 400 kg/m^3. For concrete containing PFA the maximum cement content shall be 450 kg/m^3.

In order to facilitate or increase the workability of concrete in the fresh/plastic state, to ensure water tightness without increasing the water/cement ratio, the Employer's Agent may approve the use of an additive.

The workability of concrete shall be assessed by means of the slump test. The slump shall be between 75 ± 25mm."

PSG 5.5.2 Batching

Add the following to SANS 1200 G, sub-clause 5.5.2:

"Batching of all strength concrete shall be by mass. Prescribed concrete mixes may be batched by volume. Batching shall not be done by wheelbarrow.

All concrete shall be mechanically mixed.

Stand-by mixers of adequate capacity and with an independent power unit shall be maintained on site for immediate use in the event of breakdown of the regular mixers failure of the power supply."

PSG 5.5.3.2 Ready-mixedconcrete

Replace SANS 1200 G, sub-clause 5.5.3.2 with the following:

"Concrete from a central concrete production facility other than on the construction site will be permitted if the facility is within a 40 km radius of the site and, apart from test results in terms of SANS 1200 G, sub-clauses 7.3.1, 7.3.2 and/or 7.3.3, test results obtained by such a production facility as part of its quality control system will be accepted for evaluation in terms of SANS 1200 G, sub-clause 7.3.4, provided the cubes are stored and cured on site. All tests to be done by an independent approved laboratory."

PSG 5.5.5 Placing

Add the following new sub-clause to SANS 1200 G, sub-clause 5.5.5:

***PSG 5.5.5.10 Casting of concrete in excavation**

"Structural concrete shall not be cast directly against the side of any excavation without the use of formwork unless prior approval has been obtained in writing from the Employer's Agent.

Concrete used in pipe trenches for encasement and for the thrust / anchor blocks may be cast directly against the side of the excavation.

After vibration, the concrete shall be spaded in corners, in angles and against forms to release air bubbles which may have been trapped in these positions."

PSG 5.5.7 Constructionjoints

PSG 5.5.7.1 General

Add the following to SANS 1200 G, sub-clause 5.5.7.1:

"The edge of joints, exposed to view in the finished structure, shall be formed with suitable beads to provide a straight edge true to line and level.

All joints, other than expansion, contraction and other movement joints shall be treated as follows:

As soon as practical, but not before 15 hours after placing, the construction joint surface shall be prepared to receive fresh concrete. This preparation, as specified in SANS 1200 G, sub-clauses 5.5.7.3 (a) to (d), shall be such as to remove all laitance or inert and strengthless material which may have formed and the specified chipping or sand blasting shall be such as to produce a roughened surface all over.

When concreting is interrupted concrete surfaces shall be protected from the sun as specified in SANS 1200 G, sub-clause 5.5.8 (d) or by means of hessian kept damp until con- creting is resumed.

All constructional joints shall be dealt with as specified in PSG 5.5.7.3, as amended.

Unless construction joints between designated joints shown on the drawings are authorized by the Employer's Agent in writing, concrete in the floor and wall shall be cast continuously between the designated joints shown on the drawings."

PSG 5.5.7.2 Formed joints (generally vertical or near vertical)

Add the following to SANS 1200 G, sub-clause 5.5.7.2:

"Formed joints will be considered to be designated joints as defined in SANS 1200 G, sub-clause 2.4.3. The forming of a straight edge to a construction joint as specified in PSG 5.5.7.1, as amended, does not constitute a formed joint.

Each joint shall be formed as shown on the drawings, complete with shear key rebates, waffle formwork, V-feature, waterstops, "Flexcell" or equal, approved joint filler, dowel bars and their PVC tubes, etc. as indicated."

PSG 5.5.7.3 Non-designated joints

Add the following to SANS 1200 G, sub-clause 5.5.7.3:

"Any non-designated joints shall be identical to designated joints, as shown on the drawings, which would be used in similar positions and shall perform the same function."

Add the following new sub-clause to SANS 1200 G, sub-clause 5.5.7:

***PSG 5.5.7.4 Joints between footings or floors and walls or columns**

"Construction joints between foundations, footings or floors and walls, columns or piers connected to them, shall not be made flush with the supporting surface, but shall be made at a distance above the footing or floor shown as on the drawings or approved by the Employer's Agent. The "kicker" shall be cast as an integral part of the foundation, footing or floor."

***PSG 5.5.7.5 Construction joints in circular reservoirs**

a) Construction joints in walls or footings

"Construction joints may only be placed where shown on the drawings or to the approval of the Employer's Agent. No vertical joints shall be permitted in the reinforced concrete reservoir.

The entire contact surface along the joint in the concrete already cast shall be chipped or water jetted to expose the coarse aggregate to 5 mm beyond the surrounding matrix. Care shall be taken to ensure that the concrete structure is not damaged and that all loose material is removed. The surface must be thoroughly cleaned and wetted before casting against the joint.

All construction joints in the reservoir walls and footing shall be cast with water stops. No construction joints will be permitted in the floor.

Payment shall be per linear meter. The rate shall include supply and casting in of the water stop as per detail drawings."

b) Construction joints in roof slabs

"Construction joints in roof slabs are permitted. The position of these joints shall be approved by the Employer's Agent.

These joints shall be cast against a vertical shutter leaving a 15 mm deep by 20 mm wide recess which is sealed with a one part poly-sulphide sealer on completion. The sealer used and method of application shall be to the Employer's Agent's approval.

No additional payment shall be made for these joints."

c) Expansion and contraction joints

"Expansion and contraction joints shall be constructed as detailed on drawings. Water stops extruded from recycled material shall not be permitted.

Payment shall be per linear meter. The rate shall cover all costs for the supply and application of water stops and bandaging including the installation of the stainless steel strip."

***PSG 5.5.7.6 Application of primers and adhesives**

"The concrete to which the primer or adhesive is to be applied shall be dry and shall be cleaned of all dust, grit, grease, surface laitance and foreign matter by compressed air and/or water, solvents, or other suitable approved means. The Contractor shall provide on Site an approved moisture meter to measure the degree of dryness of the joint. This meter shall be made available to the Employer's Agent for testing. The joint shall be approved for the application of the primer and adhesive if the moisture content of the concrete is less than or equal to 5%. It may be necessary to dry the concrete surfaces locally to reduce the moisture content to 5% or less."

***PSG 5.5.7.7 Contraction and expansion joints**

"Contraction and expansion joints shall be formed true to line in smooth formwork.

All surfaces shall be thoroughly cleaned of all accretions of concrete or other foreign matter by scraping or other approved means.

Particular care shall be taken to compact the concrete around waterstops, edges, etc.

Rebates for seals shall be formed to required dimensions and lines, or cut true to line and size after floating the surface and before the final set of the cement has taken place. All rebates, etc., shall be adequately protected against damage until the completion of the work; accidental damage which in the opinion of the Employer's Agent will impair the performance or appearance of the joint shall be made good by reconstructing the work as directed by the Employer's Agent. Rebates for seals shall be grit blasted or wire brushed on all faces to remove surface laitance and thoroughly cleaned with soft brushes and/or compressed air jets, and, if necessary, dried by blow-lamp or other approved means before priming."

***PSG 5.5.7.8 Installation of waterstops in joints**

"Waterstops shall be held in the formwork so as to prevent air pockets forming underneath them. Special precautions shall be taken, to the approval of the Employer's Agent, to ensure that all flexible waterstops are in perfect contact with well compacted void-free concrete."

***PSG 5.5.7.9 Installation of joint filler in expansion joints**

"Joints in the filler shall be neatly butted so as to exclude mortar from the joint. Edges of filler strip against waterstops, concrete, formwork, projections, etc., shall also be closely fitted to exclude mortar, so that there is no resistance (other than the compression of the filler) to the expansion movement for which the joint is designed.

Joint filler shall be fixed to the first cast of concrete with an approved adhesive and as directed by the Employer's Agent."

***PSG 5.5.7.10 Application of joint seals**

"Rebates shall be cleaned as required by PSG 5.5.7.6 Application of primers and adhesives, and shall be inspected and approved by the Employer's Agent's Representative beforefilling.

Joint sealants and primers shall be applied strictly in accordance with the manufacturer's instructions. Flow and non-slumping grades shall be used for horizontal and vertical joints respectively.

Immediately after the compound is applied the joint shall be protected against damage until completion of the Contract."

PSG 5.5.8 Curing and protection

Add the following new sub-clauses to SANS 1200 G, sub-clause 5.5.8:

***PSG 5.5.8.1 Post-Crystallization (concentrate & modified) slurry coat and curing**

"The Concrete surfaces to receive a concentrate slurry coat treatment shall have an open capillary system to provide 'tooth and suction', and shall be free from scale, excess form oil, laitance, curing compounds and foreign matter.

In order to improve the effectiveness of the crystallization treatment, the specified minimum time for the removal of the formwork shall be three days. All surfaces shall be pressure cleaned in accordance to the product manufacturer's requirement to remove all oil, laitance, curing compound and foreign matter.

Concrete surfaces must be thoroughly saturated with clean water prior to application in order to ensure the growth of the crystalline formation deep within the pores of the concrete. Wetting to be done must be at least 1hr before application. If concrete surface dries out before application, it must be re-wetted.

The concentrate slurry is applied at a coverage rate of 1kg/m² using a semi-stiff nylon bristle block brush – work slurry well into the surface, filling surface pores and hairline cracks. The coating must be uniformly applied at approximately 1.25 mm thickness. The second modified slurry coat with the same application rate must be applied within 48 hours of the first coat. Light pre-watering between coats may be required when drying out signs appear. Detail coating applications shall be confirmed by the manufacturing.

Cure by spray for minimum of 3 days must be established once the final coat has been applied. Protect from rainfall, puddling of water, wind & frost for at least 48 hours after application. When plastic sheeting is used as protection allowance must be made for the coating to breathe."

***PSG 5.5.8.4 Curing for normal concrete surfaces**

"The use of membrane curing compounds will be allowed on vertical faces or steeply inclined faces (i.e. steeper than 45° to the horizontal) of cast in situ members of the structures subject to the Contractor producing sufficient, satisfactory cube crushing strength test results where the crushing strength of cubes which have been cured with the proposed curing membrane and left exposed to the elements are compared with those of an equal number of water cured cubes. The crushing strength of cubes cured with the proposed membrane shall be at least 85% of the crushing strength of the water cured cubes.

Before any membrane curing compound is used, each batch shall be tested on a trial surface to ensure that it forms a satisfactory membrane, and any compound which is unsatisfactory in the opinion of the Employer's Agent, shall be rejected. Curing membranes will be disallowed if permanent discolouration of the concrete takes place. Surfaces where curing membranes are used shall be treated in such a manner that the final concrete texture and colour blends in with the rest of the concrete work. Furthermore, the Employer's Agent shall, at his discretion, require the Contractor immediately to adopt an effective alternative means of curing any area of the structure to which a membrane has been applied which, in the opinion of the Employer's Agent, is unsatisfactory. The curing compound used shall be to the approval of the Employer's Agent. Wax based curing compounds will not be permitted.

The curing compound shall be applied immediately as formwork is progressively stripped or, in the case of unformed surfaces, when the concrete has taken its initial set. It shall preferably be applied by spraying and the rate of application shall be strictly in accordance with the manufacturer's recommendations. A method of monitoring the area to which curing compound has been applied and the application rate shall be as approved by the Employer's Agent and rigidly applied by the Contractor.

Surfaces of joint rebates, where elastomeric sealant is to be applied, shall be protected from contamination by curing compound by the use of masking tape."

PSG 5.5.9 Adverse weather condition

Replace SANS 1200 G, sub-clause 5.5.9.2 with the following:

"No placing of concrete shall take place if the ambient temperature exceeds 32°C, or is likely to rise to above 32°C during the casting period or within eight hours after casting is completed.

If concrete is to be cast during times of high ambient temperature or hot drying winds, the Contractor shall be responsible for taking the necessary steps to keep the placement temperature as low as possible. Such steps include the spraying of the coarse aggregate with water, the painting of silos with a reflecting aluminium paint, the insulation of tanks and pipelines, and the protection of concrete ingredients against the direct rays of the sun. The area of the pour shall be shaded before and during concreting and the concrete shall be shaded from the time of mixing until eight hours after placing.

Windbreaks shall be erected if necessary."

PSG 5.5.10 Concrete surfaces

Replace SANS 1200 G, sub-clause 5.5.10 with the following:

PSG 5.5.10.1 Screededfinish

"After placing and compacting the concrete on a top (unformed) surface shall be struck off with a template to the designated grades and tamped with a tamping board to compact the surface thoroughly and to bring mortar to the surface, leaving the surface slightly ridged but generally at the required elevation. No mortar shall be added, and noticeable surface irregularities caused by the displacement of coarse aggregate shall be made good by re-screeding after the interfering aggregate has been removed or tamped."

PSG 5.5.10.2 Wood-floatedfinish

"Where wood-floating is ordered or Scheduled, the surface shall first be given a finish as specified in Sub-clause PSG 5.10.1, as amended, Screeded finish and, after the concrete has hardened sufficiently, it shall be wood-floated, either by hand or machine, only sufficiently to produce a uniform surface free from screeding marks."

PSG 5.5.10.3 Steel-floated finish

"Where steel-floating is specified or scheduled, the surface shall be treated as specified in PSG 5.5.10.1, as amended, Screeded finish except that, when the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, the screeded surface shall be steel-trowelled under firm pressure to produce a dense, smooth, uniform surface free from trowel marks."

PSG 5.5.10.4 Granolithicscreed

PSG 5.5.10.4.1 General

"Granolithic screed shall consist of:

Cement	1 part by mass
Sand	1,25 parts by mass
Coarse aggregate	2 parts by mass

The coarse aggregate shall consist of granite or other approved chips which shall pass a 10 mm sieve and be retained on a 5 mm sieve.

The cement/water ratio of the mix shall be at least 2,0.

Before placing any granolithic screeds the base concrete shall be chipped to expose the aggregate over 100% of the area to be screeded and soaked with water for at least 24 hours.

The base concrete shall be thoroughly cleaned by scrubbing and all standing water removed after soaking. A 1:2 cement/sand grout shall then be brushed into the prepared surface followed by the granolithic screed before the grout sets. The granolithic screed shall be of the driest feasible consistency with a slump not exceeding 50 mm and shall be formed true to profile and shape as required and shown on drawings. Before placing granolithic screed against an adjacent band of granolithic screed the edge of the latter shall be prepared by chipping back to firm material, wire brushing and brushing with grout as for the base concrete.

Granolithic screed shall be compacted to remove all air and shall be screeded and finished with a steel trowel to Degree of Accuracy 1.

The trowelling shall be carried out in the following stages:

a) First - as soon as the granolithic screed has been compacted and screeded.
b) Second - after 2 hours to close the surface and remove laitance.
c) Third - after a further 4 hours.

The time intervals are estimated as appropriate to normal temperature conditions and shall be varied by the Contractor to ensure a smooth dense finish.

Granolithic screed shall be cured as specified in Sub-clause 5.5.8(b), as amended, but shall additionally be protected from direct sunlight and drying winds as it is being placed.

All screeding necessary to accommodate mechanical equipment shall be done under the equipment supplier's supervision and in strict accordance with his instructions. It shall be commenced as soon as the equipment supplier gives notice on completion of erection and shall be finished expeditiously."

PSG 5.5.10.4.2 Screed to floor

"Where screed is specified it shall be approximately 50 mm thickness.

The screed shall be formed from granolithic concrete as specified in PSG 5.5.10.4 Granolithic screed. The screed shall be applied after the mechanical equipment has been erected by the mechanical plant contractor and shall be laid in alternate concentric rings not greater than 2,00 m in width. A period of 24 hours shall elapse before the intervening rings are laid.

The Contractor shall supply and fit a plywood template to the clarifier mechanism to act as a guide in determining the finished screed level. He shall not use the template to physically form the screed surface nor shall he place an excessive load on the scraper mechanism.

The Contractor shall only operate the scraper mechanism in strict accordance with the instructions of the manufacturer and the Employer's Agent, and he shall make good any damage resulting from the use of the machinery.

Granolithic concrete shall be placed in position for a distance of approximately 3,0 m in front of the template and consolidated and roughly trimmed to level. The surface of the screed shall then be trimmed off to the level of the template which shall be moved as required by hand operation of the mechanism.

The trimmed surface shall be steel float finished and the edges of the ring left in a rough vertical condition to provide a key for the adjoining ring.

The preparation of the base concrete shall be done in accordance with PSG 5.5.10.1, as amended, Screeded finish. Before placing granolithic concrete against an adjacent band of granolithic concrete the edge of the latter shall be prepared by chipping back to firm material, wire brushing, and brushing with grout as for the base concrete."

PSG 5.5.11 Watertight concrete

Add the following to SANS 1200 G, sub-clause 5.5.11:

"The floors, walls and roofs of all water retaining structures shall be considered to be watertight concrete structures.

All concrete manholes shall be constructed using watertight concrete."

PSG 5.5.14 Defects

Add the following to SANS 1200 G, sub-clause 5.5.14:

"All defects shall be repaired as soon as possible after the formwork has been removed and the Employer's Agent has inspected the concrete. A statement of the method to be used for each repair shall be submitted to the Employer's Agent for his approval before any work is carried out. The Employer's Agent may prohibit the further placing of concrete in the particular area concerned until he is satisfied that the repair has beensatisfactorily executed."

Add the following new sub-clauses to SANS 1200 G, sub-clause 5.5:

***PSG 5.5.16 Items to be cast in or grouted into concrete**

***PSG 5.5.16.1 Casting pipes and specials in concrete**

"Where the pipe or special is supplied by others or where ordered by the Employer's Agent, the Contractor shall provide a box-out in the wall and cast the unit in at a later stage. When constructing such box-outs reinforcement shall not be cut but shall run through the opening. Reinforcement shall be cut and/or bent out at a later stage to suit the item being cast in. After installation of the item the remaining reinforcement shall be bent back in position.

Where entry holes for pipes/specials have been provided in the walls, the

Contractor shall be responsible for the concreting in of such pipes/specials regardless of whether or not these have been supplied by himself.

Before commencing the positioning in holes of any pipes/specials the Contractor shall:

a) remove all formwork and boxing remaining in the holes;

b) make any alternations required to the position and shape of the holes and cut reinforcement to suit the item, as directed by the Employer's Agent; and

c) thoroughly scabble the sides of the holes so as to obtain a satisfactory bond surface for the new concrete and treat the surface as specified.

Immediately prior to the placing of mortar and concrete around the pipes, the surface of the existing concrete shall be saturated with water. All surplus water shall be removed and the surface covered with a layer, approximately 12 mm thick, of mortar made of the same mix as the concrete in which the pipes/specials are to be placed.

The concrete ingredients shall be mixed and placed as dry as possible to obtain a dense, waterproof concrete. The concrete shall be carefully worked around the puddle flange, if any, and the pipe barrel or body of the special, and shall be vibrated in layers so as to obviate a falling away from pipe/special surfaces of the concrete already placed. The whole shall, when set, form a dense, homogeneous, and waterproof mass."

***PSG 5.5.16.2 Fixings for equipment supplied under separate contract**

a) "The Contractor will be responsible for the forming of pockets to the details shown on the drawings to accommodate holding down bolts for equipment supplied under a separate contract. Holding down bolts will be supplied by and positioned by others.

b) After casting of the concrete all shuttering shall be removed and the sides of the bolt holes and surface on which the machine base is to be placed shall be scabbled to remove all defective concrete, laitance, dirt, oil, grease and loose material.

c) Upon completion of the positioning and alignment of equipment and when instructed by the Employer's Agent the Contractor shall in collaboration with the mechanical contractor, grout up pockets and baseplates by filling pockets and voids under the baseplates with an approved non-shrink grout."

***PSG 5.5.16.3 Fixings for items supplied under this Contract**

"Holding down bolts or other fixings required for the installation of items supplied under this Contract shall be provided by the Contractor. These fixings shall be cast in or grouted into pockets or installed by other means as approved by the Employer's Agent.

Where anchor bolts are used which are installed into holes drilled into concrete or masonry these shall be of a type approved by the Employer's Agent. All such bolts used shall be manufactured from stainless steel or a metal with a resistance to corrosion equal to that of grade 304 stainless steel. The metal used for bolts shall be compatible with galvanized mild steel.

Anchor bolts shall have minimum pull-out forces and minimum ultimate lateral loads at least equal to those specified below:"

Specified Anchor Size	Minimum Pull-out Force (kN)	Minimum Ultimate Lateral Load (kN)
M6	10,35	7,60
M8	13,70	11,15
M10	19,44	15,95
M12	31,85	26,90
M16	50,45	45,80
M20	60,50	71,20

***PSG 5.5.16.4 Plastic puddle pipe items supplied under this Contract**

"Plastic puddle pipe cast-in fittings as indicated per drawing required for the installation of items supplied under this Contract shall be provided by the Contractor. These fittings shall be cast in or grouted into pockets or installed by other means as approved by the Employer's Agent.

All such fittings shall be manufactured from uPVC CLASS 16 according to the drawings in accordance with SANS 966. The welded puddle shall be governed in accordance with standards DVS 2207 and SANS 10268. All welded items shall be issued with an accredited quality certificate from an accredited manufacturer."

PSG 7 Tests

PSG 7.1.2 Frequency of sampling

Add the following to SANS 1200 G, sub-clause 7.1.2.1:

"One sample shall consist of three concrete test cubes.

For each sample taken the position in the structure shall be recorded where the batch represented by that sample is placed as also the date sampled."

Replace SANS 1200 G, sub-clause 7.1.2.2 with the following:

"At least 2 samples shall be taken per day from every 0 m^3 to 10 m^3 of concrete of each grade placed. At least 4 samples shall be taken per day from every 10 m^3 to 20 m^3 of concrete of each grade placed. At least 6 samples shall be taken per day from concrete of each grade placed in excess of 20 m^3."

PSG 7.2 Testing

Add the following new sub-clauses to SANS 1200 G, sub-clause 7.2:

***PSG 7.2.5 Testing watertight concrete**

"The watertightness of the water retaining structures shall be tested as follows:

On completion of a water retaining structure it shall be cleaned and any clear/potable water retaining structures shall be disinfected before testing. The structure shall then be filled with water at an approved rate. Any re-testing that may be required shall be at the Contractor's expense. After allowing a period of absorption of 3 days, the depth of water shall be recorded and the water allowed to stand for a further 7 days during which the total permissible drop in water level after allowing for evaporation should not exceed 10 mm.

In the event of any leakage or dampness being evident at any stage of the filling or testing or in the event of the Employer's Agent considering the final degree of watertightness to be unsatisfactory, the Contractor, when ordered by the Employer's Agent, shall discontinue such filling or testing and shall, at his own expense, immediately take approved steps to rectify the leakage and to make the work thoroughly sound to the complete satisfaction of the Employer's Agent. All such rectification work shall be continued assiduously until a satisfactory test is obtained, which shall prove to the Employer's Agent that watertightness has been obtained.

If required by the Employer's Agent, the structure shall be retested before the expiry of the Defects Liability Period.

The Works will not be certified complete until the structure has been proved by testing to be watertight to the satisfaction of the Employer's Agent."

***PSG 7.2.6 Durability testing**

"Concrete shall comply with the durability parameters defined below:

a) Watersorptivity

Sorptivity is sensitive to surface effects and may be used to assess the effectiveness of initial curing.

b) Oxygen permeability

Permeability is sensitive to changes in the coarse pore fraction and is thus a means of assessing the degree of compaction of concrete. It may be used to quantify the microstructure of the concrete and is sensitive to macro-defects such as voids and cracks.

c) Chloride conductivity

Chloride conductivity provides a method of characterisation of concrete in the marine environment and may be used to assess the chloride resistance of concrete.

Unlike oxygen permeability and water sorptivity, chloride conductivity is not really a measure of construction quality, but it shall be used for materials selection and design of mixes in aggressive chloride conditions. It will therefore only be used as a check on mix designs during the initial stages of construction.

d) Concretecover

Concrete cover is a dimensional indicator of cover concrete depth. Cover concrete is the outer concrete layer which protects the internal reinforcing steel, and its depth varies according to the requirements of the different environmental exposure classes.

Test for cover shall be conducted using an approved calibrated electromagnetic cover meter.

This test shall be conducted when instructed by the Employer's Agent to confirm that the specified depth of concrete cover has been achieved. The cover meter tests shall cover at least 1 m^2 for every 10 m^2 exposed. The average cover of the 1 m^2 subjected to the test shall be used to determine the payment as per Table PSG 7.3.10.3 unless the Contractor chooses to carry out additional tests as detailed under clause PSG 7.3.7. The cover meter must be calibrated for each project by drilling and measuring actual cover in at least 3 locations to validate the readings.

e) General

Durability predictions will be based on the following tests that shall be arranged by the contractor. The durability testing shall be carried out by a laboratory approved by the Employer's Agent.

For testing, water sorptivity, oxygen permeability and chlorine conductivity, cores of 68 mm diameter shall be extracted from the structure when the concrete reaches the age of at least 28 days and tested for the durability criteria set out in PSG 7.3.6. The frequency of the testing at the start of the contract shall be such that there is at least one test (consisting of 2 cores) per discrete concrete element, or per 15 m^3 poured (whichever is the lesser), until such time that the Employer's Agent is satisfied that the specified criteria are consistently achievable. Hereafter testing shall be limited to one test per discrete concrete element or maximum concrete pour of 40 m^3 (whichever is the lesser), or as directed by the Employer's Agent. Depending on access requirements, the frequency and locations of the tests may be changed to suit site requirements as directed by the Employer's Agent. Note that for decks and walls, the cores shall be taken on the exposed faces of the concrete i.e. the soffit and side wall face, taking care not to cut the reinforcing bars. Where the cores do contain pieces of reinforcing steel, they shall not be used for the tests, particularly in the chloride conductivity test or where bleeding cavities may have formed.

The cores shall be extracted through the cover concrete from the constructed concrete element and a slice (25 mm thick) shall then be cut from the outer surface of this core such that the slice is representative of the middle layer of the cover concrete, i.e. the middle layer being a 25 mm thick slice of concrete, 5 mm from the exposed outer surface extending in towards the reinforcement, and tested. The positions at which the cores shall be extracted shall be as indicated by the Employer's Agent.

Filling of the holes left by the drilling of the cores shall be the responsibility of the contractor and shall be carried out using an approved proprietary non-shrink repair mortar so as to restore structural integrity and durability of the structural element tested. The cost of drilling and filling of the holes shall be included in the rate make- up of pay items for durability testing."

***PSG 7.2.7 Depth of concrete cover**

"The procedure for testing for depth of reinforcement from concrete surface shall be in accordance with the manufacturer's requirements for the relevant electromagnetic cover meter. The number of readings taken to each 1 m^2 to be tested shall be such that an accurate average cover can be determined for the tested area."

***PSG 7.2.8 Shrinkage**

"The dry shrinkage tests shall be conducted in accordance with SANS 1085. The drying shrinkage shall not exceed 0.04%."

PSG 7.3 Acceptance criteria for strength concrete

Add the following new sub-clauses to SANS 1200 G, sub-clause 7.3:

***PSG 7.3.6 Durability parameters acceptance ranges**

***PSG 7.3.6.1 General**

"When tested in accordance with the test procedures described below for each potential durability parameter, the concrete shall meet the limits given in the tables."

***PSG 7.3.6.2 Water sorptivity and oxygen permeability**

Table PSG 7.3.6.2 Water Sorptivity and Oxygen Permeability

AcceptanceCategory	Test No. / Description / Unit	
	Water Sorptivity (mm/h)	OxygenPermeability (log scale)
Concrete made, cured and tested in laboratory	6	> 10.0
Full acceptance of in-situ cast concrete	< 8	> 9.15
Conditional acceptance of in-situ cast concrete (with remedial measures)	8 - 15	8.75 – 9.15
Rejection	> 15	< 8.75

***PSG 7.3.6.3 Chloride conductivity**

Table PSG 7.3.6.3 Chloride Conductivity (severe to very severe conditions)

Concrete	100% PC		10% CSF		30% FA		50% GGBS	
Curing Period	28d	90d	28d	90d	28d	90d	28d	90d
Full wet cured	1.25	1.00	0.50	0.45	1.50	0.40	1.25	1.00
Moist cured (3 – 7d)	1.75	1.60	0.60	0.55	2.25	1.25	2.25	2.00

***PSG 7.3.6.4 Concrete cover**

Table PSG 7.3.6.4	Concrete Cover		
Test Description	Specified Cover (mm)	Acceptance Range	
		Minimum	Maximum
Concrete cover to reinforcement	20 – 30	As specified	As specified + 5 mm
	30 - 80	As specified	As specified + 10 mm

***PSG 7.3.7 Criteria for the compliance with the requirements**

"No extra payment shall be made for cube strength testing. The cost of cube strength testing shall be included in the rates tendered for concrete.

Water used for testing shall be free of charge except for failed tests when water will be charged at standard municipal rates.

In the event that the actual achieved average cube strengths of an element are less than 85% of the target mean strength, the Employer's Agent may instruct the taking of cores for additional strength testing. The cost of taking the cores and repairing the holes in the structures shall be for the Contractor's account.

The Employer's Agent will conduct routine tests for the durability parameters on cores taken from the completed elements during the construction, the costs for which shall be to the Employer's account unless the parameters are not met.

The test results shall be accepted or rejected based on the criteria as set out in Tables PSG 7.3.6.2, PSG 7.3.6.3 and PSG 7.3.6.4 based on the following categories:

(a) Full Acceptance: Concrete shall be accepted unconditionally and full payment shall be made.
(b) Conditional Acceptance: Concrete may be accepted at the Employer's Agent's discretion with a warning that construction methods be examined to improve the durability criteria. A reduced payment shall be applied to all the relevant pay items under SANS 1200 G for the non-conforming element or concrete pour as set out in Tables PSG 7.3.10.1, PSG 7.3.10.2 and PSG 7.3.10.3. Alternatively, the Contractor may elect to carry out remedial work to improve the durability of the concrete to the criterion of "Full Acceptance" to the satisfaction of the Employer's Agent, and receive full payment. All proposed remedial measures shall be subject to the approval of the Employer's Agent. The cost of all such remedial work shall be for the Contractor's account.
(c) Rejection: The concrete shall be removed and replaced with fresh concrete at the expense of the Contractor, as directed by the Employer's Agent.

Should the test result(s) indicate conditional acceptance or rejection of the item tested, the Contractor shall have the option of carrying out additional tests on that item, at his own expense, to confirm or disapprove the original test result(s). Not more than two such additional tests shall be carried out. Should one additional test confirm the original test result, then the original result shall serve to determine payment in accordance with Tables PSG 7.3.10.1, PSG 7.3.10.2 and PSG 7.3.10.3. If two additional tests are carried out and both such tests contradict the original test result(s) then the effective penalty as per Tables PSG 7.3.10.1, PSG 7.3.10.2 and PSG 7.3.10.3, based on the original test result(s), shall be halved."

***PSG 7.3.8 Procedure in the event of non-compliance with the requirements**

"Structural concrete elements or concrete pours shall be represented by test cubes and extracted cores, which shall be tested for strengths and the appropriate durability parameters.

If the durability parameters have been proved acceptable, the costs for such testing shall be borne by the Employer. However, where non-compliance to the specified parameters has been identified, the assessed element shall be rejected and at the Employer's Agent's sole discretion any of the following measures may be considered at the Contractor's expense:

(a) Coating with an approved product specifically designed to improve the non-conforming parameter depending on the severity of the test results.
(b) Acceptance at reduced payment.
(c) Demolition and rebuilding.

Where the Employer's Agent allows conditional acceptance, reduced payment shall be applied to all the relevant pay items under SANS 1200 G for the non-conforming element or concrete pour according to Tables PSG 7.3.10.1, PSG 7.3.10.2 and PSG 7.3.10.3."

***PSG 7.3.9 Tests ordered by the Employer's Agent**

"One concrete cube strength test shall comprise the results of tests carried out on three standard test cubes made from concrete sampled from one batch of concrete in accordance with these specifications."

***PSG 7.3.10 Determination of reduced payment**

"Payments for all durability concrete shall be based on the test results. The durability parameters are calculated according to Tables PSG 7.3.10.1, PSG 7.3.10.2 and PSG 7.3.10.3 below.

Table PSG 7.3.10.1 Water sorptivity

TEST	Coastal (≤ 5 km from coast and up to 15 km upriver valleys/estuaries)		Inland (> 1 km from coast)	
Water sorptivity (mm/h)	TEST RESULT	% PAYMENT	TEST RESULT	% PAYMENT
	< 8	100%	< 8	100%
	8 < 12	90%	≥ 8 < 12	90%
	12 < 15	85%	≥ 12 < 15	85%
	≥ 15	0%	≥ 15	0%

Table PSG 7.3.10.2 Oxygen permeability

TEST	Coastal (≤ 5 km from coast and up to 15 km up rivervalleys/estuaries)		Inland (> 1 km from coast)	
Oxygen Permeability Index (log scale)	TEST RESULT	% PAYMENT	TEST RESULT	% PAYMENT
	> 9.15	100%	> 9.5	100%
	> 9.0 ≤ 9.15	90%	>9.25 ≤ 9.5	90%
	> 8.75 ≤ 9.0	85%	>9.0≤ 9.25	85%
	≤ 8.75	0%	≤ 9.0	0%

Table PSG 7.3.10.3 Concrete cover

TEST	Coastal (≤ 5 km from coast and up to 15 km up river valleys/estuaries)		Inland (> 1 km from coast)	
	TEST RESULT	% PAYMENT	TEST RESULT	% PAYMENT
30 mm specified	≥ 30 ≤ 40	100 %	≥ 30 ≤ 40	100 %
	≥ 25 < 30	40 %	≥ 20 < 30	40 %
	< 25 or > 40	0 %	< 20or> 40	0 %
40 mm specified	≥ 40 ≤ 50	100 %	≥ 40 ≤ 50	100 %
	≥ 35 < 40	40 %	≥ 30 < 40	40 %
	< 35 or > 50	0 %	<30or>50	0 %
50 mm specified	≥ 50 ≤ 60	100 %	≥ 50 ≤ 60	100 %
	≥ 45 < 50	40 %	≥ 40 < 50	40 %
	< 45 or > 60	0 %	< 40or> 60	0 %
60 mm specified	≥ 60 ≤ 70	100 %	≥ 60 ≤ 70	100 %
	≥ 55 < 60	40 %	≥ 50 < 60	40 %
	< 55 or > 70	0 %	< 50or> 70	0 %
65 mm specified	≥ 65 ≤ 75	100 %	≥ 65 ≤ 75	100 %
	≥ 60 < 65	40 %	≥ 55 < 65	40 %
	< 60 or > 75	0 %	< 55or > 75	0 %
75 mm specified	≥ 75 ≤ 85	100 %	≥ 75 ≤ 85	100 %
	≥ 70 < 75	40 %	≥ 65 < 75	40 %
	< 70 or > 85	0 %	<65 or> 85	0 %
80 mm specified	≥ 80 ≤ 90	100 %	≥ 80 ≤ 90	100 %
	≥ 75 < 80	40 %	≥ 70 < 80	40 %
	< 75 or > 90	0 %	<70 > 90	0 %

Percentage payment for concrete cover shall be based on the average result of the total number of cover meter tests performed on a particular concrete element.

The overall percentage payment applied to a concrete member shall be based on the average of the percentage payments applicable to each durability parameter, together with the percentage payment based on the strength requirements described in the project specifications.

The reduced payments shall apply to the relevant payment items Scheduled in the Bill of Quantities."

***PSG 7.3.11 Grouting**

"The Contractor shall, where so ordered, carry out a site test for each grouting procedure. The tests shall be carried out on a dummy bedplate similar in configuration to that which is to be grouted, but not exceeding $1m^2$ in area unless otherwise ordered. When the dummy bedplate is dismantled, the underside shall show a minimum grout contact area of 80% with reasonably even distribution of the grout over the surface grouted except that, in the case of expanding grout, the minimum grout contact area shall be 95%. The test shall show evidence of good workmanship and materials and the results shall be to the satisfaction of the Employer's Agent.

The Contractor shall, when so ordered, make standard test cubes from various grout mixtures and also subject them to compression tests to determine whether the specified strength has been achieved. Test procedures shall comply with the relevant requirements of Sub-clauses 7.2.1 to 7.2.3."

PSG 8 Measurement and payment

PSG 8.1.1 Formwork

SANS 1200 G, sub-clause 8.1.1 to include payment for:

PSG 4.5.3	Ties
PSG 5.2.1	Classification of finishes
PSG 5.2.2	Preparation of formwork

Add the following new sub-clauses to SANS 1200 G, sub-clause 8.1.1:

***PSG 8.1.1.7 Edges of blinding layer**

"No separate payment will be made for formwork to the edge of the blinding layer. The rates tendered for concrete to the blinding layer shall cover the cost of such formwork."

***PSG 8.1.1.8 Chamfers and fillets**

"No additional payment will be made for chamfers and fillets up to 40 mm wide. Larger fillets and chamfers will be measured by length in accordance with SANS 1200 G, sub-clause 8.2.5."

PSG 8.1.2 Reinforcement

SANS 1200 G, sub-clause 8.1.2 to include payment for:

PSG 5.1.2 Fixing

Add the following to SANS 1200 G, sub-clauses 8.1.2.2 and 8.1.2.3:

"Notwithstanding the method of measuring and paying for reinforcement specified in SANS 1200 G, sub-clauses 8.1.2.2 and 8.1.2.3, reinforcement will be measured and paid for as scheduled."

PSG 8.1.3 Concrete

SANS 1200 G, sub-clause 8.1.3 to include payment for:

PSG 3.2.1	Cement: Applicable specifications
PSG 3.2.3	Storage of cement
PSG 3.3	Water
PSG 3.4.1	Aggregates: Applicable specification
PSG 3.4.2	Use of plums
PSG 3.5	Admixtures
PSG 4.3.1	General requirement for mixing plant
PSG 4.4	Vibrators
*PSG 4.6	Water-bath
PSG 5.5.1.1	Quality: General
PSG 5.5.1.4	Chloride content
PSG 5.5.1.5	Durability

PSG 5.5.1.6	Prescribed mix concrete
PSG 5.5.1.7	Strength concrete
PSG 5.5.2	Batching
PSG 5.5.3.2	Ready-mixed concrete
PSG 5.5.5.10	Casting of concrete in excavation
PSG 5.5.8	Curing and protection
PSG 5.5.9	Adverse weather conditions
PSG 5.5.11	Watertight concrete
PSG 5.5.14	Defects
PSG 7.1.2	Frequency of sampling
PSG 7.2	Testing
*PSG 7.3.6 to *PSG 7.3.10	

PSG 8.2 Scheduled formwork items

Add the following new payment item to SANS 1200 G, sub-clause 8.2:

***PSG 8.2.7 Kickers .... Unit: m^2**

"Formwork to the edges of kickers will be measured as plane (or circular) vertical (not as narrow widths)."

PSG 8.4 Scheduled concrete items

PSG 8.4.4 Unformed surface finishes

Add the following to SANS 1200 G, sub-clause 8.4.4:

"The rates for unformed surface finishes shall cover the cost of providing the respective surface finish as specified in PSG 5.5.10, as amended, Concrete Surfaces."

PSG 8.5 Joints

Add the following to SANS 1200 G, sub-clause 8.5:

"Only designated joints as shown on the drawings will be measured for payment according to the length of each type of joint constructed. The rate shall cover the cost of all materials, labour and plant required to construct each type of joint specified on the drawings, including the cost of all shuttering, treatment of the joint as specified in SANS 1200 G, sub-clause 5.5.7.3 and PSG 5.5.7.3, as amended, the provision of chamfers as specified where concrete is exposed, as well as testing and repairing where necessary.

Non-designated joints will not be measured for payment."

SANS 1200 G, sub-clause 8.5 to include payment for:

*PSG 3.9	Materials for movement joints
PSG 5.5.7	Construction joints

Add the following new payment items to SANS 1200 G, sub-clause 8.5:

***PSG 8.5.1 Formed joints ....Unit: m**

"Formed joints will be measured by the length of the joint.

The rates shall cover the cost of all operations and materials specified in PSG 5.5.7, as amended, and detailed on the drawings such as joint filler, dowel bars and tubes, bitumen coats, waterstops or waterbars, etc."

PSG 8.7 Grouting

Add the following to SANS 1200 G, sub-clause 8.7:

"Grouting of base plates and equipment bases will be measured by the volume of grout used.

The rate shall cover the cost of the supply and floating in of grout under the plates to ensure solid and complete filling of the gap."

SANS 1200 G, sub-clause 8.7 to include payment for:

*PSG 5.5.16.2	Fixing of equipment supplied under separate contract
*PSG 5.5.16.3	Fixing for items supplied under this Contract
*PSG 7.3.11	Grouting

PSG 8.8 HD bolts and miscellaneous metal work

Add the following to SANS 1200 G, sub-clause 8.8:

"Fixing of holding down bolts will be measured by number. The rate shall cover the cost of all things necessary to ensure that the bolts are effectively and rigidly held in position during casting, complete with sleeved pockets, all as detailed on the drawings."

Add the following new payment items to SANS 1200 G, clause 8:

***PSG 8.9 No-fines concrete ....Unit: m^2**

"No-fines concrete will be measured by area.

The rate shall cover the cost of supplying materials, constructing and placing in position and compaction of the no-fines concrete as specified in PSG 5.5.1.7, Strength concrete, as amended, and shall include for the steel floated 20 mm mortar skim to the approval of the Employer's Agent."

***PSG 8.10 Items cast in concrete .... Unit: No.**

"Items cast in concrete will be measured by number separately for each type of item.

Notwithstanding SANS 1200 G, sub-clause 8.2.6, the rate shall cover the cost of fixing in position and casting in the item as construction proceeds, irrespective of whether the Contractor chooses to fix the item in the formwork and cast it in directly or to box out a hole and grout the item in subsequently. The rate is to include payment for *PSG 5.5.16.1, Casting pipes and specials in concrete, and *PSG 5.5.16.4, Plastic puddle pipe items supplied under this Contract.

The rate for the puddle pipes shall cover the cost of all things necessary to ensure that the fitting are effectively and rigidly held in position during casting including the certification and all as detailed on the drawings. Repairs for leaking cast in items will not be paid for."

***PSG 8.11 Granolithic screeds ....Unit: m²**

"Special floor finish will be measured by area. The rate shall cover the cost of the supply and application of the specified material, complete as specified by the manufacturer and to the approval of the Employer's Agent. Repairs to unsatisfactory work will not be paid for.

Measurement of granolithic screeds will be by the surface area covered.

The unit rate or lump sum shall cover the cost of all materials, labour and equipment required to provide the screed as specified in PSG 5.5.10.4, Granolithic screeds. The rate shall include the steel float finish."

***PSG 8.12 Precast paving slabs.. Unit: m²**

"Precast paving slabs will be measured by the area paved.

The rate shall cover the cost of compacting the area, application of weed-killer, supplying, laying and bedding the slabs, grouting the joints and filling any gaps, all as specified in *PSG 3.10, Precast paving slabs."

***PSG 8.13 PFA concrete...Unit: m³**

"Measurement and payment for PFA concrete shall be as specified in PSG 8.1.3, Concrete, as amended.

The tendered rate shall cover all costs in connection with the supply, storage, handling on site and mixing in of PFA."

***PSG 8.14 Watertightness test ....Unit: No.**

"The watertightness test will be paid by a lump sum separately for each structure.

The sum shall cover the cost of all labour, equipment and materials to carry out the tests, as specified in *PSG 7.2.5, Testing watertight concrete, to rectify faults and to achieve a test result to the satisfaction of the Employer's Agent."

***PSG 8.15 Slurry coat and curing ....Unit: m²**

"Supply & apply waterproof treatment with Xypex Concentrate and Xypex modified to all areas as specified.

The rate shall cover for the supply and surface treatment of specified concrete surfaces according to *PSG 5.5.8.1, Post-Crystallization (Concentrate & Modified) slurry coat and curing."

PSG 8.16 Bond Breaker... Unit: m²

"Where a black plastic continuous layer is to be laid over the no-fines concrete under floor slabs, the side and end laps shall not be less than 100mm. Just before casting the sheeting shall be perforated in a grid pattern at 1 m centres.

Care shall be taken not to rip or tear the sheeting. All repairs shall be at the Contractor's expense.

The rate shall include payment for *PSG 3.9.4, Bond breakers, primers and sealants."

PSHA STRUCTURAL STEELWORK (SUNDRY ITEMS) (SANS 1200 HA)

PSHA 3 Materials

Add the following under SANS 1200 HA, clause 3:

“Where the words "Structural Steelwork" appear in the heading and in other relevant Clauses, amend to read "Aluminium, Stainless Steel and Structural Steel".”

PSHA 3.1 Structural steel

Add the following to SANS 1200 HA, sub-clause 3.1:

“All stainless steel items shall be Grade 304L material.

Structural steelwork shall comply with Grade 43 of BS 4360. All steel pipes and specials, irrespective of diameter, shall be fabricated from plain ended pipes. The use of screwed flanges and fittings shall not be permitted, except for use on air-valve assemblies. All fabrication shall take place in a suitable workshop prior to galvanizing, and no cutting or welding of pipes on site shall be permitted.

All aluminium items shall be grade M57S material anodized in accordance with SANS 999 Grade 25.”

PSHA 3.3.1 Bolts and nuts

Add the following to SANS 1200 HA, sub-clause 3.3.1:

“All bolts, nuts and washers within water retaining structures or exposed to the rain, or with a diameter of 10 mm or less, all anchor bolts of any size in concrete or brickwork and all bolts of any size used in conjunction with stainless steel items, shall be manufactured from Grade 304L stainless steel.

All other bolts, nuts and washers with a diameter of 12 mm or greater shall be hot dip galvanized to SANS 10684. Nuts shall be tapped before galvanizing, taking into consideration the extra clearance necessary to allow for the thickness of galvanizing on the bolts. If, after installation, there is any indication that galvanising has been stripped from either the nut or the bolt, both nut and bolt shall be removed and replaced.”

PSHA 5 Construction

PSHA 5.2.6 Handrails

Add the following to SANS 1200 HA, sub-clause 5.2.6:

“The handrails shall be manufactured by an approved manufacturer specializing in such work and shall be of galvanized steel tubing of nominal thickness 2,6mm and of normal outside diameter at least 34 mm.

Stanchions shall be manufactured preformed in one piece and shall be at least 42 mm nominal outside diameter. The bases of the stanchions shall be preformed to suit the situation in which they are to be installed, and the stanchions and spheres shall be preformed to suit right angled or other angled intersections as shown on the drawings.

Stanchions shall be spaced at intervals not exceeding 2,0m. All joints shall be welded, cold galvanised and painted after the erection of handrails."

PSHA 5.2.10 Protective treatment

Replace the last sentence of SANS 1200 HA, sub-clause 5.2.10 with the following:

"The open grid and chequer plate flooring panels and frames, handrails, ladders and similar items shall be hot-dip galvanized in accordance with the requirements of SANS 1200 HC, sub-clause 5.9.

In addition handrails shall be degreased, primed and painted yellow with two coats of recoatable polyurethane to a minimum total dry film thickness of 70 micrometers after installation."

Add the following new sub-clause to SANS 1200 HA, sub-clause 5.2:

***PSHA 5.2.11 Hand stops and stop logs**

"Stainless Steel 316 hand stops shall close drop tight and be manufactured to the dimensions shown on drawings.

Fabrication details of hand stops and stop logs shall be submitted to the Employer's Agent for approval before manufacture commences. Hand stops with daylight openings exceeding 0,5 m^2 shall be supplied in equal 250 mm stop logs with a neoprene interface seal.

The hand stops and stop logs shall be supplied with Stainless Steel 316 frames which are suitable for casting into concrete, and shall, where necessary, be provided with strengthening plates to withstand the pressure of the full water depth. The stop logs shall be provided with resilient water seals under each unit to provide a drop-tight seal."

PSHA 8 Measurement and payment

PSHA 8.3.1 Structural steel

SANS 1200 HA, sub-clause 8.3.1 to include payment for:

PSHA 3.1 Structural steel
PSHA 3.3.1 Bolts and nuts

PSHA 8.3.2 Handrails

Add the following to SANS 1200 HA, sub-clause 8.3.2:

"Handrails will be measured according to SANS 1200 HA, sub-clause 8.3.2 (a) and the relevant drawing. The rate shall include for PSHA 5.2.6, Handrails, as amended."

PSHA 8.3.6 Corrosion protection

"Notwithstanding the requirements of SANS 1200 HA, sub-clause 8.3.6, corrosion protection will not be measured separately, the rates tendered for the steel items being held to include for the cost of corrosion protection as specified in PSHA 5.2.10, Protective treatment, as amended."

Add the following new payment item to SANS 1200 HA, sub-clause 8.3:

***PSHA 8.3.7 Hand stops ....Unit: No.**

"The tendered rate shall cover the cost of supply, delivery, corrosion protection and complete installation of gates and frames. The rate shall also make provision for *PSHA 5.2.11, Hand stops and stop logs."

PSHC CORROSION PROTECTION OF STRUCTURAL STEELWORK (SANS 1200 HC)

PSHC5 Construction (execution of work)

PSHC 5.9 Application of metal coatings (hot-dip galvanizing, metal spraying)

Add the following to SANS 1200 HC, sub-clause 5.9:

“All structural steel members shall be hot-dip galvanized.”

PSL MEDIUM-PRESSURE PIPELINES (SANS 1200 L)

PSL 2 Interpretations

PSL 2.4 Abbreviations

Add the following to SANS 1200 L, sub-clause 2.4:

GRP : Glass Reinforced Polyester

PSL 3 Materials

PSL 3.1 General

Add the following to SANS 1200 L, sub-clause 3.1:

"The materials and construction of all pipes, fittings, valves and specials shall comply with the appropriate SANS, BS or other appropriate specification, whether stated or not, and shall be approved by the Employer's Agent. Only full-length pipes bearing the relevant standard's mark will be acceptable. Cut pipes shall only be used at pipe junctions to position valves and specials as shown on the drawings, and at connections to structures. When laying the pipes the markings shall be visible from above.

Pipelines shall be high density polyethylene (HDPE), PVC-U pipes, PVC-O pipes and PVC-M pipes complying with SANS 966, as scheduled or shown on the drawings.

HDPE pipes shall be joined using of the "Plasson" compression type, or equivalent, approved couplings which have a polypropylene body, nut and compression ring with rubber O ring.

The Contractor shall be responsible for the structural and hydraulic design of all bends and fittings where these are not standard off the shelf items designed and guaranteed by the manufacturer for the purpose intended. Acceptance of the Contractor's design will be subject to the Employer's Agent's approval.

The Employer's Agent shall at all reasonable times have free access to the place where the goods are manufactured for the purpose of examining and sampling the materials and goods, and if necessary for supervising the testing and marking of goods. The manufacturer shall supply free of charge every facility and all labour required for such examination, sampling, inspection, testing and marking before delivery and shall provide and maintain in good order suitable, convenient and accurate apparatus for testing goods.

Mild steel specials shall have a minimum wall thickness of 4,0 mm, and shall be hot dipped galvanised. The ends of plain ended specials which join onto FC or CI pipework shall be fitted with 150 mm wide collars and machined to the OD of PVC-U pipes of the diameter specified.

Steel pipes shall be groove ended galvanised carbon steel pipes with Klambon type cast galvanised SP couplings or similar approved and shall comply with the requirements of SANS 815.

Stainless steel pipework specials shall be manufactured from Grade 304L Schedule 10 as scheduled. Grade 304L specials shall have a minimum wall thickness of 3 mm. All welds shall be pickled and passivated.

The ends of plain ended specials which join onto uPVC or CI pipework shall be fitted with 150 mm wide collars and machined to the OD of uPVC pipes of the diameter specified.

All pipes, specials and valves arriving on site shall be marked clearly with the item number appearing in the Bill of Quantities. Furthermore the nuts, bolts, washers and other ancillary equipment for each individual item shall be kept separate in a bag which shall also bear the respective reference number of that item. The cost of such marking will be held to have been included in the rates tendered for the items.

The Contractor shall satisfy the Employer’s Agent that the manufacturers' recommendations for good practice for transporting, handling, stacking, storing and installing pipes, pipe fittings, sealing rubbers etc. are being diligently followed. The Employer’s Agent shall be given the opportunity to inspect all materials immediately prior to installation and shall have the right to reject any materials which, in his opinion, have suffered damage which may impair the long term durability or strength of said items.

Pipes and specials shall be protected against damage during all stages of manufacture, delivery, storage and handling. The ends of all steel pipes and specials shall be protected against denting. Steel pipes shall be transported and stacked in such a manner that the pipe barrel is not deformed by more than 2% of its diameter. Dents which cause a protrusion of more than 1 mm on the inside of the steel special, may result in the special being rejected.”

PSL 3.4 Steel pipes, fittings and specials

PSL 3.4.1 General

Add the following to SANS 1200 L, sub-clause 3.4.1:

“All steel pipes and specials, irrespective of diameter, shall be fabricated from plain ended pipes. The use of screwed flanges and fittings shall not be permitted, except for use on air-valve assemblies. All fabrication shall take place in a suitable workshop prior to galvanising, and no cutting or welding of pipes on site shall be permitted.

The Contractor shall, when called upon to do so, make available to the Employer’s Agent the manufacturer’s certificates covering the chemical analysis and physical properties of the steel used in the manufacture of the pipes. The pipes shall be hydraulically tested before leaving the factory to the test pressure specified in sub-clause 7.3 of SANS 1200 L. The methods of sampling and testing of the manufactured pipes shall comply with Sections 6 and 7 of SANS 719. Tests shall be carried out at the place of manufacture and at the expense of the Contractor. On delivery of the goods concerned the Contractor shall supply a signed certificate giving results of the tests and certifying that the goods have been manufactured in accordance with the Specification.”

PSL 3.4.3 Pipes of nominal bore over 150mm

Replace SANS 1200 L, sub-clause 3.4.3 with the following:

“Steel pipes of nominal bore over 150 mm shall comply with the applicable requirements of SANS 719 and shall be Grade B. The minimum wall thickness of steel pipes, fittings and specials up to 660mm external diameter shall be 6 mm, and above 660mm to 914mm external diameter shall be 8mm. The ends of pipes, fittings and specials used with uPVC pipes shall have suitable spigot ends.

Pipes shall be longitudinally and circumferentially butt-welded by the submerged arc welding process. Spirally welded pipes will also be accepted. The welding processes and materials used for the fabrication of the pipes shall conform to SANS 044. The Contractor shall, when called upon to do so, provide written confirmation that welding has been carried out by coded welders.

Plain ends shall be machined to suit the outside dimensions of connecting pipework.

The Contractor shall be responsible for the structural design of all steel bends, tees, fittings and specials, which design shall be carried out by a registered Professional Employer's Agent. Costs for design shall be included in the rates for design, supply and laying. The Contractor shall submit certification of the designs and manufacture to the Employer's Agent for approval prior to delivery to site.

All steel pipes and specials shall be hot-dip galvanised after manufacture.

Any damage to the coatings prior to or during laying/fixing of the pipes will be cause for the pipes to be rejected by the Employer's Agent unless the damage is repaired to the approval of the Employer's Agent."

PSL 3.7 Other types of pipes

Add the following new sub-clauses to SANS 1200 L, sub-clause 3.7:

***PSL 3.7.4 mPVC pipes**

"mPVC pipes and fittings shall be fitted with spigot and socket rubber ring joints and shall comply with the requirements of SANS 966-1."

***PSL 3.7.5 GRP pipes**

"Glass reinforced pipe and fittings shall conform to ASTM D3262, ASTM3754, AWWA C950 and SANS 1748 -1 : 1998 Glass Fibre Reinforced Thermosetting Plastics (GRP) pipes Part 1 : Pipes for Water Supply , Sewerage or drainage. GRP pipe shall be stiffness SN 5000 jointed with Double Bell couplings. The pressure rating and diameter shall be as detailed in the Bill of Quantities and drawings."

PSL 3.8 Jointing material

PSL 3.8.2 Flexible couplings

Replace SANS 1200 L, sub-clause 3.8.2.1 with the following:

"Detachable couplings shall be of the "Viking-Johnson" or similar approved type without central register unless otherwise specified. Coupling flanges shall be designed to withstand the hydrostatic test pressures and all stresses due to tightening of the bolts, and the rubber rings shall generally comply with BS 2494 Class D. Detachable couplings shall suit the outside dimensions of pipe-work complying with either BS 2035 or the relevant SANS specification as the case may be.

Mild steel "Viking-Johnson " couplings shall be lined and coated with SIGMA EP 2300 or approved equivalent to the manufacturer's specification, and a minimum dry film thickness of 350 micron.

All cast iron pipes, specials and valves shall be given two coats of approved epoxy paint except where cast into concrete. The cost of this work shall be included in the rates tendered for supplying and fixing pipes, specials and valves."

PSL 3.8.3 Flanges and accessories

Add the following to SANS 1200 L, sub-clause 3.8.3:

"All flanges shall be to SANS 1123 Table 1600/3 unless otherwise specified or shown on the drawings. The Contractor shall be responsible for ensuring that the flange drillings on all pipeline components including valves, fittings, specials and fixtures etc. are compatible.

Where used with mild steel pipes underground, the connections shall be bitumen mastic wrapped.

All gaskets for flanged joints shall be 3 mm thick, full face rubber insertion in accordance with the requirements of BS 3063.

Where services are relocated or connected to existing pipes, the dimensions of existing flanges and pipes shall be verified by the Contractor prior to ordering of materials.

Any item of pipework or special or valve of which the flanges are incorrectly drilled, will be rejected. The reaming of bolt-holes to oversized dimensions to enable a particular item to fit will not be allowed.

All flanges shall be provided complete with bolts, nuts, washers and rubber O-rings as appropriate. Rubber O-rings dimensioned in accordance with DIN 2514 specification shall be supplied to suit suitably machined flanges.

"All bolts, nuts and washers used in the jointing of mild steel pipes shall be hot-dip galvanised in accordance with SANS 121:2011. Under no circumstances shall electro-plating be accepted as an alternative means of corrosion protection."

All bolts, nuts and washers for jointing of stainless steel pipes shall also be stainless steel all in accordance with SANS 1700."

PSL 3.9 Corrosion protection

PSL 3.9.1 Cast iron pipes

Replace SANS 1200 L, sub-clause 3.9.1 with the following:

"All cast iron pipes, specials and valves shall be given two coats of approved epoxy paint except where cast into concrete. The cost of this work shall be included in the rates tendered for supplying and fixing pipes, specials and valves."

PSL 3.9.3 Protection against electrolytic corrosion

Add the following new sub-clause to SANS 1200 L, sub-clause 3.9.3:

***PSL 3.9.3.1 Cathodic protection**

"Soil resistivity tests and a stray current survey are to be carried out by the contractor.

The design of the Cathodic Protection System shall be carried out by an approved

Specialist in this field appointed by the Contractor and submitted to the Employer's Agent, one calendar month before commencing construction, for acceptance.

A Provisional Sum has been allowed in the Tender Documents for the testing, design, supply and construction of a cathodic or other corrosion protection system. After acceptance by the Employer's Agent of the design of the system the Contractor shall with in fourteen days prepare a detailed cost proposal, including schedules of quantities, for the supply and installation of the system for approval by the Employer's Agent. The proposal shall be supported by a full breakdown of costs with supporting documentation such as quotations from suppliers etc. Payment may be claimed after completion of the relevant item, at the approved rates, in the monthly Certificates in the normal manner. The contractor shall allow in his programme for completion of the design prior to commencement of laying of pipes. Any pipes which have to be removed subsequent to laying for implementation of a corrosion protection system shall be to the Contractor's cost."

PSL 3.9.5 Joints, bolts, nuts and washers

Replace SANS 1200 L, sub-clause 3.9.5 with the following:

"All bolts, nuts and washers shall be hot-dip galvanised in accordance with SANS 121:2011. Under no circumstances shall electro-plating be accepted as an alternative means of corrosion protection."

PSL 3.9.6 Corrosive soils

Replace SANS 1200 L, sub-clause 3.9.6 with the following:

"All underground screwed steel joints and saddles are to be treated with a compatible primer, packed with a bitumen or tar based mastic and wrapped with "Denso Tape". The cost of this work shall be included in the rates tendered for supplying and fixing pipes and specials."

PSL 3.10 Valves

Add the following to SANS 1200 L, sub-clause 3.10:

"All valves (other than those manufactured from non-corrodible material such as stainless steel or brass) shall be coated with fusion bonded epoxy.

Fusion bonded epoxy (FBE) coating shall comply with the provisions of SANS 12176 as for a Type 2 powder coating which shall apply mutatis mutandis to the coating of fittings. Such coating may only be done in a shop with a known or proven proficiency in such type of work.

- The entire surface to be coated must be free of dust and moisture and must comply with the provisions of Sub-clause 4.1.1 of SANS 12176. The total dry film thickness shall be at least 400 micrometres (+ 50 micrometres).
- The sealing area of the flanges shall be treated to a dry film thickness of 150 micrometres (+ 25 micrometres) (i.e. masked off before the second coat is applied).
- The painting shall be such that all trimmings are covered by paint for a distance of at least 5 mm to discourage bi-metal corrosion.

No field repairs of damaged paint areas (if any) are allowed. Where parts may become distorted because of their large size when heated the Contractor shall provide full details of the alternative proposal to the Employer's Agent's approval."

Add the following new sub-clauses to SANS 1200 L, sub-clause 3.10:

***PSL 3.10.1 Gate valves**

"Unless otherwise scheduled, gate valves shall be double flanged with ductile iron bodies and stainless steel trim, and shall conform with all relevant sections of SANS 664 or BS 5163, specifications and subsequent amendments. Flanges shall be drilled to BS4504 or SANS 1123 for 25 bar or 16 bar working pressure as specified, and compatible with pipework flanges.

Gate valves shall be of the wedge gate type, VOSA or similar approved. Approval shall only be given for the specified or equivalent valves from well-established and well known manufacturers with a proven record of supply and service of equivalent products within the southern African region. Valves shall be Class 16 or 25 as specified or shown on the drawings, clockwise closing and shall have non-rising spindles of high quality high tensile manganese bronze. The direction of closing shall be cast into the handwheel (where specified) or valve casing with the words "OPEN" and "CLOSE" respectively. The gate shall be guided within the body of the valve to fit accurately onto the seat and to avoid possible buckling. Where extended spindles are required, they shall be suitably supported to prevent swaying and buckling, and to guarantee the intended use of the valve. All gate valves shall be drop tight when tested in accordance with the requirements of BS 5163. All gate valves of 600mm and larger shall be fitted with an integral bypass valve.

All gate valves shall be capable of being operated manually with a maximum applied torque of 150Nm for valves with a nominal diameter of more than 450mm and 100Nm for valves with a nominal diameter less than 450mm.

Valves shall be grit blast cleaned to S15 standard and a solvent-free sintered epoxy powder applied in one coat by the use of arc-spray machines to provide a dry film thickness of not less than 450 micron.

Flanged valves shall be complete with galvanised or titanium coated bolts and nuts, gaskets and insertion rings."

***PSL 3.10.2 Air valves**

"Air release and vacuum break valves shall be double orifice with anti-shock orifice mechanism, of type "Vent-O-Mat Series RBX" or similar approved with flanged inlets and rated for a minimum of 16 or 25 bar working pressure as specified.

The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent rejoining of separated water columns. The limitation of pressure rise must be achieved be deceleration of approaching water prior to valve closure.

The intake/discharge orifice area shall be equal to the nominal size of the valve.

The inlet shall be fitted with an isolating valve with vertical spindle, key operated from above.

Air valves shall be able to withstand twice the maximum rated pressure and must provide a positive drop tight closure from a minimum pressure of 50 kPa up to the maximum rated pressure."

***PSL 3.10.3 Non-return valves**

"Non-return valves shall comply with the requirements of BS 5153 or the relevant SANS specification for working pressures as specified for each application. They shall be double flanged and of general construction details as specified for gate valves with anti-shock closing characteristics. Flanges shall be drilled to BS4504 or SANS 1123 for 25 bar or 16 bar working pressure as specified, and compatible with pipework flanges.

Check valves shall be RGR axial flow, Vent-O-Mat Maxiflow or similar approved. Valves shall be fast acting with short travel and designed to minimise slamming."

***PSL 3.10.4 Knife gate valves**

"Knife gate valves shall be AVK Stainless steel AISI 316 with Teflon gaskets, or equal approved."

***PSL 3.10.5 Isolating valves**

"Valves shall conform to all relevant sections of SANS 664 (2011) and SANS 665 (2011) specifications and subsequent amendments.

Valves shall be anti-clockwise closing and have non-rising spindles of high quality tensile manganese bronze fitted with caps suitable for use with a key in the vertical position. The direction of rotation shall be permanently marked on the cap top or wheel.

All isolating valves for air valves shall be supplied with a cast iron hand wheel. All other valves shall be provided with a cap top for use with a valve key."

Add the following new sub-clauses to SANS 1200 L, clause 3:

***PSL 3.12 Meters**

***PSL 3.12.1 Flow meters**

"Magnetic Flow Meters specified shall be IP68 rated Endress & Hauser or similar approved magnetic flow type meters suitable for measuring flows in the ranges specified and for installation in a pipelines of diameter specified. The unit shall be capable of link up to the existing telemetry system and shall have 2 x 4 to 20mA outputs and two relays.

Measurement accuracy shall be within 0.2%. Maximum head loss through the meter and taper sections (if any) shall not be greater than 0.3m.

The rate tendered shall include for selection, supply and fitting of the meter with all necessary fittings and specials to fit the meter in a nominal 600mm diameter pipe, linking up to power supply, link up to the existing telemetry system located within 50m, including all necessary fittings and sundries to provide a complete working installation, testing and commissioning.

Mechanical flow meters, where specified, shall be able to provide pulsed output for continuous flow rate monitoring suitable for telemetry link-up. Flanged in-line strainers shall be provided with all mechanical flow meters installed. The strainers shall have removable components to allow access for cleaning and maintenance without removing the flanged strainer body."

The rate tendered shall include for selection, supply and fitting of the mechanical meter with all necessary fittings, specials and sundries to provide a complete working installation, testing and commissioning.

***PSL 3.12.2 Water meters**

"The meters shall be of the semi-positive rotary piston volumetric type and be to Class C specification.

Bulk water meters shall be supplied and built into the meter chambers as detailed in the drawings. Fittings and the construction of the chambers will be measured elsewhere.

Water meters must comply with the SANS Specification No. 1529-1: 2006 and must be approved in terms of Section 18 of the Trade Metrology Act, Act No. 77 of 1973, as amended by the Trade Metrology Amendment Act, Act No. 42 of 1994.

All water meters offered must be tested and sealed by an authorised official in an SANS 17025 accredited laboratory, situated within the borders of the Republic of South Africa."

PSL 4 Plant

Add the following new sub-clause to SANS 1200 L, clause 4:

***PSL 4.4 Protection of linings during transportation**

"The ends of every pipe, fitting and special shall be fitted with suitable end closures as a precautionary measure against damage being caused to the lining material. The end closures shall be capable of preventing the ingress of dirt but at the same time allowing air to ventilate through the pipework which they protect. They shall be secured in such manner that they cannot be dislodged or damaged by normal pipe handling operations."

PSL 5 Construction

PSL 5.1 Laying

PSL 5.1.1 General

Add the following to SANS 1200 L, sub-clause 5.1.1:

"Pipes shall be handled and laid in accordance with the manufacturer's specifications.

Large changes in horizontal or vertical alignment of the pipeline will be accommodated by special bends as detailed on the drawings.

Small changes in horizontal or vertical alignment will be accommodated at the pipe joints. In no case shall the deflection exceed two thirds of the recommendations of the relevant SANS, BS or other relevant specification, or of the pipe manufacturer."

PSL 5.1.3 Keeping pipelines clean

Add the following to SANS 1200 L, sub-clause 5.1.3:

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

Metal night-caps approved by the Employer's Agent shall be used to close off all ends of each laid section of pipeline when work is stopped at the end of the day or for longer periods and shall be left on the ends of sections of completed pipework until such sections are tied-in with the remainder of the completed pipeline.

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

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

PSL 5.1.4 Depth and cover

Add the following to SANS 1200 L, sub-clause 5.1.4.1:

"A minimum depth of cover to main pipelines are:

- Generally: 1000mm (min. 600mm with cement-stabilized bedding and backfill
- Under cultivated land: 1000mm
- Road crossings: 1500mm

During construction there shall be not less than 1,0 m of cover over the pipes where construction traffic is liable to cross the pipeline, Road crossings shall not be utilised until the construction of the road layers has reached the stage where 1,0 m cover over the pipe is available.

Where the actual clearance between pipe crossings or other services is less than the minimum clearance of 150 mm the main shall be laid beneath the service crossed at an invert level which allows for the minimum clearance. The main shall be laid horizontally at this level for a distance of at least 3.0 m on either side of the centreline of the service crossed and then gradually revert to the minimum cover.

No decrease in cover or clear space between the pipe barrels as specified will be permitted unless otherwise instructed by the Employer's Agent in writing.

Additional protection is to be provided to pipes subject to vehicle loads and stream crossings"

Add the following new sub-clause to SANS 1200 L, sub-clause 5.1:

***PSL 5.1.5 Connection to existing bulk main**

"The work involves location of the exact position of the existing pipe to be connected. Before any pipe fittings and accessories for connecting with existing pipelines are ordered, the precise dimensions of the existing pipe shall be determined on site. The method of cutting into the existing pipe, the special pipefittings to be used as well as the dimensions of the pipe fittings shall be determined in consultation with the Employer's Agent.

Where "live" pipelines are involved, a suitable date for the connection the existing pipe must be arranged beforehand with the Employer's Agent. In order to accommodate operation aspects, it may be necessary that the connection be made during the night, over the weekend or even on Sunday. The Contractor must ensure that all materials and accessories are available when starting with such operation in order to complete the work within the shortest possible time."

PSL 5.2 Jointing Methods

PSL 5.2.2 Flanges (Steel pipelines)

Add the following to SANS 1200 L, sub-clause 5.2.2:

"All flanges shall be installed with bolt holes off-centre and symmetrically offset from the vertical centre-line of the flange. Flanges shall be installed truly square to the axis of the pipe.

The Contractor shall ensure that the correct jointing materials, i.e. gaskets, bolts and nuts are available when required. Only correct diameters and lengths of bolts and studs shall be used. Flat washers shall be used under all nuts and bolt heads. 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.

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."

Add the following new sub-clause to SANS 1200 L, sub-clause 5.2:

***PSL 5.2.5 Cut pipes**

"Cut pipes may be used where required as closure lengths. The cut ends shall be dressed square and to a smooth even finish, which shall not be inferior to that of the ends of uncut pipes. The finished dimensions of ends cut at Site must be within the tolerances applicable to the ends of the particular types of pipe to be laid."

PSL 5.5 Anchor/Thrust blocks and pedestals

Add the following to SANS 1200 L, sub-clause 5.5:

"All anchor/thrust blocks and pedestals shall be constructed to the dimensions shown and the concrete shall have the strength specified on the Project Drawings.

In addition to conventional anchor and thrust blocks, where specified, the pipe will be secured on reinforced concrete and steel pipe supports according to the details on the drawings, including all excavations (where applicable), concrete, reinforcing, shuttering, holding down bolts, GMS straps and final benching with a concrete repair mortar."

PSL 5.6 Valve and hydrant chambers

Add the following to SANS 1200 L, sub-clause 5.6:

"The Contractor shall provide the Employer's Agent with all relevant dimensions of valves fittings and specials for the purposes of finally sizing chambers and the designing of the reinforcement at least 40 working days prior to such sizes and reinforcement schedules being required. No extensions of time for delays resulting from failure to supply this information on time will be entertained. Any redesign costs due to supply of incorrect information will be to the Contractor's account."

PSL 7 Testing

PSL 7.1 General

Add the following to SANS 1200 L, sub-clause 7.1:

"The price for testing the pipeline must be included in the scheduled items for supply and installation."

PSL 8 Measurement and payment

PSL 8.2.1 Supply, lay and bed pipes

SANS 1200 L, sub-clause 8.2.1 to include payment for:

PSL 3.1 General
PSL 3.4.1 General
PSL 3.4.3 Pipes of nominal bore over 150mm
*PSL 3.7.4 mPVC Pipes
*PSL 3.7.5 GRP Pipes
PSL 3.8.2 Flexible couplings
PSL 3.8.3 Flanges and accessories
PSL 3.9.1 Cast iron pipes
PSL 3.9.3.1 Cathodic protection
PSL 3.9.5 Joints, bolts, nuts and washers
PSL 3.9.6 Corrosive soils
*PSL 4.4 Protection of linings during transportation
PSL 5.1.1 General
PSL 5.1.3 Keeping pipelines clean
PSL 5.1.4 Depth and cover
*PSL 5.1.5 Connection to existing bulk main
PSL 7.1 Testing: General

PSL 8.2.4 Extra-over 8.2.1 for the cutting of the pipe and the suppling and fixing of the extra coupling

SANS 1200 L, sub-clause 8.2.4 to include payment for:

*PSL 5.2.5 Cut pipes

PSL 8.2.5 Supply and place pipes, valves and specials

SANS 1200 L, sub-clause 8.2.5 to include payment for:

*PSL 3.10.1 Gate valves
*PSL 3.10.2 Air valves
*PSL 3.10.3 Non-return valves

*PSL 3.10.4 Knife gate valves
*PSL 3.10.5 Isolating valves
*PSL 3.12.1 Flow meters
*PSL 3.12.2 Water meters

PSL 8.2.11 Anchor/trust blocks and pedestals

SANS 1200 L, sub-clause 8.2.11 to include payment for:

PSL 5.5 Anchor/Thrust blocks and pedestals

PSL 8.2.13 Valve and hydrant chambers

SANS 1200 L, sub-clause 8.2.13 to include payment for:

PSL 5.6 Valve and hydrant chambers

PSLB BEDDING (PIPES) (SANS 1200 LB)

PSLB 3 Materials

PSLB 3.1 Selected granular material

Add the following to SANS 1200 LB, sub-clause 3.1:

"Wherever the words "Selected Granular Material" are used in the specification, these shall be replaced with "Selected Bedding Material". In the case of flexible pipes the selected granular material shall consist of sand."

PSLB 3.2 Selected fill material

Replace SANS 1200 DM, sub-clause 3.2 with the following:

"Selected fill material shall be free from vegetation and from lumps and stones of diameter exceeding 30mm, and shall be obtained from the trench excavations or other necessary excavations on the site, all to the approval of the Employer's Agent."

PSLB 3.3 Bedding

Add the following to SANS 1200 LB, sub-clause 3.3:

"Selected bedding material shall comply with the following requirements:

- A maximum particle size of 20 mm
- A minimum grading modulus of 0,5
- A minimum CBR of 15% at 93% of modified AASHTO maximum density
- A maximum plasticity index of 10

The Bedding shall be compacted to at least 93% of modified AASHTO maximum density (100% for sand).

The type of bedding to be used shall be in accordance with the details shown on the drawings."

PSLB 3.4 Selection

PSLB 3.4.1 Suitable material available from trench excavation

Add the following to SANS 1200 LB, sub-clause 3.4.1:

"Wherever practicable, the Contractor shall use suitable material selected from the excavations for selected bedding and selected fill material."

PSLB 8 Measurement and payment

PSLB 8.1 Principals

PSLB 8.1.2 Sources of bedding material

Add the following to SANS 1200 LB, sub-clause 8.1.2:

"Payment for the provision of imported bedding materials will only be made where they cannot be selected from the excavation within the confines of the site or within 5 km of the point where it is required and where it is ordered in writing by the Employer's Agent."

PSLB 8.1.3 Volume of bedding materials

Add the following to SANS 1200 LB, sub-clause 8.1.3:

"The volume of bedding material will be measured net, excluding the volume occupied by the pipe. The volume of bedding material will be computed from:

- the trench width specified or scheduled, and
- the depth of each bedding layer as shown on the drawings, and
- by deducting the volume occupied by the pipe."
-

PSLB 8.2.1 Provision of bedding from trench excavation

SANS 1200 LB, sub-clause 8.2.1 to include payment for:

PSLB 3.1 Selected granular material
PSLB 3.2 Selected fill material
PSLB 3.3 Bedding
PSLB 3.4.1 Selection from trench excavation

PSLC CABLE DUCTS (SANS 1200 LC)

PSLC 3 Materials

PSLC 3.1 Ducts

Add the following to SANS 1200 LC, sub-clause 3.1:

“Class 6 uPVC pipes (diameter 110 mm or 160 mm) shall be used as ducts for electric cables under roads. Ducts for Telkom shall be of pitch-impregnated fibre pipes.”

Add the following new sub-clause to SANS 1200 LC, sub-clause 3.1:

*PSLC 3.1.1 Supply of ducts by Telkom

“Notwithstanding any provisions of the contract in terms of which the Contractor is required to provide all materials necessary for the construction of the works, Telkom will supply the ducts for telephone cables. Consequently, the Contractor's obligations under the contract shall include taking delivery, the construction, completion and maintenance of the works and the provision of all labour, materials (other than those that are to be supplied by Telkom), plant, temporary works, and everything, whether of a temporary or permanent nature, required in and for such construction, completion and maintenance, so far as the necessity for providing the same is specified in or reasonably to be inferred from the contract.

To assist Telkom in arranging for the goods to be supplied to suit the Contractor's construction program, the Contractor shall submit to the Employer’s Agent, at agreed intervals, lists of his requirements. These lists shall be submitted at least 6 weeks (or another approved period) in advance of the date by which the goods are required. The Employer’s Agent will ascertain in advance the actual dates of delivery of consignments and will advise the Contractor who shall adjust his construction program as necessary to minimise any disruption of his work.

In the event of supply being effected, the Contractor shall, provided that appropriate due notice of dispatch has been given, be responsible for taking immediate delivery of such goods as they arrive at the site. He shall be responsible for checking the actual deliveries against delivery notes. From the time of taking delivery the Contractor shall be responsible for the handling, transportation and storage of the goods and he shall at the same time accept the risk of damage to or loss of the goods.

Should any goods reach the point(s) of delivery in a damaged or an apparently damaged condition, the Contractor shall report this fact to the Employer’s Agent, and he shall, before removing the goods from the transport vehicle, to avoid demurrage or similar charges, afford the Employer’s Agent reasonable opportunity to inspect such damaged goods.

On receipt of the goods, the Contractor shall issue a receipt to Telkom in an approved form. The Contractor shall accept full responsibility for checking deliveries and ensuring that the goods supplied to him are in sound condition.

The Contractor's receipt will be deemed to indicate that he has satisfied himself that the goods enumerated on it are in sound condition. Unless the Contractor at the time of receipt advises the Employer’s Agent that goods have been short delivered or are defective and obtains the Employer’s Agent’s approval to take delivery (which approval will not be unreasonably withheld), no subsequent claim for short deliveries or replacement of damaged goods will be considered by the Employer's Agent."

PSLC 3.2 Bedding

Replace SANS 1200 LC, sub-clause 3.2 with the following:

"The provisions of SANS 1200 LB: Bedding (Pipes) and the relevant project specification shall apply mutatis mutandis and payment shall be made under the appropriate payment clauses of SANS 1200 LB."

PSLC 3.3 Backfill

Replace SANS 1200 LC, sub-clause 3.3 with the following:

"The provisions of SANS 1200 DB: Earthworks (Pipe Trenches) and the relevant project specification shall apply mutatis mutandis and payment shall be made under the appropriate payment clauses of SANS 1200 DB."

PSLC 3.4 Cable duct markers

Add the following to SANS 1200 LC, sub-clause 3.4:

"Cable duct markers shall be provided as specified in PSLC 5.10, Position to be marked, as amended."

PSLC 5 Construction

PSLC 5.1 Excavation of trenches

PSLC 5.1.1 Trench widths and depths

Add the following to SANS 1200 LC, sub-clause 5.1.1:

"Trench widths shall be in accordance with the provisions of SANS 1200 DB: Earthworks (Pipe Trenches).

The minimum depth of cover over ducts shall be 600 mm from the final road level."

Add the following new sub-clause to SANS 1200 LC, sub-clause 5.1:

***PSLC 5.1.3 Excavation of trenches at road crossings**

"The minimum depth of cover over ducts shall be 300 mm where construction traffic is liable to cross them. Road crossings shall therefore be constructed after the construction of the roadworks has reached the stage where the required cover is available."

PSLC 5.2 Bedding and compaction of bedding

Replace SANS 1200 LC, sub-clauses 5.2.1 and 5.2.2 with the following:

"All ducts shall be laid on a Class C bedding according to the provisions of SANS 1200 LB: Bedding (Pipes). Backfilling shall be according to the provisions of SANS 1200 DB: Earthworks (Pipe Trenches)."

PSLC 5.4 Backfilling and compaction

Add the following to SANS 1200 LC, sub-clause 5.4:

"Road crossings shall be backfilled with sand from designated borrow pits, the site or commercial sources, whichever is applicable, up to underneath the subbase, and compacted to a minimum of 100 % of MOD AASHTO density."

PSLC 5.8 Road crossings

Substitute "0,5 m" in the last sentence of SANS 1200 LC, sub-clause 5.8 with "1,0 m" and add the following:

"Ducts for road crossings shall be effectively sealed by means of end caps."

PSLC 5.10 Position to be marked

Add the following to SANS 1200 LC, sub-clause 5.10:

"The lettering height shall be at least 70 mm.

The positions of ducts shall be marked by means of incisions on top of the kerb. The dimensions of such incisions shall be at least 40 mm long, 3 mm wide and 5 mm deep and the spacing, where more than one incision is required, shall be 20 mm. Ducts for Telkom crossings and electrical crossings shall be marked with green and red painted incisions respectively.

The draw wire, as specified in SANS 1200 LC, sub-clause 5.3.3, shall be secured to a 150 x 150 x 150 mm grade 20 MPa/19 mm concrete marker, which shall be installed with a depth of cover of 50 100 mm below the top of kerb or sidewalk level."

Add the following new sub-clause to SANS 1200 LC, clause 5:

***PSLC 5.12 Draw and joint boxes for Telkom cables**

"Draw and joint boxes shall be constructed strictly in accordance with the positions and details given on the plans."

PSLC 7 Testing

PSLC 7.2 Compaction tests

Replace SANS 1200 LC, sub-clause 7.2 with the following:

"The Contractor shall, for at least one out of every five road crossings, submit density tests to the Employer's Agent at his own expenses. The decision as to which road crossing densities shall be tested, rests with the Employer's Agent. The Contractor shall, if such densities fail to meet the minimum requirements, prove at his expense that all the other densities do comply with the specified minimum requirements."

PSLC 8 Measurement and payment

PSLC 8.2 Scheduled items

PSLC 8.2.5 Supply, lay, bed and prove duct

Substitute "GPO" in SANS 1200 LC, sub-clause 8.2.5 (a) with "Telkom".

Add the following to SANS 1200 LC, sub-clause 8.2.5 (a):

“The rates for the installation of Telkom distribution ducts parallel to streets shall first be submitted by the Employer to Telkom for approval. The installation of these ducts will only form part of this contract if approved by Telkom.”

PSLC 8.2.8 Cable markers

Add the following to SANS 1200 LC, sub-clause 8.2.8:

“The rate shall also cover the cost of the end cap and the incisions, concrete marker and draw wire, as specified in PSLC 5.8, Road crossings, as amended and PSLC 5.10, Position to be marked, as amended.”

PSM ROADS (GENERAL) (SANS 1200 M)

PSM 2 Interpretations

PSM 2.2 Definitions

Add the following to SANS 1200 M, sub-clause 2.2:

"The road construction material codes that are used in this Project Specification and drawings refer to "TRH 14: 1985 - Guidelines for road construction materials"."

PSM 5 Construction

Add the following new sub-clause to SANS 1200 M, clause 5:

*PSM 5.1 Traffic control/safety measures

"When roads to be constructed under this contract join onto existing surfaced trafficked roads, the Contractor shall take all the necessary precautions to ensure the safety of the traveling public. To this end, signs warning through traffic of vehicles encroaching into the travelled way shall be erected by the Contractor prior to such work being undertaken. In addition flagmen shall be installed along the through road. These control measures shall be checked and recorded on a daily basis.

Under no circumstances shall drums be permitted to be used as traffic demarcation devices.

All signs must comply with the latest edition of the South African Road Traffic Sign Manual."

PSM 6 Tolerances

Add the following new sub-clause to SANS 1200 M, clause 6:

*PSM 6.4 Level control of road layers

"The Contractor shall submit to the Employer's Agent, at the time of requesting acceptance of a road layer, a record of the surface levels of that section, taken at metre intervals to coincide with the level pegs. A sample form will be obtainable from the Employer's Agent."

PSM 7 Testing

PSM 7.1 General

Add the following to SANS 1200 M, sub-clause 7.1:

"The random sampling method of TMH 5, for the location of positions, for field density testing will not necessarily be applied by the Employer's Agent. Density testing shall be carried out where, in his opinion, the density of the compacted layer is suspect. The Contractor shall present the full width of the layer, between the stated linear stake values, for acceptance. Only in exceptional cases will partial widths of a layer be accepted for testing."

PSM 7.3 Routine inspection and testing

Add the following to SANS 1200 M, sub-clause 7.3.1:

"The request for acceptance of a layer shall be submitted in writing, specifying the exact location of the section and type of layer. On receipt of all these details the Employer's Agent will arrange for the necessary inspections and tests to satisfy himself that the road layer complies. Testing will be carried out as expeditiously as possible, and the results will be available within 24 hours of receipt of test request. The Contactor shall backfill the test holes left in the layer with a similar material to that of the layer tested and compact the material to a similar density. Concrete shall not be used."

Add the following to SANS 1200 M, sub-clause 7.3.2:

"Notwithstanding the requirements for minimum densities for single tests, as set out in the relevant standardized specification, no lot for which any single test result is below the specified density will be deemed to comply with the requirements for density.

The Contractor shall bear the cost of all tests carried out by the Employer's Agent at the request of the Contractor or as specified for process control."

PSM 7.4 Compaction control

Add the following to SANS 1200 M, sub-clause 7.4:

"Density test shall be carried out by the Contractor on each layer of the selected subgrade, subbase, base-course and shoulders/layers as soon as possible but not later than twenty-four hours (24) after compaction of that layer has been completed, and the results of the test shall be submitted to the Employer's Agent without delays and in any case not later than twelve hours (12 hours) after they become available.

The contactor shall locate and test any soft or wet areas evident in any layer and shall, if these tests fail, re-compact and retest such areas for density before requesting the Employer's Agent to carry out check tests.

The Contractor shall provide adequate equipment and facilities for carrying out the tests required to be performed by him. Should the Employer's Agent at any time consider that the equipment and facilities are inadequate for this purpose, he may instruct the Contractor to cease work on the completion of subgrade, sub-base and base course until such time as the Contractor has remedied the deficiency of equipment, labour and facilities.
The results of the test carried out by the Employer's Agent shall be regarded as final."

Add the following new sub-clause to SANS 1200 M, clause 7:

***PSM 7.5 Employer's Agent's discretion**

"Notwithstanding the provision of SANS 1200 M, clause 7 and of PSM 7, testing of a section of completed work shall be at the sole discretion of the Employer's Agent who may refuse to check test and consequently not approve a section of work which contains obvious defects such as loose patches, over-wet material etc."

PSM 8 Measurement and payment

SANS 1200 M, clause 8 to include payment for:

PSM 2.2 Definitions
PSM 5.1 Traffic control/safety measures
PSM 6.4 Level control of road layer
PSM 7.1 General
PSM 7.3 Routine inspection and testing
PSM 7.4 Compaction control
PSM 7.5 Employer's Agent's discretion

Add the following new sub-clause to SANS 1200 M, clause 8:

***PSM 8.1 Inspection and testing of a road layer**

"The cost of refilling and compacting the density test holes shall be included in the rate tendered for the construction of that layer."

PSMK KERBING AND CHANNELLING (SANS 1200 MK)

PSMK 3 Materials

PSMK 3.2 Precast kerbing and channelling

PSMK 3.2.1 General

Add the following to SANS 1200 MK, sub-clause 3.2.1:

"Precast units as indicated on the drawings shall be required in 1m lengths. Lengths of 300 mm shall be used in bellmouths and for radii less than 20 m. These kerbs shall be cast and not saw-cut."

PSMK 3.9 Bedding material

Replace SANS 1200 MK, sub-clause 3.9 with the following:

"The material on which precast kerbs and channels are bedded shall consist of Grade 15/19 concrete to SANS 1200 GA and to the dimensions indicated on the drawings."

PSMK 5 Construction

PSMK 5.2 Precast concrete kerbing and channelling

Replace the second paragraph of SANS 1200 MK, sub-clause 5.2 with the following:

"Provision shall be made for expansion joints of width 10 mm at intervals not exceeding 10 m for kerbing, channelling and edging. The joints shall be filled with a suitable silicone or polysulphide sealant.

Notwithstanding the fact that vertical curves have not been specified where changes to grade of up to 2% occur, the kerbs and channels shall be laid to levels based on a minimum vertical curve length of 20 m.

No change in grade shall be applied on kerbs in bellmouths unless specific levels are indicated."

PSMK 8 Measurement and payment

PSMK 8.1 Basic principles

Add the following new sub-clause 8.1.4 to SANS 1200 MK, sub-clause 8.1:

"Measurement and payment for bedding as well as the backing of kerbs as specified in PSMK 5.2, as amended, shall be included in the separate items scheduled in terms of SANS 1200 MK, sub-clause 8.2.1 and 8.2.2. The rates shall cover the cost of supplying and installing the bedding as specified in PSMK 3.9, as amended. The rates shall include payment for PSMK 3.2.1, as amended."

PSMM ANCILLARY ROADWORKS (SANS 1200 MM)

PSMM 8 Measurement and payment

PSMM 8.3.4 Excavation and backfilling and concreting (if any) for sign supports

Replace: "Excavation and backfilling and concreting (if any) for sign supports Unit: m^3" **with the following**:

"PSMM 8.3.4 Excavation and backfilling and concreting (if any) for sign supports ...Unit: No."

Add the following to SANS 1200 MM, sub-clause 8.3.4:

"The unit of measurement shall be the number of sign post foundations excavated, backfilled and concreted as specified. The rate shall include for all plant, labour and materials needed to cast concrete surrounds and backfilling with soil for each sign post base."

PSPG HIGH SECURITY FENCES AND GATE FENCING (SPEC PG)

PSG1 General

PSPG 1.1 Scope

This specification covers material requirements and installation of security fencing and gates.

PSPG 1.2 Work included

Furnish and install fence and gates, and accessories as required and shown.

PSPG 1.3 Submittals

The following must be submitted for approval by the Employer's Agent before the installation of the security fence commences.

a) Certificate of compliance for materials and coatings.
b) Shop drawing for gates.
c) Quality control program shall be submitted to the Employer's Agent for review prior to commencement of any work.

PSPG 2 High security fences and gates

PSPG 2.1 General

a) All steel materials shall be of good commercial quality, galvanized steel.
b) All pipes shall be galvanized, one piece without joints. Furnish moisture proof caps for all posts.
c) Zinc coating shall be smooth and essentially free from lumps, globs, or points.
d) Miscellaneous material shall be galvanized.

PSPG 2.2 Description of fence system

PSPG 2.2.1 Post

The posts shall comply with the following specifications:

a) Post shall be 2.7m long.
b) Post width shall be 85mm tapering to 45mm with a depth of 85mm.
c) Post shall include locking mechanism to secure panel edge.
d) Post shall be sealed with a UV stabilized polymer cap.
e) Post shall be galvanized.
f) Post foundation shall be 600mm x 400mm2 and minimum 15 MPa concrete (28-day compressive strength) concrete, 19mm aggregate; no air entrapment.

PSPG 2.2.2 Panel

The panel shall comply with the following specifications:

a) Panel shall be 3.297m width and 2.1m high.
b) Panel aperture size (centres) shall be 76.2mm x 12.7mm.
c) The panel shall be reinforced with 4 x 50mm deep "V" formation horizontal

recessed bands (rigidity).

d) Panel shall have 2 x 70° flanges along sides (internal fixtures – all fixtures shall be on the inside of the fence line).

e) Panel shall have 2 x 30° flanges along top and toe (integrated rigid angle).

f) Panel post shall have a flush panel post finish with no climbing aid.

g) Panel shall be affixed to post over 48 line wires using 8 x double bolt comb clamps and 8 x Single bolt comb clamps using 24 x Anti vandal bolts.

h) Panel and fixtures shall be galvanized.

PSPG 2.2.3 Topping

A 100mm high toughened steel spike shall be affixed to top panel edge, internally at 150mm intervals using Anti-vandal bolts. Spike finish shall be Hot Dipped Galvanized.

PSPG 2.2.4 Anti-burrow

The fence shall be equipped with the specified anti-burrow option.

PSPG 2.2.3 Gates

PSPG 2.2.3.1 Swing gates

All connections and joints shall be welded to form rigid frames or assembled with corner fittings. Hinges shall not twist or turn under the action of the gate and shall be so arranged that a closed gate cannot be lifted off the hinges to obtain entry.

PSPG 2.2.3.2 Sliding gates

Gate frame fabrication and miscellaneous items shall be similar to Swing Gates. All fittings, brackets and rear wheel tracks shall be standard manufactured products for the intended application.

PSPG3 Execution

PSPG 3.1 Clearing the fence line

The fence line shall be cleared over a width of at least 1 m on each side of the centre line of the fence and surface irregularities shall be graded so that the fence will follow the general contour of the ground. Clearing the line shall include the removal of all trees, scrub, stumps, isolated boulders or stones and other obstruction which will interfere with the construction of the fence. Stumps within the cleared space shall be grubbed as described in SANS 1200C. The bottom of the fence shall be located at a uniform distance above the ground line in accordance with the requirements shown on the drawings. All material removed shall be disposed of by the Contractor.

PSPG 3.2 General

Install all fencing and gates in accordance with the drawings, specifications, instructions, and as specified lines and grades indicated. Line posts shall be spaced at intervals not exceeding 3.3m. Terminal posts shall be set at abrupt changes in vertical and horizontal alignment.

PSPG 3.3 Posts

Post holes shall be cleared of loose material. Waste material shall be spread where directed by the Employer's Agent. The ground surface irregularities along the fence line shall be eliminated to the extent necessary.

Posts shall be set plumb, and follow the indicated alignment. All posts shall be set to the depth indicated on the design documents. Concrete shall be thoroughly consolidated around each post, free of voids, and finished with a domed shaped surface, with the base of dome at grade elevation. Concrete shall be allowed to cure prior to installing any additional components to the posts.

Concrete footings shall be carried down to at least the depth indicated on the design documents and shall not be smaller than the dimensions shown. Where a rock layer is encountered within the required depth to which the post is to be erected, a hole of a diameter slightly larger than the largest dimension of the post may be drilled into the rock and the post grouted in. Then the regular concrete footing shall be placed between the top of the rock and the top of the footing elevation as shown on the design documents. Posts shall be approximately centered in their footings. All concrete shall be placed promptly and consolidated by tamping or other approved methods. Where the ground is firm enough to permit excavation of the post hole to neat lines, the concrete may be placed without forms by completely filling the hole. Curing may be achieved by covering the concrete with not less than four inches of loose moist material immediately after placing concrete, or by using a curing compound. All excess material from footings, including loose material used for curing, shall be disposed of as directed by the Employer's Agent.

Where the ground cannot be satisfactorily excavated to neat lines, forms shall be used to place concrete for footings. Under these conditions the earth and forms coming in contact with the concrete shall be moistened and all ponded water shall be removed from the hole prior to placing concrete. When forms are removed, the footing shall be backfilled with moistened material, and thoroughly tamped. The top of the concrete shall then be covered with not less than 100 mm of loose moistened material or use curing compound if the 7-days cure is not completed. All excess material from footings, including loose material used for curing, shall be disposed of as directed.

PSPG 3.4 Gates

Gates shall be installed at the locations shown. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. Slide gates shall be installed as recommended by the manufacturer.

Gates shall be erected at the positions indicated on the drawings. Gates shall be hung on gate fittings as indicated on the drawings and shall be erected such that they swing in a horizontal plane at right angles to the gate posts, clear of the ground in all positions. For double leaf gates the gap between the individual gates shall not exceed 20 mm when closed and shall not be further than 40 mm from the gate post when closed.

PSPG 3.4.1 Adjusting

Adjust gate to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

PSPG 8 Measurement and payment

PSPG 8.1 Fence clearance

Clearing the fence line, 2,0m wide strip ....Unit: km

The rate shall cover clearing the fence line as specified including the removal of trees of girth less than 1,0 m, stones and other obstructions, the disposal of all waste material resulting from the clearing operations including all haul.

The removal of trees and stumps with a girth exceeding 1,0 m shall be paid for separately.

Clearing of the fence line shall be measured linearly along each fence line cleared as directed by the Employer's Agent.

PSPG 8.2 Security fence

Supply, fabricate, deliver and install security fence complete as detailed on drawing… ...... Unit: km

The rate shall cover the supply of all materials and the full installation thereof to erect the security fence as per the drawing and the project specifications.

PSPG 8.3 Security Gate

Supply, fabricate, deliver and install security gate as detailed on drawing… ...Unit: Sum

The rate shall cover the supply of all materials and the full installation thereof to erect the security gate as per drawing and the project specifications.

C3.4: PARTICULAR SPECIFICATIONS

GNR 155 of 10 February 2002

OCCUPATIONAL HEALTH AND SAFETY ACT 85 OF 1993

ASBESTOS REGULATIONS

The Minister of Labour has under section 43 of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), after consultation with the Advisory Council for Occupational Health and Safety, made the regulations in the Schedule.

SCHEDULE

1. Definitions

In these Regulations, any word or expression to which a meaning has been assigned in the Act shall have the meaning so assigned and, unless the text otherwise indicates-

"approved asbestos inspection authority" means an approved inspection authority for the monitoring of asbestos concentrations in the air;

"asbestos" means any of the following minerals:

(a) Amosite

(b) Chrysotile

(c) Crocidolite

(d) Fibrous actinolite

(e) Fibrous anthophyllite; and

(f) Fibrous tremolite,

or any mixture containing any of these minerals;

"asbestos dust" means airborne or settled dust, which contains or is likely to contain regulated asbestos fibres;

"asbestos waste" means an undesirable or superfluous asbestos-containing byproduct, emission or residue of any process or activity that has been-

(a) discarded by any person;

(b) accumulated and stored by any person with the purpose of eventually discarding it with or without prior treatment connected with the discarding thereof; or

(c) stored by any person with the purpose of recycling, re-using or extracting a usable product from such matter;

“asbestos work” means work that exposes or is likely to expose any person to asbestos dust.

“demolition work” includes demolition, alteration, stripping, removing, repair, gleaning of any spilt asbestos, or high-pressure water jetting of any structure containing asbestos lagging or insulation, but does not include work performed on asbestos cement sheeting and related products and asbestos cement products that form part of the structure of a workplace, building, plant or premises;

“exposed to asbestos” means exposed or likely to be exposed to asbestos dust while at the workplace, and “exposure” has a corresponding meaning;

“HSG 173” means the Monitoring Strategies for Toxic Substances, HSG 173, published by the Health and Safety Executive of the United Kingdom;

“MDHS 39/4” means the Methods for the Determination of Hazardous Substances 39/4 of the Health and Safety Executive of the United Kingdom: *Asbestos fibres in air, sampling and evaluation by phase contrast microscopy (PCM)* under the Control of Asbestos at Work Regulations, 1995 HSE ISBN 0 7176 0913 8, as revised from time to time;

“measurement programme” means a programme according to the monitoring strategy as contemplated in OESSM and HSG 173;

“monitoring” means the planning and carrying out of a measurement programme and the recording of the results thereof;

“occupational exposure limit” or “OEL” means a limit value set by the Minister for a stress factor in the workplace;

“OESSM” means the Occupational Exposure Sampling Strategy Manual, published by the National Institute for Occupational Safety and Health (NIOSH), United States of America: Department of Health, Education and Welfare;

“occupational exposure limit for asbestos” means an occupational exposure limit of 0,2 regulated asbestos fibres per milliliter of air averaged over any continuous period of four hours measured in accordance with MDHS 39/4;

"provincial director" means the provincial director as defined in regulation 1 of the General Administrative Regulations published under Government Notice R. 1449 of September 1996;

"registered asbestos contractor" means a mandatory or employer conducting demolition work, who is registered with the chief inspector;

"regulated asbestos fibre" means a particle of asbestos with a length-to-diameter ratio greater than 3 to 1, a length greater than 5 micrometres and a diameter less than 3 micrometres;

"respiratory protective equipment" means a device which is worn over at least the mouth and nose to prevent the inhalation of air that is not safe, and which device conforms to a standard approved by the Minister;

"respirator zone" means a respirator zone contemplated in regulation10(a);

"SABS 0228" means the Code of Practice for the Identification and Classification of Dangerous Substances and Goods, SABS 0228, published by the South African Bureau of Standards (SABS);

"SABS 0229" means the Code of Practice for Packaging of Dangerous Goods for Road and Rail Transportation in South Africa, SABS 0229, published by the South African Bureau of Standards (SABS);

"short-term exposure limit" means the concentration to which workers can be exposed continuously for a short period of time, which is a 10-minute Time Weighted Average (TWA) exposure for asbestos, which should not be exceeded at any time during the working day even if the 4-hour TWA is within the DEL-TWA;

"short term exposure limit for asbestos" means an exposure limit of 0,6 regulated asbestos fibres per milliliter of air averaged over any 10 minutes;

"the Act" means the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).

2. Scope of application

(1) Subject to subregulation 2, these Regulations shall apply to every employer and self-employed person who carries out work at a workplace that may expose any person to asbestos dust at that workplace.

(2) Regulations 5(1), 5(2), 5(3), 5(4), 5(6), 7(2), 8, 9, 11(2)(f), 14(2), 14(3), 14(4) 16(c), 16(f) and 17(6) shall not apply in the case of self-employed persons.

3. Notification of asbestos work

No employer or self-employed person shall carry out any asbestos work unless he or she has notified the provincial director in writing thereof prior to the commencement of such work.

4. Exposure to asbestos

Subject to regulation 17(1) no employer or self-employed person shall require or permit any person to work in an environment in which he or she would be exposed to asbestos in excess of the prescribed occupational exposure limit.

5. Information and training

(1) An employer shall, before any employee is exposed or may be exposed to asbestos dust, after consultation with the health and safety committee established for that section of the workplace, ensure that the employee is adequately and comprehensively informed and trained, on both practical aspects and theoretical knowledge, with regard to-

(a) the contents and scope of these Regulations;

(b) the potential sources of exposure, including the recognition of derelict asbestos-containing materials;

(c) the potential health risk caused by exposure to asbestos, including the health risks to employees' families and others, which could result from taking home asbestos contaminated equipment and clothing, and the dramatically increased risk of lung cancer for asbestos workers who smoke;

(d) the measures taken by the employer to protect an employee against any risk from exposure;

(e) the precautions to be taken by the employee to protect himself or herself against the health risks associated with the exposure, which precautions include the wearing and use of protective clothing and respiratory protective equipment;

(f) the necessity, correct use, maintenance and limitations of protective equipment, facilities and engineering control measures provided;

(g) the assessment of exposure, the purpose of air sampling, the necessity for medical surveillance and the long term benefits and limitations thereof;

(h) the occupational exposure limit and its meaning;

(i) the importance of good housekeeping at the workplace and personal hygiene;

(j) the safe working procedures regarding the use, handling, processing, and storage of any material containing asbestos, which procedures include the correct use of control measures to limit the spread of asbestos dust outside the work area, and to limit the exposure of workers inside the work area as far as is reasonably practicable;

(k) procedures to be followed in the event of an accidental spillage or any other similar emergency situation likely to result in the release of asbestos dust;

(l) procedures for reporting and correcting defects likely to result in the release of asbestos dust;

(m) safe disposal of asbestos waste;

(n) procedures for record keeping; and

(o) matters contemplated in regulation 6.

(2) Refresher training on matters contemplated in subregulation (1) shall be given at least every year or at more frequent intervals that may be recommended by the health and safety committee.

(3) Training should be given more frequently than once a year if-

(a) work methods change;

(b) the type of work carried out changes significantly; or

(c) the type of equipment used to control exposure changes.

(4) Training shall be provided by somebody who is competent to provide it and has adequate personal practical experience and theoretical knowledge of all aspects of the work being carried out by the employer.

(5) An employer or a self-employed person shall ensure, as far as is reasonably practicable, that his or her mandatory or any person other than employees who may be exposed to asbestos at the workplace are given adequate information, instruction and training.

(6) An employer shall keep a record of any training, both practical and theoretical, that was given to an employee.

(7) An employer or a self-employed person shall give instructions in writing of the procedures contemplated in subregulation (1)(k) to the drivers of vehicles carrying asbestos or asbestos-containing material, that has the potential of causing environmental pollution or affecting human health.

6. Duties of persons who may be exposed

Any person who is or may be exposed to asbestos in the workplace, shall obey any lawful instruction given by or on behalf of the employer or a self-employed person, regarding-

(a) the prevention of asbestos dust from becoming airborne;

(b) the wearing and use of personal protective equipment and clothing,

(c) the wearing of monitoring equipment to measure personal exposure to asbestos;

(d) the reporting for medical surveillance as required by Regulation 9;

(e) the cleaning up and disposal of nay material containing asbestos;

(f) housekeeping at the workplace, personal hygiene, good environmental and health practices, including eating, drinking and smoking in designated places provided; and

(g) information and training received contemplated in regulation 5.

7. Assessment of potential exposure

(1) An employer or self-employed person shall cause -

(a) his or her undertaking to be assessed within six months after the commencement of these regulations, and thereafter at intervals not exceeding two years, to determine if any person may be exposed to asbestos; and

(b) the assessment results contemplated in paragraph (a) to be recorded as required by regulation 16.

(2) An employer contemplated in subregulation (1) shall, before causing an assessment to be made, consult with the relevant health and safety representative or relevant health and safety committee and thereafter inform them in writing of the arrangements made for the assessment, give them reasonable time to comment thereon and ensure that the results of the assessment are made available to them for comment.

(3) When making the assessment contemplated in subregulation (1)(a), the employer or self-employed person shall take the following into account:

(a) The presence of any material containing asbestos being used, processed, handled or stored;

(b) where asbestos may be present, the ease with which the asbestos dust may be released and the extent to which a person may be exposed;

(c) the nature of the work, process and any likely deterioration in or failure of any control measures;

(d) the details of expected exposures, in particular-

(i) whether the expected exposure is above the OEL for asbestos, so that the appropriate respiratory protective equipment can be selected pending the implementation of engineering control measures;

(ii) whether such exposures are intermittent, including the frequency and duration of exposures;

(iii) the number of employees exposed and any other person who may be exposed, and their expected exposure values; and

(iv) where applicable, results which may be available from any previous monitoring performed at that workplace;

(e) the steps to be taken to reduce exposure to the lowest level reasonably practicable and the steps to be taken to reduce the release of asbestos dust into the environment;

(f) procedures for dealing with emergencies; and

(g) procedures for the removal of asbestos waste from the workplace, and the disposal thereof.

(4) If the assessment or any of its reviews made in accordance with subregulation (1) and (5) indicates that any person is likely to be exposed to asbestos, the employer or self-employed person shall ensure that the exposure is adequately controlled as contemplated in regulation 11.

(5) An employer or self-employed person shall forthwith review the assessment required by subregulation (1) if-

(a) there is reason to believe that the previous assessment is no longer valid;

(b) control measures are no longer efficient;

(c) technological or scientific advances allow for more efficient control methods; or

(d) there has been a significant change in-

(i) work methods;

(ii) the type of work carried out; or

(iii) the type of equipment used to control exposure;

and subregulations (2) and (3) shall apply.

8. Air monitoring

(1) Where exposure is in excess of half the OEL for asbestos, an employer shall ensure that a measurement programme of the concentration of airborne regulated asbestos fibres to which an employee is exposed, is

(a) carried out in accordance with these Regulations;

(b) carried out only after the relevant health and safety representative or relevant health and safety committee has been informed thereof and was given a reasonable opportunity, as mutually agreed upon, to comment thereon;

(c) carried out by-

(i) an approved asbestos inspection authority; or

(ii) a person whose ability to do the measurements is verified by an approved asbestos inspection authority;

(d) representative of the exposure of employees to the airborne asbestos fibres in accordance with subregulation (2); and

(e) verified in accordance with subregulation (3) if the measurements are carried out by a person contemplated in subregulation (1)(c)(ii).

(2) In order to comply with the provisions of subregulation (1)(d), an employer shall ensure

(a) that the measurement programme-

(i) in the case of a group measurement, makes provision for the selection of the number of persons for a sample to be done as contemplated in chapters 3 and 4 and table A-2 of Technical Appendix A of the OESSM: Provided that measurements of exposure shall be by personal sampling taken in accordance with MDHS 39/4: Provided further that in so far as any provision of the OESSM and the MDHS 39/4 is repugnant to a provision of the Occupational Health and Safety Act, 1993, and these Regulations, the provisions of the Act and these Regulations shall take precedence; and

(ii) if in the case of the most exposed employee measurement, the exposure exceeds the OEL for asbestos, then any other employee whose exposure could be above the OEL for asbestos is identified and that measurements representative of typical exposure shall be carried out on every employee identified; and

(b) that representative measurements contemplated in subregulation 1 (d) are carried out at least every 12 months: Provided that whenever the OEL for asbestos is exceeded, regulation 11 shall apply.

(3) In order to comply with subregulation (1)(e), an employer shall obtain the services of an approved asbestos inspection authority who shall, at intervals not exceeding 12 months, do the required verification-

(a) by examining the measurement and analysis equipment of the employer;

(b) by questioning the person contemplated in subregulation (1)(c)(ii) regarding the measurement programme;

(c) by carrying out, together with the person contemplated in subregulation (1)(c)(ii), the measurement programme required by subregulation (2) for any one group; and

(d) by ensuring that the results of the measurement and investigation as contemplated in subregulation (2) and (3) respectively, have been recorded as required by regulation 16.

9. Medical surveillance

(1) An employer shall ensure that an employee is under the medical surveillance of an occupational medical practitioner if-

(a) an employee is exposed or is likely to be exposed to asbestos dust exceeding the OEL for asbestos; or

(b) an occupational medicine practitioner certifies that the relevant employee should be under medical surveillance.

(2) In order to comply with subregulation (1), an employer shall, as far as is reasonably practicable, ensure that a structured medical surveillance programme be drawn up by an occupational medicine practitioner which shall include at least the following:

(a) An initial health evaluation, carried out by an occupational health practitioner immediately or within 14 days after a person commences employment, which comprises-

(i) an evaluation of the employee's medical and occupational history;

(ii) medical examinations and tests which should include chest X- rays, pulmonary function testing and an appropriate physical examination; and

(iii) any other essential medical examination which in the opinion of the occupational medicine practitioner is necessary in order to enable such practitioner to do a proper evaluation; and

(b) subsequent to the initial health evaluation contemplated in paragraph (a), evaluations of the relevant employee as contemplated in paragraph (a)(ii) and (iii), at intervals not exceeding two years, or at shorter intervals specified by an occupational medicine practitioner.

(3) An employer shall not permit or allow an employee who has been certified unfit for work by an occupational medicine practitioner to work in a workplace or part of a workplace in which he or she will be exposed or is likely to be exposed to asbestos dust: Provided that the relevant employee may be permitted to return to work if he or she is certified fit for that work beforehand by an occupational medicine practitioner.

(4) Where the reason for the employee being certified unfit as contemplated in subregulation (3) is as a result of exposure to asbestos in that workplace, the employer shall record and investigate the incident in compliance with regulation 8 of the General Administrative Regulations.

10. Respirator zone

An employer or self-employed person shall ensure that-

(a) any workplace or part of a workplace under his or her control, where the concentration of regulated asbestos fibres in the air is, or may be, such that the exposure of persons in that workplace exceeds the OEL for asbestos without the wearing of respiratory protective equipment, is zoned as a respirator zone;

(b) a respirator zone is clearly demarcated and identified by notice indicating that the relevant area is a respirator zone and that the respiratory protective equipment and protective clothing contemplated in regulation 17 must be worn there;

(c) no person enters or remains in a respirator zone unless he or she wears the required respiratory protective equipment and protective clothing; and

(d) the reason why the OEL for asbestos is exceeded is identified and action is taken, as soon as is reasonably practicable, to lower the concentration of asbestos in the air by means other than respiratory protective equipment, so that it does not exceed the OEL for asbestos.

11. Control of exposure to asbestos

(1) An employer or self-employed person shall ensure that the exposure of a person to asbestos is either prevented, or, where this is not reasonably practicable, adequately controlled: Provided that the control of the exposure shall be regarded as adequate if the level of exposure is-

(a) at or below the OEL for asbestos; or

(b) above the OEL for asbestos but the reason has been identified and action is taken, as soon as is reasonably practicable to lower exposure by means other than respiratory protective equipment, so that it does not exceed the OEL for asbestos.

(2) Where reasonably practicable, an employer or self-employed person shall control the exposure of a person-

(a) by using a substitute for asbestos;

(b) by limiting the number of persons who will be exposed or may be exposed;

(c) by limiting the period during which persons will be exposed or may be exposed;

(d) by limiting the amount of asbestos dust that may contaminate the working environment;

(e) by introducing, inter alia, the following engineering control measures for the control of exposure:

(i) Process separation, automation or enclosure;

(ii) bonding of asbestos fibres with other material to prevent the release of asbestos dust;

(iii) the installation of local extraction ventilation systems to processes, equipment or tools for the control of emissions of asbestos dust;

(iv) the use of wet methods where appropriate;

(v) separate workplaces for carrying out different processes; and

(vi) a fault indicator to enable early corrective action to be taken; and

(f) by introducing appropriate written work procedures that an employee must follow to ensure that-

(i) asbestos is safely handled, used and disposed of;

(ii) process machinery, installations, equipment, tools and local extraction and general ventilation systems are safely used and maintained; and

(iii) early corrective action regarding the control exposure.

12. Cleanliness of premises and plant

Every employer or self-employed person shall take steps to ensure, as far as is reasonably practicable, that-

(a) workplaces are maintained in a clean state and are free of asbestos waste and, whenever asbestos is accidentally spilled or asbestos dust is accidentally released into the workplace, that remedial measures are taken immediately before work is resumed;

(b) machinery, plant and equipment, as well as external surfaces of ventilation equipment and internal surfaces of buildings, are kept free of asbestos dust;

(c) cleaning is carried out by vacuum-cleaning equipment with a filtration efficiency of at least 99 per cent for particles one micrometre in size, or in such other manner that asbestos dust neither escapes nor is discharged into the air to such an extent that it contaminates any workplace or the environment;

(d) the vacuum cleaning equipment is regularly serviced and its external surfaces are kept in a clean state and free from asbestos dust; and

(e) where the use of vacuum-cleaning equipment is impracticable, the relevant surfaces are first dampened and that persons undertaking such cleaning are wearing appropriate protective clothing and respiratory protective equipment.

13. Control of exposure to asbestos of persons other than employees

(1) An employer or self-employed person shall ensure that the release of asbestos dust into any environment or water system complies with the provisions of the Atmospheric Pollution Prevention Act, 1965 (Act No. 45 of 1965), the Environment Conservation Act, 1989 (Act No. 73 of 1989), the National Water Act, 1998 (Act No. 36 of 1998), and the National Environmental Management Act, 1998 (Act No. 107 of 1998).

(2) In respect of asbestos dust which may be released from a workplace into any environment or water system which may affect the health of persons other than persons at his or her workplace, an employer or self-employed person shall ensure-

(a) with regard to airborne emissions

(i) that all work performed with asbestos be controlled as far as is reasonably practicable; and

(ii) that suitable filtration systems are used to control the release of asbestos dust into the environment to levels as low as is reasonably practicable;

(b) with regard to the contamination of water with asbestos

(i) that any water that is contaminated with asbestos as a result of work being performed is passed through a filtration system before being released into any environment or water system; and

(ii) that a suitable water filtration system is used which will ensure that the asbestos being released or entering into any environment or water system are reduced as far as is reasonably practicable;

(c) that contaminated parts of the filtration system, when discarded, are disposed of as asbestos waste; and

(d) that appropriate measures are taken to prevent the release of asbestos dust into the environment arising from the transport of asbestos.

14. Asbestos that forms part of structure of workplace, building, plant or premises

(1) Where asbestos forms part of the structure of a workplace, building, plant or premises, the employer or self-employed person shall-

(a) take reasonable steps to ensure that he or she determines the location of asbestos in such workplace, buildings, plant or premises, where that asbestos is likely to release asbestos dust that could impact on health or pollute the environment;

(b) make and maintain a written inventory of the location of asbestos in such workplace, buildings, plant or premises.

(2) An employer shall inform the relevant health and safety representative or relevant health and safety committee in writing of the arrangements made for the identification and location procedure contemplated in subregulation (1),

give them reasonable time to comment thereon and ensure that the asbestos inventory is made available to the relevant representative or committee who may comment thereon.

(3) The health or safety representative, or a person nominated by the health and safety committee, shall be entitled to take part in the identification and location procedure contemplated in subregulation (1).

(4) With regard to any dispute as to whether any substance is in fact asbestos, the health and safety representative or a person nominated by the employees may require that a sample of that substance be taken and the true nature of the substance be determined by an approved asbestos inspection authority: Provided that the cost of the identification shall be borne by the employer.

(5) The employer or self-employed person shall regularly examine the condition of asbestos recorded in the inventory for deterioration or damage.

(6) The employer or self-employed person shall assess the risk of exposure to such asbestos as contemplated in subregulation (1) and document the action necessary to ensure that-

(a) information about the location and condition of material containing asbestos is given to anyone likely to disturb it;

(b) any material containing asbestos is maintained in a good state of repair and that, where necessary, a planned maintenance program is implemented;

(c) any material containing asbestos and which may create a risk of exposure because of its state and location, is repaired or, if necessary, removed: Provided that, if the removal constitutes demolition work, the asbestos shall be removed in accordance with regulation 21; and

(d) procedures and arrangements are in place so that work that may disturb the material complies with all other requirements of these Regulations.

15. Asbestos cement sheeting and related products

(1) An employer or self-employed person who erect, maintain, alter, renovate, repair, dismantle or add asbestos-cement roof sheeting, wall paneling, gutters, fascia boards and related products to a building shall ensure that-

(a) if any roof work is performed, suitable roof ladders or duckboards or crawling boards are used in accordance with regulation 12 of the General Safety Regulations published by Government Notice No. R. 1031 of 30 May 1986;

(b) written work procedures are laid down and followed to prevent the release of asbestos dust into the environment;

(c) any water which contains asbestos dust as a result of the activities contemplated in subregulation (1), shall be treated in accordance with regulation 13(2)(b) and (c);

(d) the work procedures contemplated in paragraph (b) shall be available for perusal by the relevant health and safety representative or relevant health and safety committee and for inspection by an inspector;

(e) removal work is conducted under controlled conditions in accordance with regulations 11 and 13;

(f) cutting or drilling is performed under controlled conditions in accordance with regulation 11 and 13, including the use of wet methods where possible, and a suitable slow-speed cutter is used, provided that a respirator shall be used by the operator and others at risk of exposure;

(g) asbestos waste of any form, including dust, is collected and disposed of in accordance with regulation 20;

(h) once installed and where reasonably practicable, the relevant items are painted or otherwise sealed with a protective coating to limit the release of asbestos dust, combat weathering and inhibit growth of lichen or moss;

(i) cleaning is done under controlled conditions ensuring that-

(i) dry-brushing, scraping, sanding or abrasion techniques are not used;

(ii) where reasonably practicable, high-pressure water jetting is not used unless in conjunction with a suitable profiled hood that limits dispersal of contaminated water and, if the said jetting is used, that suitable control methods are used in accordance with regulation 13(2)(b); and

(iii) when fungicidal solution or moss killer is applied, a standing time of 24 hours or any other period specified by the manufacturer is allowed, and a low-pressure hose is used after such period to keep the sheets wet whilst employing a stiff broom or any similar means to remove any moss or lichens.

16. Records

An employer shall -

(a) keep records of the results of all assessments, air monitoring, medical surveillance reports and the asbestos inventory required by regulations 7, 8, 9 and 14(1)(c), respectively: Provided that personal medical records shall only be made available to an occupational health practitioner;

(b) subject to paragraph (c), make the records contemplated in paragraph (a), excluding personal medical records, available for inspection by an inspector;

(c) allow any person, subject to formal consent in writing of an employee, to peruse the records with respect to that particular employee;

(d) make the records of all assessments and air monitoring, and the asbestos inventory available for perusal by the relevant health and safety representative or relevant health and safety committee;

(e) keep all records of assessments and air monitoring, and the asbestos inventory for a minimum period of 40 years;

(f) keep all medical surveillance records for a minimum period of 40 years and, if the employer ceases activities relating to asbestos work, shall hand over or forward by registered post all these records to the relevant provincial director: Provided that those records contain at least the following information:

(i) Surname, forenames, gender, date of birth, name of spouse or closest relative and where available, permanent address and postal code;

(ii) a record of types of work carried out with asbestos and, where relevant, its location, the starting and ending dates of exposure and average duration of exposure in hours per week;

(iii) a record of any work with asbestos prior to this employment; and

(iv) dates of medical surveillance reports;

(g) keep a record of the tests and investigations carried out in terms of regulation 18 (b) and of any repairs resulting from the relevant tests and investigations, and keep that record for at least three years; and

(h) keep a record of training given to an employee in terms of regulation 5(5) for as long as the employee remains employed at the workplace in which he or she is being exposed to asbestos.

17. Personal protective equipment and facilities

(1) An employer or self-employed person shall provide

(a) all persons exposed to asbestos at the workplace with suitable protective clothing; and

(b) a person with suitable respiratory protective equipment to ensure that the person's exposure is adequately controlled as contemplated in regulation 11(1).

(2) Where respiratory protective equipment is provided, the employer or self-employed person shall ensure that-

(a) the relevant equipment is capable of keeping the exposure level at or below the OEL for asbestos;

(b) the relevant equipment is correctly and properly used;

(c) information, instruction, training and supervision that are necessary with regard to the use of the equipment are provided to the persons; and

(d) the equipment is kept in good condition and efficient working order.

(3) An employer or self-employed person shall, as far as is reasonably practicable-

(a) issue no personal protective equipment to a person, unless such equipment is cleaned, decontaminated and, where appropriate, sterilised;

(b) provide separate containers or storage facilities for personal protective equipment when not in use; and

(c) ensure that all personal protective equipment not in use is stored only in the place provided.

(4) An employer or self-employed person shall, as far as is reasonably practicable, ensure that all personal protective equipment contaminated with asbestos dust is cleaned and handled in accordance with the following procedures:

(a) Where the equipment is cleaned on the premises of the employer or self-employed person, care shall be taken to prevent contamination during handling, transport and cleaning;

(b) Where the equipment is sent off the premises to a contractor for cleaning purposes-

(i) the equipment shall be packed in impermeable containers;

(ii) the container shall be tightly sealed and clearly labeled in the form of Annexure 1; and

(iii) the relevant contractor shall be informed of these Regulations and the precautions to be taken for the handling of the asbestos contaminated equipment; and

(c) water that is used for decontamination or cleaning of equipment shall be filtered in accordance with regulation 13(2)(b) before being released into any water system.

(5) Subject to subregulation (4)(b), an employer or self-employed person shall ensure that no person removes dirty or contaminated personal protective equipment from the workplace: Provided that where personal protective equipment contaminated with asbestos dust has to be disposed of, it shall be treated as asbestos waste as contemplated in regulation 20.

(6) Subject to the provisions of the Facilities Regulations published by Government notice R. 1593 of 12 August 1988, the employer shall, where reasonably practical, provide employees who use personal protective equipment as contemplated in subregulation (1), with-

(a) adequate washing facilities which are readily accessible and located in an area where the facilities will not become contaminated, in order to enable the employees to meet a standard of personal hygiene consistent with the adequate control of exposure, and to avoid the spread of asbestos dust;

(b) two separate lockers labeled “protective clothing” and “personal clothing” respectively, and shall ensure that the clothing is kept separately in the lockers concerned; and

(c) separate change rooms labeled “clean change room” and “dirty change room”, with suitable barrier and bathing facilities between to prevent the contamination of personal clothes with asbestos dust.

18. Maintenance of control measures

An employer or self-employed person shall ensure that-

(a) all control equipment and facilities provided in terms of regulations 11, 12, 13, and 17 are maintained in good working order; and

(b) examinations and tests of engineering control measures are carried out at intervals not exceeding 24 months by an approved inspection authority or by a person whose ability to do such examinations and tests is verified by an approved inspection authority.

19. Labeling, packaging, transportation and storage

An employer or self-employed person shall, in order to avoid the spread of asbestos dust, take steps, as far as is reasonably practicable, to ensure that-

(a) the asbestos in storage or being distributed is properly identified, classified and handled in accordance with SABS 0228;

(b) a container or a vehicle in which asbestos is transported is clearly identified, classified and packed in accordance with SABS 0228 and SABS 0229; and

(c) any article or substance which contains asbestos is clearly labeled, in the form of Annexure 1.

20. Disposal of asbestos

An employer or self-employed person shall as far as is reasonably practicable ensure that-

(a) all asbestos waste is placed in containers that will prevent the likelihood of exposure during handling;

(b) all vehicles, re-usable containers or any other similar articles which have been in contact with asbestos waste are cleaned and decontaminated after use, in such a way that such vehicles, containers or similar articles do not cause a hazard inside or outside the workplace concerned;

(c) all asbestos waste which can cause exposure, is disposed of only on sites specifically designated for this purpose in terms of the Environment Conservation Act, 1989 (Act No. 73 of 1989), and the National Environmental Management Act,1998 (Act No. 107 of 1998), and in such a manner that it does not cause a hazard inside or outside the site concerned;

(d) all persons occupied in the collection, transport and disposal of asbestos waste, who may be exposed to that waste, are provided with suitable personal protective equipment; and

(e) where the services of a contractor for the disposal of asbestos waste are used, a provision is incorporated into the contract stating that the contractor shall also comply with the provisions of these Regulations.

21. Demolition

Any person who intends to have demolition work carried out, shall-

(a) before the commencement of that work, take steps to ensure that-

(i) demolition work is carried out by a person who is a registered asbestos contractor;

(ii) all asbestos materials likely to become airborne are identified;

(iii) a plan of work is submitted for approval at feast 30 days prior to the commencement of that work to an approved asbestos inspection authority who may at its discretion allow a shorter period of time for such submission and may approve standardised procedures for routine alterations or repairs: Provided that the stipulated time period shall not apply if the plan of work is drawn up by an approved asbestos inspection authority;

(iv) a copy of the approved plan of that work, which has been signed by the approved asbestos inspection authority, the employer and, if the person performing that work is not the employer or self-employed person, the mandatory of the employer or self-employed person, is submitted to the provincial director at least 14 days prior to commencement of such demolition work: Provided that an inspector may allow a shorter period for such submission; and

(v) copies of approved standardised procedures for demolition work are submitted to the provincial director at least 14 days prior to commencement of that work; and

(b) during and after the completion of demolition work, take steps to ensure that-

(i) all asbestos and materials containing asbestos are handled and disposed of in accordance with these regulations;

(ii) all persons exposed to or likely to be exposed to asbestos are issued with appropriate personal protective equipment and that such equipment is used properly; and

(iii) the premises, structure or area are thoroughly checked to ensure that all asbestos waste has been removed.

22. Prohibition

No person shall-

(a) use compressed air or permit the use of compressed air to remove asbestos dust from any surface or person;

(b) smoke, eat, drink or keep food or beverages in an area not specifically designated for it or require or permit any other person to smoke, eat, drink or keep food or beverages in such area; or

(c) apply asbestos by means of spraying or any other similar process or require or permit any other person to apply asbestos by means of such process.

23. Offences and penalties

Any person who contravenes or fails to comply with any provision of regulations 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13(2), 14, 15, 16, 17,18, 19, 20, 21 or 22 shall be guilty of an offence and liable on conviction to a fine not exceeding R1000 or imprisonment for a period not exceeding 12 months and, in the case of a continuous offence, to an additional fine of R200 for each day on which the offence continues or to additional imprisonment of one day for each day on which the offence continues: Provided that the period of such additional imprisonment shall in no case exceed 90 days.

24. Repeal of regulations

The Asbestos Regulations published under Government Notice No. R.773 of 10 April 1987, as Government notice No. R. 1637 of 4 August 1989, are hereby repealed.

25. Short title

These Regulations shall be called the Asbestos Regulations, 2001.

ANNEXURE 1

OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 (ACT 85 OF 1993)

REGULATION 19 *(C)* OF THE ASBESTOS REGULATIONS, 2001

WARNING!!! ASBESTOS
INHALATION OF ASBESTOS DUST IS DANGEROUS TO HEALTH. FOLLOW THE SAFETY INSTRUCTIONS

PARTICULAR SPECIFICATION: FIBRE OPTIC RING

PARTICULAR SPECIFICATION: FIBRE OPTIC RING

CONTENTS

1 FIBRE OPTIC RING

The outer sheath identification is important to the client as is the position within the trenches to assist with easy identification of the cables in the field.

The optical fibres shall comply with SANS IEC 60793 and the optical fibre cables shall comply with SANS IEC 60794, and shall be installed in accordance with SANS IEC 60794-1-1.

All cables or cable lengths shall be supplied along with Factory Test Certificates. Cable ends shall be suitably made off / protected to avoid water ingress, damage etc while in storage.

The cables shall be constructed to the following specification:

- Fibre optic cables shall be armoured, ie protected by PVC / SWA / PCC sheaths over the inner cladding.
- The fibre optic cable shall consist of 12 fibres (50 / 125µm), graded index, 850 / 1300nm, multimode and armoured, as stated above.
- Fibre Optic cables may be run in the same trenches as the power cables, but care must be taken to prevent mechanical damage to the cable. A separate cable marker shall be used to indicate that a fibre optic cable is installed in the electrical trench.
- Tubes shall not be filled with water blocking compound
- The cable core shall be filled with water blocking compound
- The cable shall be designed with sufficient strength members to meet installation and service conditions so that the fibres are not subjected to strain of more than the limits specified by the manufacturer
- A moisture barrier shall be provided by a metallic tape applied over the cable core with a longitudinal overlap and bonded to the sheath
- The inner sheath shall be made of polyethylene

The specialist Communications Contractor shall be required to supply and install the necessary interface ST Leads (Single Core Monofilament Fibre Optic Patch Lead) between the respective patch panels.
The cable type shall comply as follows:

FIBRE CABLE SPECIFICATION	
Type:	50/125 µm graded index, 850/1300 nm Multimode
Fibres	12 Fibre.
Max Tensile Strength	1.5kN
Crush Resistance	As per IEC 794-1-E3
Cable Sheath	Black Low Halogen (LH) Polyethylene Sheath (MV Network Data) Orange Low Halogen (LH) Polyethylene Sheath (Process Information Network Cable)
Armour	Steel Wire Armour
Joints	Fusion Type with .15dB max Loss (Only if absolutely necessary)
Termination	ST Type

The following table indicates the new Fibre Optic cable route. The Control Single Line Diagram indicates the number of cores and connections in more detail.

2 FIBRE JOINTS

Optic Fibre joints shall be kept to an absolute minimum but where individual cable lengths exceed the maximum drummed cable lengths from the Manufacturer the cables will need to be jointed.

The joints shall be contained within an underground FOSC Slim In–Line enclosure type Tyco FOSC-500AA.

The fusion connections shall be made within the enclosure and protected via Type Tyco SMOUV Fibre Optic Fusion Splice Protectors

The Contractor must NOTE:
Where fusion Joints are required within the trench, he shall ensure that the cable ends overlap by 10 meters. This is to allow for the jointer to perform the joint in a clean environment.

3 FIBRE TERMINATIONS

Fibre optic cables shall be terminated in optical fibre termination boxes, and shall be made off with pigtails / fly-leads of approximately 3 m. The ends of the fibres shall be ST type connectors, of nylon or PVC type material. A label shall be attached to the termination closure warning of the danger of laser beams.

Fibre Optic cables shall be supplied, installed and terminated by specialist companies.

PARTICULAR SPECIFICATION: GENERAL INSTRUMENTATION SPECIFICATION

PARTICULAR SPECIFICATION: GENGERAL INSTRUMENTATION SPECIFICATION

CONTENTS

1 DESIGN BASIS

1.1 General

1.1.2 All panel mounted instrumentation and control equipment shall be capable of operating at the required capacity in ambient temperatures not exceeding 50°C and an average, over a period of 24 hours, not exceeding 40°C. The field mounted instruments and control equipment shall however, be suitable for operation under ambient temperatures not more than 55°C unless higher ambient temperatures are specifically stated in the Technical Specification.

1.1.3 All equipment and accessories shall be designed to withstand the atmospheric and operational conditions within the plant.

1.1.4 Instrumentation sensing system shall be pneumatic or electronic. Electric signal transmission shall be of common standard and level or converted, where required to the common standard.

1.1.5 Special care shall be taken to make the equipment enclosures proof against entry of vermin and insects.

1.1.6 The design shall include all reasonable precautions and provisions for the safety of operating and maintenance personnel as well as for their accessibility

1.2 Panel Instruments

1.2.1 It should be endeavoured not to have any panel instruments, but rather to make use of the PLC / SCADA. Where panel instruments are required for instance at a T/A set the following shall apply.

1.2.2 Standard size instruments shall be used on the control panels to indicate, record and control the major portion of the process variables.

1.2.3 Factory assembled panels or field assembled panels shall be furnished in accordance with Item 4.1 of this specification.

1.2.4 Process fluids shall not be piped directly to instruments in the control room.

1.2.5 Where separate electric power supplies are required for electronic instrumentation systems, it shall be taken off the UPS supplying that area Instrumentation as required.

1.3 Field Instruments

1.3.1 All field mounted instruments shall be weather-proof and dust-tight, suitable for use under ambient conditions prevalent in a specific plant area.

1.3.2 In plant areas giving rise to corrosive atmospheres, field mounted instruments such as transmitters, 1/P converters, solenoid valves, pressure switches etc. shall be housed in steel boxes with IP65 rating. Piping and cable entries shall be made at the bottom of the box.

1.3.3 All field boxes will be fitted with canopies.

1.3.4 All valves and drives shall be correctly sized with a 50% turn down ratio.

1.4 Control Performance

1.4.1 Automated production is performed by a distributed process control and information management system comprising supervisory computers and controllers linked to a distributed real-time network.

1.4.2 Automatic control systems shall, in general, be of feedback type, however, feed-forward control shall be used when process time-lag conditions that exist in a feed-back system are not tolerable. Modes of control shall, in general, be proportional (P), proportional plus automatic reset (I), or proportional plus reset plus rate (D).

1.4.3 All control loops shall be stable for all process conditions. Cyclic stability will not be accepted. Final value error shall be minimised whenever practical.

1.5 Metering Base and PCS Units

Pressure above 1 bar: Pressure	kPa Pa
Pressure below 1 bar: Draft/Vacuum	mm H_20 kPa (abs)
Temperatures Flow (all gases)	°C
Flow (steam and condensate)	m^3/hr
Flow (liquids)	kg/hr, tonne/hr, kg/hr, lt/hr, It/sec
Flow base	based at 760mm Hg and 0°C
Level	% or meters
Density	kg/m^3

1.6 Utilities

1.6.1 Electrical power, available from the plant system is 3 phase 400 V and 1 phase 240 V, 50Hz.
If the equipment is required to operate at any other voltage level, the necessary transformer and/or conversion units shall be included in the scope of supply by the Contractor.

1.6.2 A power supply calculation shall be performed to determine the capacity of UPS capacity including battery

Standard voltage	3 x 400/220 V, 50 Hz
Mains power supply	1 x 220 V ± 5%, 50 Hz
UPS Supply	1 x 220 V ± 5%, 50 Hz
Instrument Control Voltage	24 V ±5%, DC
Digital Signals	24 V ±5%, DC
Analogue Signals	4 to20 mA DC

1.6.3 Clean instrument compressed air will generally be available, however where specific instruments may require air quality above the normal quality of plant instrument air or at a lower pressure than the plant instrument air the contractor is to ensure that all necessary regulators, dryers, separators and lubricators are allowed for.

2 PANEL INSTRUMENT DESIGN

2.1 Recorders

Recorders are not preferred, SCADA/DCS trends, i.e. Real Time and History trends should be available for all measured variables.

2.2 Controllers

Stand-Alone controllers, (panel mount controllers), are not preferred.

2.3 Indicators

Stand-Alone indicators, (panel mount electronic indicators), are not preferred.

2.4 Alarm Annunciator

All alarm annunciation will take place on the PLC/SCADA or DCS

3 FIELD INSTRUMENT DESIGN ·TRANSMITTER DESIGN

3.1 Magnetic Flow Meter

Transmitter shall be indicating, electronic type based on the law of induction.

Transmitter shall meet the following minimum requirements:

Accuracy	0,5% of span or better
Repeatability	0,2% of span
Output	Linear
Ambient temperature effect	Not to exceed 0,5% of maximum span per 1°C change
Material: -Tube	Stainless Steel
- Liner	Teflon (depending on application)
- Electrode	Hastalloy, Tantalum

3.2 Vortex Shedding Meter

3.2.1 Transmitter shall be indicating, electronic type based on the Vortex shedding measuring principle.

3.2.2 Transmitter shall meet the following minimum requirements :

Accuracy	0,2% of span or better
Repeatability	0,2% of span
Output	Linear
Ambient temperature effect	Not to exceed 0,5% of maximum span per 1°C change
Material – Tube	Stainless Steel
Material – Vortex shedder	Stainless Steel

3.3 Pressure Transmitter

Transmitter shall be indicating, electronic type based on force balance principle.

Transmitter shall meet the following minimum requirements:

Accuracy	0,2% of span or better
Repeatability	0,1% of span
Dead band	Not to exceed 0,1% of span
Ambient temperature effect	Not to exceed 0,5% of maximum span per 1°C change
Proof Pressure	200% of max. process static pressure.

Mounting	Universal bracket type
Material	Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere
Adjustment:	Independent for span and zero Adjustment may be via bus or hand held calibrator

3.4 Temperature Transmitter

Transmitter shall be electronic type for thermocouple or RTD connection. Transmitter shall meet the following minimum requirements

Accuracy	0, 5% of span or better
Repeatability	0,1% of span
Dead band	Not to exceed 0,1% of span
Ambient temperature effect	Not to exceed 0,5% of maximum span per 1°C change
Proof Pressure	200% of max. process static pressure
Mounting	Head mounted unless specifically stated otherwise in instrument specification
Material	Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere
Adjustment:	Independent for span and zero
	Adjustment may be via bus or hand held calibrator

3.5 Capacitance Level Transmitter

Transmitter shall be indicating, two-wire electronic type for rod -or rope-probe connection. Transmitter shall meet the following minimum requirements

Accuracy	1% of span or better
Repeatability	0,2% of span
Dead band	Not to exceed 0,2% of span
Ambient temperature effect	Not to exceed 0,5% of maximum span per 1°C change
Material	Standard materials that are suitable for process and ambient conditions shall be used
Probes	Shall generally be stainless steel/ Teflon coated.
Adjustment	Independent for span and zero

3.6 Ultrasonic Level Transmitter

Ultrasonic level measuring device shall have facilities to compensate echo changes due to temperature changes and to ignore periodically recurring false echo due to agitators.

Evaluating device shall be indicating, two-wire electronic type.

Transmitter shall meet the following minimum requirements

Accuracy	1% of span or better
Repeatability:	0,2% of span
Dead band	Not to exceed 0,2% of span
Ambient temperature effect	Not to exceed 0,5% of maximum span per 1°C change
Material	Standard materials that are suitable for process and ambient conditions may be used
Adjustment	Independent for span and zero (Adjustment may be via bus or hand held calibrator)

3.7 Radar Level

Microwave level measurement. Measures the transit time of a radar signal that is reflected from the surface of a liquid

Transmitter shall meet the following minimum requirements

Accuracy	1% of span or better
Repeatability	0.2% of span
Temperature Drift	<100ppm/°K
Material	wetted parts stainless steel

Device shall be 2 wire, with a local indication

3.8 Guided Radar Level

Guided radar (TOR) level transmitter. Guided radar is based on time domain reflectometry principle. Low power microwaves are sent along conductors and at the point where the waves meet the product surface the waves are reflected

Transmitter shall meet the following minimum requirements

Accuracy	1% of span or better
Repeatability	0.2% of span
Temperature Drift	<100ppm/°K
Material	rod or cable - stainless steel

Device shall be 2 wire, with local indication

3.9 3.9 Weight Transmitter

Weight transmitters shall be selected in conjunction with load cells, shall have high immunity to plant vibration, allow long distances to load cells and shall be designed to compensate for temperature effects

Transmitter shall meet the following minimum requirements

Accuracy	0,5% of span or better
Dead band	Not to exceed 0,1% of span
Ambient temperature effect	Not to exceed 0,1% of maximum span per 10°C change
Material	Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere
Adjustment	Independent for span and zero (Adjustment may be via bus or hand held calibrator)

3.10 3.10 Open Channel Flow Transmitter

Open Channel Flow ultrasonic measuring device shall have facilities to compensate echo changes due to temperature changes and to ignore periodically recurring false echoes due to agitator

Evaluating device shall be indicating, two-wire electronic type.

Transmitter shall meet the following minimum requirements

Accuracy	1% of span or better
Repeatability	0,2% of span
Dead band	Not to exceed 0,2% of span
Ambient temperature effect	Not to exceed 0,5% of maximum span per 1ooc change
Material	Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere
Adjustment	Independent for span and zero (Adjustment may be via bus or hand held calibrator)

4 CONVERTER DESIGN

4.1 Electric-Pneumatic Converter (I/P)

Electric to pneumatic converters are intended primarily for use in conjunction with controllers having electrical output or with electrical transmitter where the final control element is actuated from pneumatic actuator or controller.

Pneumatic-electric converter shall be of force balance type and shall convert the direct current input into a standard pneumatic output signal.

Converter shall be provided with a 1:1 relay wherever required in order to provide large volume of air required for rapid operation at long distance.

Transmitter shall meet the following minimum requirements

Accuracy	0,5% of span or better
Linearity	0,1% of span
Hysteresis	0.2% of span
Ambient temperature effect	Not to exceed 0,5% of maximum span per 1°C change
Adjustment	Independent for span and zero

Mounting	Universal bracket suitable for horizontal or vertical support
Case	Dust-tight for general application

5 PRIMARY ELEMENT DESIGN

5.1 Orifice Plate Design

Orifice plates shall be made of suitable grade stainless steel, unless process conditions require some other material.

In general, orifice plates shall be designed for flange taps, however, Vena contracta taps may be substituted when designated by good engineering practice.

Concentric type orifices are preferential.

Eccentric or segmented types shall be used for measurement of dirty gases or fluids carrying suspended matter which might tend to cause build-up.

The orifice ratio (orifice inside diameter to process pipe line internal diameter) shall, in general, be between 0,3 and 0,7 for metering accuracy

5.2 Annubar Design

Annubar material shall be made of suitable grade stainless steel, unless process conditions require some other material.

In general, Annubars shall be designed for single support and on-line vertical, or horizontal taps.

Opposite side support are to be used only in extreme diameter and high flow cases.

On-line steam purge accessories are to be included for measurement of dirty gases or fluids carrying suspended matter which might tend to cause build-up.

Flow turndown of 10:1 is acceptable.

Annubar element shall meet the following minimum requirements

Accuracy	1,0% of actual value
Repeatability	0,1% of actual value
Mounting	Universal bracket suitable for horizontal or vertical support

5.3 Pressure Elements

Directly connected instruments shall be diaphragm, Borden or bellow type elements depending upon the service requirements.

In general, diaphragm elements shall be used in the range of 0 to 1OOkPa vacuum or pressure, bellow type element for range of 0 to 1000 kPa and Borden tube element for range higher than 1000 kPa.

Primary element material shall be corrosion resistant to process fluid or chemical seals must be provided for protection.

Primary element material shall provide good creep and fatigue resistance, and low hysteresis.

Proof pressure shall be at least twice the maximum system pressure.

5.4 Temperature Elements

The primary elements for temperature services shall consist of resistance thermometers or thermocouples or radiation pyrometers, depending upon the range of measurement

The following types of elements shall be used for stated ranges

Pt-Rh (10%) Pt	0 to 1500°C (type S)
Chromel-Alumel	0 to 1000°C (type K)
Copper resistance Element	-50 to +100°C
RTD (Pt100)	0 to +600°C

Whenever specified, duplex thermocouple shall be provided.

Thermocouple/emf calibration shall conform to the International Practical Temperature Scale of 1968 (IPTS).

Gas-tight mineral insulated type, reinforced with stainless steel protective tubes shall be used for thermocouples. Preferred outside diameter shall be 6mm. Lengths to fit standardised thermo-wells shall be use.

Resistance thermometer shall be of three lead connection system to the instrument and shall be gas-tight internal insulated type, reinforced with stainless steel protective tubes shall be used for thermocouples. Preferred outside diameter shall be 6mm. Lengths to fit standardised thermo-wells shall be used.

The resistance/temperature relationship shall conform to British Standard 1904 Table 1, 1979 revision or with DIN 43760.

Thermo-wells shall be used for all temperature elements under pressure application. Construction material for thermo-wells shall be suitable stainless steel, unless some other material is required due to process conditions

5.5 Radiation Pyrometers

Radiation pyrometers shall be used when:

- Temperatures are above practical operating range of a thermocouple
- Environment will contaminate or seriously limit the life of thermocouples
- The target is not easily accessible

Radiation pyrometers shall be of solid state circuitry type and shall, for standard application, respond to 98% of target temperature changes within 2 seconds

The burner flame detector applications, radiation pyrometers shall be designed for use with self-checking flame self-guard controls

5.6 Filled Systems

Filled systems shall not be used unless otherwise specified

6 INDICATOR DESIGN

6.1 Flow Indicators

Flow indicator shall be variable area (Rotameter) or differential pressure type

Variable Area Meters (VA Meters), when used, shall preferably be of metal type with magnetic indicator extension. Glass type VA Meters shall be used for purge or auxiliary services

Differential pressure type, when used, shall in general be of dry type complete with equalising valve manifold

Indicators shall have suitable body material and packing of process fluid being monitored

Scales shall be linear or square root direct reading.

Accuracy shall be 1% of full scale or better and repeatability at least 0,255 of full scale range. Proof pressure shall be at least 200% of maximum static process pressure at maximum process fluid temperature

6.2 Pressure Indicators

Pressure gauges shall generally be 150mm diameter. Case and movement - stainless steel. Scales shall be white with black lettering. Accuracy shall be 1% of full scale range or better.

Scale ranges shall be selected so that normal process pressure is approximately 50% of full scale.

Rotary geared stainless steel movements shall be used.

Gauges for steam service shall be connected with ail siphon. Dampers shall be provided for all pulsating fluids.

Draft gauges shall be diaphragm type or fluid filled manometers

6.3 Temperature Indicators

Temperature indicators shall generally be 1OOmm dial, bi-metallic or fluid type with thermowell suitable for application.

Material of construction for thermo-well shall be suitable stainless steel, unless some other material is required due to process conditions.

Fluid filled type indicators, when used, shall be either rigid stem or capillary tubing type. Capillary tubing shall be armour protected.

Stem or bulb shall be suitable stainless steel with welded joints.

Indicator shall be provided with automatic ambient temperature compensation. Accuracy shall be 1% of full scale range or better

6.4 Level Indicators

Sight level glasses or dial type or float type level indicators shall be used

Each sight glass shall be complete with a pair of offset valves, valves shall have union level connection, flanged tank connection, vent and drain plugs

If float type indicators are used, cable must be made of braided stainless steel

Dial type indicator shall be· of differential pressure type having accuracy of 1% of full scale or better

7 SWITCHES AND CONTROLLERS

7.1 Mechanical Switches

Pressure, flow level, temperature etc. type switches shall be provided with enclosures of a type to suit individual area environment.

Actuating switches shall be either hermetically sealed mercury type or snap action micro-switches. Contacts shall have a minimum rating of 3A inductive braking at 220V AC.

All switches shall have two parallel contacts normally open/closed and the on-off differential switches shall be adjustable. Adjustable range shall be suitable for switch application, actuation set point shall be adjustable over full scale range.

All switches shall have an accuracy of 1% or better of full scale range.

Level switches shall be in general resonating or displacer type. Standard material shall be suitable for process and ambient conditions. Material of the displacer shall be stainless steel.

Conductivity level switches shall be either single or double type with contacts changeable to minimum/maximum closed safety circuit. Electrodes shall be heavy version, either single or three rod types, material shall be preferable of special steel.

Position switches shall be of inductance or capacitance proximity sensors with single or dual potential free contacts

8 ACTUATORS

8.1 General

Actuators shall be either pneumatic diaphragm or pneumatic piston type.

All actuators shall have a stall torque rating of at least 150% of maximum required torque for the driven element.

All actuators shall have a minimum repeatability of 0,5% of full travel. Hysteresis effect shall not exceed 1,0% of full scale travel.

Manual over-ride facilities shall be provided.

A mechanical shaft position indicator shall be standard on all actuators.

Actuators shall have a totally enclosed housing to provide complete protection for all moving, pneumatic and electronic parts. Construction material shall be suitable for ambient and process conditions

Unless specified otherwise, actuators be of spring return type for fail-safe operation

8.2 Pneumatic Actuators

Actuators shall be of diaphragm or cylinder type for either rotary or linear version depending upon specific application and shall be reversible for air-to-open or air-to-close action

Actuator shall operate on 600 kPa, cylinder shall be able to withstand a line pressure of 1500kPa. Positioner shall operate on 20 to 100 kPa

Corrosion, endangered parts such as cylinder wall, piston rod, torque plug, etc. shall be manufactured of hard wearing and rustless metal, with high lubricity

Actuators shall be provided complete with line filter, lubricator, positioner, manual operating handle and air lock-up system, unless otherwise specified

For actuator position remote indication the provision for two limit switches attachment shall be provided

8.3 Electric Actuators

Actuators shall be fitted with a 3 phase 400 squirrel-cage motor.

If two speeds are required a pole-changeable motor may be used.

Output force of the motor shall be transmitted through a stage of spur gears, a spring- balanced worm with axial bearings, a worm wheel, and a clutch stage to the output shaft.

All actuators shall be fitted with a double torque-dependent switch.

For remote position indication of actuators fitted to modulating valves, prov1s1on for an analogue 4-20 mA attachment shall be provided. For isolation valves two limit switches shall be provided.

Provision for manual operation shall be made by means of a hand wheel - the mechanically independent hand-wheel shall be engaged by means of a clutch, which also de-clutches the motor drive from the output shaft.

Actuators shall be fitted with a mechanical position indicator

Technical specifications:

Torque and travel dependent switches

NO, NC or change-over	10A at 30V AC, SA at 250V AC 5A at 30V DC, 0,4V at 25OV DC
Mechanical life time	± 106 cycles
Suitable for ambient temperature	-20 to +80°C

Electronic position indicator:

Supply voltage	15 to 30V smoothed
Communication	Modbus Ethernet
Linearity deviation	±1% from 5 to 95% of measuring range
Suitable for ambient temperature	-25 to +90°C·
Adjustment	Independent for span or better
Linearity	0,1% of span
Hysteresis	0,2% of span
Accuracy	0,5% of span or better
Case	Dust-tight for general application

8.4 Control Valves - General

Control valves for modulation services shall be pneumatically operated.

Flange facing and drilling shall be according to either BS or equivalent DIN standard. Control valves of size 40mm and above shall have flanged end connections.

In general control valves of size 40mm and below shall have screwed connection.

Valve size shall be based on specified allowable pressure drop at 130% of normal process design flow conditions.

Valve top-works shall be sized so that the valve will operate properly when upstream pressure is 10% above maximum inlet pressure and downstream pressure is atmospheric.

Isolating valves and by-pass valves shall in general be provided for each control valve application. Isolating valves shall be of line size whereas by-pass valves shall be of control valve size.

Seals and liner material used for valves in boiler gas lines shall be made of VITON. Nylon shall not be used unless otherwise specified.

Close attention shall be given to the selection of valve body, line and diaphragm material depending upon specific application, however, Engineer approval is required prior to order

8.5 Diaphragm Valves

Diaphragm valves shall be used where process control quality requirements are comparatively poor and a low pressure drop across the valve is required or where the valve function is restricted to on-off control

Diaphragm valves shall be used for aggressive fluids such as weak sulphuric acid, corrosive, slurry and sludge which contain solids in suspension.

For application with high control frequency another valve type shall be considered.

Material of construction

Body	Cast Iron
Liner	Hard rubber, Soft rubber Butyl
Diaphragm	Depending on application

8.6 Globe Valves

Globe valves shall be used in the majority for conventional control application

For water, steam, gas and air control applications, a cast steel valve body with stainless steel trim shall be provided

In case of special treated water, selection of stainless steel body may become necessary.

For oxygen control application, a bronze valve body with Monel-metal trim and a PTFE Chevron packing shall be provided

Trim material shall normally be of 316 stainless steel, for special applications stellite shall be used

Extended bonnets and graphite laminate/filament packing shall be used for operating temperature higher than 200°C up to 530°

8.7 Butterfly Valves

Butterfly valves may be used for modulating service but shall not be used for shut-off service if the maximum differential pressure across the valve exceed 500 kPa

Butterfly valves shall be used for high control performance and where low process pressure loss with high recovery is required

For water, gas and air application, a cast steel valve body with stainless steel disk shall be provided. Packing shall be of PTFE Chevron up to 100°C and graphite laminate/filament packing for high temperatures. In case of special treated water, selection of a stainless steel body may become necessary

For acid application polypropylene valves shall be provided

Close attention shall be paid to the selection of valve body, disk and packing material depending upon specific application: however, Engineer approval is required prior to order

8.7 Ball Valves

Ball valves shall be used for modulating *and* shut-off service where high control performance with low process loss and high recovery as well as tight shut-off function is required

For water, gas and air application, a stainless steel valve body with stainless steel disk shall be provided. Packing shall be of PTFE Chevron up to 1oooc and graphite laminate/filament packing for higher temperatures

9 ANALYTICAL INSTRUMENTS

9.1 General

Instruments measuring pH-value, Dissolved Oxygen, Conductivity, Concentration or other properties of process streams shall consist of a suitable design primary element to convert or transform the measured variable into an electrical signal which shall be fed to a control system

Analyser shall be capable of operating under the ambient conditions prevalent in the specific plant area and to maintain calibration within 0,5% during a 24-hour period while subject to temperature variations between 10°C and 50°C

Analysis time shall not exceed 30 seconds

Reproducibility of analysers shall be 1% of span or better and sensitivity shall be 0,5% of full span

For calibration purposes, analysers shall be provided with one year supply of a certified calibration sample as well as calibration curves

All necessary accessories including nozzles, valves and fittings shall be provided. For high temperature applications, sample coolers shall be provided. Sampling accessories shall be of material suitable for each specific application

9.2 pH Measurement

For pH-measurement, reference electrode shall be of rugged and sealed construction moulded in glass coupled polypropylene. Electrical connection shall be made directly onto the outer end of the element ensuring first class electrical performance of the electrode

Measuring pH-electrode shall be of toughened all-purpose glass type giving accurate pH reading with long electrode life

In applications where variations in sample temperature may occur, automatic temperature compensation device shall be provided

The reference and glass electrode including the automatic temperature compensator shall be housed in a compact sensor holder assembly provided with terminal block, cable glands, silica-gel desiccator and screened top cop to prevent against spurious pick-up

Electrodes assembly materials shall be of glass couples polypropylene and the assembly shall be provided with either flow through type or immersion type, depending upon specific application, complete with all associated accessories and mounting bracket

pH transmitter shall be electronic two wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements

Accuracy	0,5% of span or better
Measuring range	0-14pH

Temperature Compensation	Glass electrode 0 to 130°C max
Cycle	1,5 seconds
Analogue Output	4 to 20 mA DC
Relay Output	Alarm contact 220 V AC 5A NC
Mounting	Universal type bracket

9.3 Conductivity Measurement

Cell electrode material shall be carbide lined high grade steel or platinum black coated nickel and the cell range shall be selected to suit the required measurement

Cell shall be equipped with semiconductor temperature sensor for temperature compensation

Cell shall be either of flow through type or immersion type, depending upon specific application, complete with all associated accessories and mounting bracket

Conductivity transmitter shall be electronic two wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements

Accuracy	2% of span or better
Measuring range	0,1 to 100 mS/m depending on used cell type and application
Reproducibility	1% within range or better
Temperature Compensation	Semiconductor 0 to 130°C
Cycle	max. 1,5 seconds
Analogue Output	4 to 20 mA DC
Relay Output	Alarm contact 220 V AC 5A NC
Mounting	Universal type bracket

9.4 Oxygen in Combustion Measurement

Cell electrode material shall be of Zirconia

Cell shall be equipped with semiconductor temperature sensor for temperature compensation

Cell shall be direct insertion type, complete with all associated accessories and mounting brackets

Oxygen analyser transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirement

Accuracy	1,0% of span or better
Measuring range	0 to 5, 0 to 10 or 0 to 21 vol %
Reproducibility	02 1% within range or better
Temperature Compensation	0 to 1400°C·
Response rate	90% response within 5 sec when calibration gas is introduced
Warm up time	15 minutes
Analogue Output	4 to 20 mA DC
Relay Output	Alarm contact 220 V AC 5A NC
Mounting	Universal type bracket

Calibration	One-touch calibration using calibrated memory

9.5 Dissolved Oxygen Measurement

The measuring sensor shall be of the Luminescent type- LDO technology.

The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion. The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application to allow easy access for cleaning purposes.

The DO transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy	0,2% of span or better
Measuring range	0-20.0 ppm or 0-20 mg/L
Temperature Range	0 to 50°C
Response time	90% in less than 40 sec
Power Supply	220 *V* AC
Output	4 to 20 mA DC
Mounting	Universal type bracket

9.6 Turbidity Measurement

The measuring sensor shall be of the self-cleaning type with wiper blade

The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion. The cable end shall be fitted with a quick disconnect plug

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application for ease of maintenance

The Turbidity transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements

Accuracy	0.001 NTU
Measuring range	0.001 - 4000 NTU
Temperature Range	0 to 50°C
Power Supply	220 V AC
Output	4 to 20 mA DC
Mounting	Universal type bracket

9.6 Suspended Solids Measurement

The measuring sensor shall be of the self-cleaning type with wiper blade

The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion.

The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application for ease of maintenance.

The Suspended Solids transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements

Accuracy	< 5%of reading
Measuring range	0.001 -50 mg/l
Temperature Range	0 to 50°C
Power Supply	220 V AC
Output	4 to 20 mA DC
Mounting	Universal type bracket

9.7 Tank or Hopper Mass Measurement

If mass content measurement of a vessel is required the vessel shall be supported on load cells.

The mechanical design shall make provision for load cell protection against overload, shock load and vibration. It shall also take into consideration the prevention of excessive shear loads being transmitted to the load cell without affecting the accuracy of the scale.

Jacking facilities shall be provided to enable the load cell to be removed without taking the vessel out of service.

Copper braiding shall be connected across load cells to protect them against welding currents.

Continuous weight monitoring shall be achieved by the load cells weight detectors, weight transmitters and suitable indicators. An electrical signal, preferable 4 to 20 m A, shall be provided to be fed to a control system

Load cells shall be of robust hermetically sealed stainless steel construction and shall meet the following minimum requirements

Accuracy	0,5% or better
Overload:	200% of nominal load
Temperature Compensation	0 to 50°C
Temperature Effect	Not to exceed 0,5% of maximum span per 1°C
Rated Output	1mV/V

Load cell cable joints are to be soldered according to manufacturer's instruction.

10 INSTRUMENT PANELS AND CABINETS

10.1 Construction

Panels shall be free standing type and shall be fabricated from cold rolled sheet steel of thickness not less than 2mm with welded construction throughout. All welds shall be ground smooth, all corners to be ground and all weld spatters shall be cleaned

Surface of panels shall be painted and free from all marks and defects

Mounting angle, flush with bottom of panel, shall be provided. All panels shall be supported on suitable sized vibration isolators, designed for bolting to panel frame and flooring

The degree of protection shall comply with IP 65. Construction material shall be suitable to resist the conditions prevalent in the specific plant area

Accessories such as swing rack mounting frames, circuit breaker panels and covers, base gland plates, etc, shall be standardised

Front doors shall be fitted with suitable armoured glass cut-out and rubber gasket and shall be hinged door lockable. Rear doors shall be of solid construction and lockable

All instrument cut-outs and drillings shall be straight and true. If provisions are to be made for further instrument installation, cut-outs shall be made and suitable blanks shall be provided. Blanks shall be painted with same colour as panel and a minimum of four anchors shall be used to attach them to panel board

Instruments mounted on panels shall be spaced to provide access for adjustment and removal of equipment

Removable eye bolt lifting lugs shall be furnished and installed on all panels

10.2 Field Junction Boxes

Field boxes are to be fitted with knife type termination, indicating fuse holders are to be used where power is supplied to solenoids or any other secondary field instrument

All cables should be properly glanded and all cores will be terminated PLC/DCS connections are to be terminated at the left and field connections terminated at right

All terminals to display an identification number according to the numbering standard as applied

Boxes shall be constructed of 304SS and painted with hinged and lockable door. Mounting plate and bottom gland plate suitable for electric and pneumatic process connection shall be standardised

All instrument cut outs and drillings shall be straight and true. If provisions are to be made for further instrument installation, cut outs shall be made and suitable blanks shall be provided

Instruments mounted on boxes shall be spaced to provide access for adjustments and removal of equipment

PARTICULAR SPECIFICATION: INSTRUMENTATION INSTALLATION SPECIFICATION

PARTICULAR SPECIFICATION: INSTRUMENTATION INSTALLATION SPECIFICATION

CONTENTS

1 GENERAL

This standard specification furnishes information and sets out requirements for the installation of instrumentation equipment.

All equipment and material shall be of a quality and type approved by the Engineer.

No equipment or material shall be installed unless it complies with the requirements of this specification.

All equipment and material shall be checked for suitability, quality and adherence to this specification. Every approval must be obtained by the Contractor prior to installation.

Any installation or installation procedure which is in contravention to this specification shall be made good or replaced, to the satisfaction of the Engineer, and all costs for making good or replacement shall be for the contractors account.

Failure to adhere to the requirements of this specification may result in the equipment or material being rejected by the Engineer.

2 STANDARD OF WORK

The complete instrumentation installation shall be carried out by skilled, competent and qualified operatives to the highest standard of safety and workmanship, using the correct tools for the operations and best quality materials

A clean, orderly and safe environment shall be maintained in the Instrumentation Contractor's workshop, the stores and offices and in the construction areas

Cabling and wiring shall form a neat and functional appearance

Work shall be planned such that access to equipment for the current installation or future maintenance shall not be obstructed

The completed installation including supports, brackets, wiring, cabling and piping shall present a clean, tidy appearance and shall conform to good engineering practice

The contractor shall install instruments and other equipment in accordance with the manufacturers’ instructions, and the project drawings, taking due cognisance of the Standards and Codes listed in this Specification

The standards and codes which shall apply to this project are those issued by the following organisations

The standards and codes which shall apply to this project are those issued by the following organisations:

- British Standard Institution (BSI)
- Deutsche Industria Normen (DIN)
- American National Standards Institute (ANSI)
- The Instrumentation, Systems and Automation Society (ISA)
- South African Bureau of Standards (SANS)

3 INSTRUMENT LOCATIONS

General locations of the instruments are shown on the instrument location drawing. It may however be necessary to make minor changes on site. In the interests of the prevention of rework, confirmation of the exact location shall be obtained by the contractor from the site representative before the work is carried out

Where no instrument location drawing is available the instrument shall be positioned as close as possible to the process monitoring point bearing in mind the requirements below

The instrument shall be mounted in an easily accessible position to facilitate maintenance and removal

The contractor shall avoid, where possible, locating instruments in locations subject to leaks and spills. Where an instrument is unavoidably located where exposure to the above mentioned is likely, a splash guard shall be provided over or around the instrument.

Field mounted instruments, excluding in-line and close-coupled devices shall be mounted so that the centre line of the housing, chart or scale is approximately 1,400m above grade, floor or platform, unless otherwise specified on an installation drawing

Instruments must not be mounted where there is excessive vibration. Instruments must be mounted away from steam lines and other sources of heat

Instruments are not to be mounted on hand rails or process parts of the plant (e.g. pipe lines)

Transmitters or local controllers shall be located as close to the primary process connection as possible but instrument accessibility must be maintained

Instruments shall be installed so as not to cause any obstruction to walkways, headroom or access to other plant items

Instruments are not to be mounted near or in the *way* of sections of the plant that are regularly removed

Direct mounted dial thermometers, pressure switches, pressure gauges and thermowells shall be plainly visible and accessible from floor or adjacent platform

4 SUPPORTING BRACKETING AND FIXING

The drilling of holes in structural steelwork is not permitted except with the prior written approval of the engineer

The drilling of holes in vessels or pipe work is expressly prohibited. Explosive type fixing devices shall not be used

Instrument pipe stands where required are to be manufactured according to the drawings. All stands should be floor mounted unless otherwise stated. Fixing bolts, nuts and washers must not be cadmium plated. They shall be hot dipped galvanised or stainless steel

Mounting brackets must be hot dipped galvanised

Instrument supports and mounting brackets shall be of a suitable strength and rigidity to ensure proper operation of the instrument. Careful attention shall be given to ensure that instruments are not mounted on or attached to equipment or structures which are subject to vibration. All proposed locations must be approved by the Engineer before installation

Brackets shall in general, be made of mild steel flat bar, angle or channel. All brackets shall be hot dipped galvanised

5 INSTRUMENT PIPING AND TUBING

The instrument primary process connection is defined as the connection after the first isolation valve on the process pipeline, duct, vessel, or tank. The isolation valve will be supplied and installed by others unless specifically stated otherwise in the instrument installation/wiring diagram.

Piping from the primary process connection to the instrument shall be as short as possible and shall be installed so that no pockets or traps can occur. Where such pockets are unavoidable, drain valves and pots shall be provided at the lowest points. All such piping shall be properly supported to relieve all connections points of strain, and where expansion is likely, suitable offsets should be incorporated.

Instrument piping impulse lines shall be 12mm seamless stainless steel, except in specific high pressure temperature applications where the process conditions will dictate the material. Process connection tubing shall be 12mm seamless stainless steel and 1Omm or 6mm seamless stainless steel for signal lines, depending on application.

Air supply manifolds are to be made of stainless steel. Drain valves must be fitted to the lowest point of the manifold. Each take-off point must have an isolation ball valve. Each take-off point shall be labelled with the instrument reference number. An allowance must be made for 20% spare take-off points. All take-off points not utilised must be plugged after the isolation valve.

Air supply tubing from manifolds to air regulators or solenoid operated valves shall be 12mm seamless stainless steel.

Air supply tubing from regulators and solenoid operated valves to actuators, positioners, etc. shall be 1Omm seamless stainless steel.

All tubing fittings shall be Gyrolok, or an approved equivalent.

Isolation valves, other than those intended for use with an orifice carrier, are not normally the responsibility of the instrument section, but are supplied as part of the plant pipe work.

Valves shalt be accessible for operation from floor and operating platforms unless otherwise approved by the Employer. Valves or equipment shalt not obstruct passageways.

All instrument piping entering or leaving a control cubicle, box or panel shall do so via a bulkhead coupling.

In cases where pipe penetration openings are not provided in gratings which are installed by others, openings shall be field cut and the grating banded. The contractor shall then paint the cuts and welds according to the paint specification. This must be avoided at all times where possible

Capillary tubing for filled system temperature instruments, diaphragm level transmitters and the like, shall be supported and protected by running the tubing in angle iron or 'Unistrut' channel for the entire exposed length of the capillary. Excess capillary tube shall be neatly coiled and secured. Minimum bend radius for capillary tube shall be 75mm.

Piping within plant building shall be carried on overhead racks attached to the building frame or other supports. Piping racks shall be separate from cable racks. Existing piping racks may be used after permission is obtained from the Engineer.

Every pipe installed on racking in a building or on a supporting structure shall be supported in such a manner that there is no undue mechanical strain on any termination

6 CABLE RACKS AND SUPPORT

Cable rack/tray shall follow the building *or* mechanical construction line to which they are attached, with as few direction changes as possible.

Cable racks shall be mounted in the vertical plane and shall be positioned so as to avoid obstruction to walkways and access routes. Racks shall not be mounted in the horizontal position without the prior written permission of the Engineer.

Cable rack/tray bends and tees will be constructed as to allow all cables within trays to have a bending radii of not more than the manufacturer's specifications. No right angle jointing of rack/tray will be allowed.

Cable rack/trays shall be properly aligned and supported and the completed installation should have no visible deflection and be devoid of any distortion, kinks or sags.

The maximum distance between centres of adjacent supports shall be 2 metres. Additional supports shall be located at the joints of straight tray lengths and at every change in direction.

Supports shall be attached to permanent members of the building.

Cable racks to be fabricated mild steel and hot dipped galvanised similar or equal to the 'O' line support system.

Touching up after fabrication shall be by cold galvanising.

Single angle cable supports may be used under the following conditions

- Up to no more than 3 cables may be run on an angle iron support
- The size of the angle iron shall be such that in cross section, no part of any cable shall project beyond the square of which the angle iron forms two sides
- The minimum size angle iron to be used shall be 25 x 25 x 5mm and maximum size 40 x 40 x 6mm

Where required, any cable in danger of mechanical damage will be protected by using galvanised pipe or channel

Cable rack/trays shall be installed in accordance with the route diagram. Minor deviations in routing to avoid interference may be allowed subject to the approval of the Engineer. Where no cable routing drawing is available the cable routes shall be "site" determined in conjunction with the Engineer.

All cables run on racking or angle iron supports shall be fully supported to within 150mm from the gland entry on the equipment serviced or as cable size dictates.

For buried cables, refer to the Electrical Installation Specification.

7 CABLING AND WIRING

Cable sizes, number of cores and cable number shall be as indicated on the cable schedules. Cables shall be tested per drum length on delivery to site prior to installation. Results shall be documented.

Cable drums shall be rolled in the proper direction to prevent loosening of the cable. Cable shall be drawn into position using a sufficiency of rollers and cornering apparatus to avoid damaging the cable by excessive bending or dragging.

Cable shall be stored in dry areas.

Where cables pass through a floor, they shall be protected by a metal pipe or suitable mechanical protection, extending from 50mm to 350mm above floor or ground level.

The contractor shall observe the manufacturer's recommendations for minimum bending radius but shall never use less that the following radii:

- Unarmoured cables : 5 times the overall outside diameter of the cable
- Armoured cables : 10 times the overall outside diameter of the cable

Clips, saddles or clamps for securing of cables shall have smooth and rounded edges and shall not damage the cable sheath or serving. The type of saddle or clamps shall be approved by the Engineer before installation commences.

Instrument signal and electric power may not run bunched in the same rack/tray. A minimum distance of 300mm shall separate such racks/trays. If instrument cables are required to run on the same cable rack as electrical cables, then there must be at least a 300mm gap between the electric and instrument cables.

To avoid interference arising from electrical power supply voltage dips or spikes, instrument signals and electrical power cables shall only cross at right angle to each other.

On no account will instrument signal and electrical power wiring be transmitted in the same multi- core cable. Solenoid coils of 24V or less may be run with instrument switching signals.

Instrumentation cables may only be installed a maximum of 2 deep on racks if approved by the Engineer.

Joints in cables are permitted only where the length of the run exceeds the standard manufactured length of cable available on a drum. In these cases, the joints will be made in a junction box. No through jointing of cables will be permitted on cable racks/trays or in any cable way.

All cables shall be labelled at each end and at 1Om intervals along its length with a strap on plastic marker tags bearing the cable number as shown on the cable schedule. (Black letters on a yellow background).

All cables shall be mechanically anchored at the position of termination by the use of flanges of the correct size, as follows

- Where equipment supplied is provided with cable entries having DIN, NPT, etc., threads, the contractor shall provide all necessary adapters to permit the use of standard ISO Metric thread cable glands
- Where glands are to be used with non-threaded clearance holes, a heavy duty lock-but, together with suitable weatherproofing gaskets shall be provided. Holes with a tolerance greater than 1.5mm larger than the gland size will not be accepted
- Cables shall always be made off according to the gland manufacturers recommendations
- When glanding off SWA cables in non-conducting enclosures the gland shall be provided with an internal earthing washer and connected to a suitable earth connection

Where wiring is specified to be run in conduit, the following shall be observed

- The conduit used shall be heavy gauge seamless metal conduit with galvanised finish. Flexible conduit shall be of the PVC sheathed variety
- The conduit shall have a smooth bore. The smallest size to be used shall be 20mm and the largest 5Omm nominal diameter
- All conduit joints and entries shall be screwed a minimum of 20mm and made tight and weatherproof. Conduit threads shall be protected from corrosion by the application of an approved cold galvanising paint
- Draw-in boxes shall be installed after every second bend or a combination of sets and bends which equal 180 deg. or after every 7,5m of straight run. All boxes shall be supplied with gaskets for weatherproofing
- Where the possibility of condensation exists, the conduit shall be installed with a slope of approximately 3 in 100 and a 3mm diameter drain hole shall be drilled at the lowest point
- Metal conduits shall be bonded and earthed. Conduit bends, boxes, flexible conduits, etc., shall not interrupt the earth continuity
- Conduit must not be used as an earth continuity conductor
- The minimum bending radius of conduit shall be 6 times the conduit diameter
  - Conduit shall be fixed with clips or saddles at a pitch not exceeding 1,5m

8 CABLE AND WIRE TERMINATIONS AND CONNECTIONS

All instruments, control panels, junction boxes, etc., shall be wired in accordance with the relevant project drawings.

Each conductor shall be fitted with an insulated double crimp lug of the correct size. Pin lugs shall be used for pressure type terminals. Ring or spade lugs shall be used for post type terminals.

A proprietary type of wire stripper must always be used. The stripping tool must be checked regularly and is subject to inspection by the Engineer. The termination of stranded conductors where one or more strands have been damaged or broken is expressly prohibited.

The crimping tool used for attaching termination lugs shall be of the ratchet type which requires a specific amount of pressure prior to release, recommended by the manufacture of the crimp lugs.

All wires are to be terminated. Spare terminals shall be provided for unused pairs or cores. All spare terminals of field multi-cores shall be connected together and bonded to instrument earth.
Termination of cables in connector boxes (eg CCG) shall be terminated with the correct terminals (eg Klippon). Termination of wires in “chocolate block” type connections is not allowed.

Terminated wires shall be arranged neatly and loomed where necessary using cable ties. Spiral lacing shall be used for flexible or semi flexible looms.

Each wire shall be numbered with the respective terminal number by means of interlocking slip- on plastic ferrules of the correct size. Split or clip on ferrules are not acceptable. The ferrules shall be a tight or interference fit on the wire

Cable colours

Normal signal cables	black outer sheath
Earth cables	green

Conductors to be 0,5mm flexible stranded twisted copper wire for normal instrument signals and 1,5mm to solenoid valves

Nylon washers shall be put on all cable glands and cable gland adapters on weatherproof boxes. Cables must not be trapped in lagging

Cables to field instruments must have at least 30cm slack which should be neatly looped before the instrument

Cables incorporating shields or screens shall have the shield or screen isolated for electrical earth throughout its length and it shall be earthed only at the point indicated on the drawing

Only cable in the following standard sizes shall be used

Pairs	Triads
1 pair	1 triad
2 pairs	2 triad
4 pairs	4 triad
8 pairs	8 triad
12 pairs	12 triad
16 pairs	16 triad

For field instrumentation power supply only 3 core S.W.A. or Dekabon cable shall be used. The approved cable is Dekabon type M855 single pair, M877 multi pairs and M865, M887 respectively for triads. The conductor size shall be 0,5mm^2 for instrumentation signals unless specified otherwise in the instrument cable schedule

A variation from this type of cable must have the permission of the engineer.

Instrument cabling identification

Cables are to be labelled according to the cable schedule. The numbering will be made up as follows

Field instrument to JB or marshalling

Analogue	IA + instrument tag number
Digital	ID + instrument tag number
Instrument power	P + instrument tag number
JB to marshalling	marshalling terminal strip number

9 JUNCTION BOXES

Junction boxes must be numbered on the door or lid with an engraved plastic type label having numbers at least 5mm in height. (Refer section 12 Instrument Labels).

Terminal rails and individual terminals shall be numbered.

An earth plate or rings for the cable glands shall be put in the bottom of each junction box, where required.

Cables must enter from the bottom of the junction box.

Spare holes for cable glands must be plugged with the approved type of plugs.

Boxes with pneumatics inside must have a vent at the bottom of the box and shall be fitted with a port protector/silencer

Shield wires must be strapped together. The box must be classified IP65 or better. The box must be mounted securely.

Junction boxes shall be polycarbonate. Painting or other colouring is not required

10 INSTRUMENT INSTALLATION - SPECIFIC REQUIREMENTS

10.1 Flow Meters

The in-line element of the flow meter will be installed by others. It is the responsibility of the instrumentation contractor to check that the correct element is installed and that it is correctly installed and is undamaged before accepting the installation for his part of the work.

The flowmeter/dp cell shall be installed and piped up according to the instrument installation diagram.

Orifice plates shall be clearly stamped with the orifice diameter, direction of flow and tag number. The minimum slope of lines to instruments situated above or below the primary element shall be 25mm per metre.

If seal-pots are used, they shall be located as close as possible to the orifice taps and shall be installed so that both seal-pots are the same elevation.

DP cells must not be mounted where there is excessive vibration. On steam applications, the measuring element and isolation valves must be below the orifice tapping points.

Magnetic flow meters shall be installed such that the product lines remain full when flow occurs and when flow is zero.

Magnetic flow meters mounted on lined pipes shall have earthing rings mounted on the upstream and downstream flanges. Earth bonding trays shall be installed as per manufactures instructions and/or the instrument installation diagrams.

10.2 Control Valves

Control valves shall be mounted by others so that the direction of flow indicator (if any) on the valve body is compatible with the direction of flow of process fluid in the pipe. It is the responsibility of the instrumentation contractor to check that the correct valve is installed and that it is correctly installed and there is no damage visible before accepting the valve for hooking up to pneumatics or electrics.

The control valve shall be installed and piped up according to the instrument installation diagram. A bulkhead plate will be provided where stainless steel/dekabon lines end and flexible lines start.

Flexible lines are to be tidy and are not to be in contact with any hot surface. The position of the limit switches on a valve should be made adjustable

10.3 Level Measuring Instruments

Ultrasonic transducers shall be mounted in such a way that any vibration present at the site of installation cannot be mechanically transmitted to the transducer housing. In this respect, the manufacturer's instructions must be strictly adhered to.

Flange mounted ultrasonic transducers must be mounted on a thick gasket of soft resilient material and lightly secured with PVC or nylon nuts and bolts. Under no circumstances shall the bolts be over tightened, finger tightening is sufficient

Differential pressure type level transmitters shall be installed onto instrument stands unless they are of the flange mounted type. Connections shall be as per hook-up drawings

10.4 Temperature Elements

A thermowell must be inserted first to protect sensor against damage from corrosion, erosion, abrasion and high pressure processes.

The elements used to measure temperatures will be either thermocouples, platinum resistance temperature bulb (R.T.D.) or capillary filled local indicators.

The element must be installed in such a way that it is easily accessible for inspection and replacement.

The tip of the measuring element must reach and be in contract with the end of the thermowell. Positions of detecting elements shall be such to facilitate easy removal without fouling.

Capillary lines are to be protected

10.5 Pressure

All pressure points shall be fitted with Y2 inch N.P.T. isolation cocks unless flush mounted diaphragms are used.

If the fluid to be measured is toxic or corrosive, a drain or vent shall be provided to discharge the fluid to a safe location.

Where the pressure pulsates heavily, suitable damping shall be fitted.

Gauges more than 3m from their impulse points shall have an additional isolation valve at the gauge.

If the unit is not flange mounted and the process fluid is dangerous, a valve must be fitted for releasing the pressure in the impulse line.

Gauges shall be mounted in a vertical position

11 INSTRUMENT LABELS

Each instrument shall be fitted with a label giving the function and tag number as detailed in the label schedule. Field mounted instruments including final control elements shall have labels mounted on a bracket which is fixed independent of the instrument and stays in position if the instrument is removed. The label must be in a clearly visible location

Labels shall be made of laminated trafolite and have black letters on a white background.

The size of the labels shall be:

Type 1	Field Instruments/ Transmitters/ Control Valves	80mmW x 30mmH
Type 2	Cabinets/ Field Junction Boxes	200mmW x 30mmH
Type 3	Terminal Rails	39mmW x 18mmH
Type 4	Power Supplies	70mmW x 20mmH
Type 5	Power Rails	15mmW x 1OmmH
Type 6	Marshalling Cubicles	150mmW x 50mmH
Type 7	Distribution Boards	150mmW x 50mmH

Type number will be included in the label schedule with the letter size

12 INSTRUMENT NUMBERING

Refer to the attached Numbering System.

13 ACCEPTANCE OF INSTRUMENTATION

When all the testing and flushing on an instrument loop has been completed the contractor shall notify the Engineer in writing and request inspection. Defects attributable to the contractor shall be punch listed and shall be rectified at the contractor expense. The Engineer shall accept equipment in a particular area on a loop by loop basis in writing, but the contractor shall retain responsibility for the loop until the complete area is handed over and accepted in writing by the Engineer

PARTICULAR SPECIFICATION: WATER TREATMENT

CD: CHEMICAL DOSING EQUIPMENT

PARTICULAR SPECIFICATION: WATER TREATMENT CD: CHEMICAL DOSING EQUIPMENT

CONTENTS

1 SCOPE

This specification deals with the general requirements for the design, supply, delivery, installation and testing of polyelectrolyte chemical dosing equipment for a small water treatment works.

2 INTERPRETATION

2.1 References

2.1.1 Supporting Specifications

This Specification is to be read in conjunction with the following specifications (where included in the Contract document):

SPEC MG : GENERAL MECHANICAL
SPEC CP : GENERAL CORROSION PROTECTION

2.2 Application

This specification contains clauses that are generally applicable to mechanical engineering construction. Interpretations of and modifications to this specification are set out in the Project Specifications which precedes this specification in the contract document.

2.3 Definitions and abbreviations

For the purposes of this specification the definitions and abbreviations given in the applicable specifications listed in 2.1.1(b) to (f) and the following definitions shall apply:

Polyelectrolyte: A proprietary ionically-charged coagulant and flocculent polymer used to destabilise colloids in raw water and form a stable, settleable floc.

SCD: 'Streaming Current Detector' or 'Streaming ion detector' or 'Zeta potential' sensing device used to continuously sample incoming raw water. Its output is linked to a chemical dosing pump to continuously and automatically adjust the dosage rate to always maintain an optimum dosage despite changing conditions or flows.

Static Flash Mixer An: in-line device with static internal baffles built into a pipeline to introduce and, in a split second, uniformly distribute a polyelectrolyte solution into the full body of the incoming water.

Dosing Pump A device to precisely meter-out a flow of polyelectrolyte solution and inject same into a static flash mixer.

2.4 Additional abbreviations

The following abbreviation shall have the meaning given:
NTU : Nephelometric Turbidity Unit

3 DESIGN, MATERIALS AND MANUFACTURE

3.1 Raw Water to be treated and design rate of flow

The quality of the raw water to be treated and the design maximum and minimum range of flows are given in the Project Specifications.

It should be noted that the raw water inflow will be augmented with recycled water drawn from the supernatant overflow from a sludge settling and holding tank. The latter receives flows from the clarifier desludging hoppers and spent backwash water from the filters. The recycled water is added upstream of the flow regulating valve and, being pumped from a balancing tank, is intermittent in nature. Being upstream of the flow regulating valve, the rate of flow through the dosing point and clarifiers is, however, constant (except when minor adjustments are made to balance works output with demand).

3.2 Design Overview

The chemical dosing system shall designed to automatically dose an optimum rate of polyelectrolyte (combined coagulant and flocculent) solution into the incoming raw water via an in-line static flash mixer .

The method of determining the required dosage rate for optimum floc settling characteristics shall be by a SCD.

The SCD shall be electronically compatible with the chemical dosing pumps such that the latter automatically adjusts the dosing rate to maintain optimum flocculation in response to the SCD's changing signal.

3.3 SCD Requirements

The sampling point for drawing raw water for the SCD shall be as close as possible from where the raw water is dosed (to minimise response time to changes in water quality), but sufficiently far downstream to ensure that the electrically-charged poly has fully interacted with the raw water where the residual charge (representing under or over dosing) can be properly measured.

The SCD unit shall be a widely recognised and trusted brand which is freely available in South Africa and which has at least one well-established local agency selling and servicing and supporting the particular make and model offered.

In the design of the SCD sampling system, the following shall be taken into account:

The Contractor shall be responsible for demonstrating to the Engineer that the optimum draw-off point has been identified. To this end, at least 3 alternative draw-off points shall be provided.

The SCD shall be mounted in an easily-accessible position at least 1m off the ground and under shelter from direct sun and rain.
The SCD electronics housing shall have an IP 65 rating.

The SCD installation shall include everything necessary to:

Provide a sufficiently-strong flow of water through the device to minimise response time;
Be able to easily remove the sensing unit and place it to one side while the container it sits in is flushed clean with potable water from an adjacent tap;
Drain the sampled water and wash water directly to the sludge holding tanks for recycling (or to the nearest clarifier sludge waste line).

A 15 amp 230V plug socket will be made available in the chosen locality of the unit (measured for payment separately).

- The electronic control systems shall include robust surge protection devices.

3.4 Poly storage and make-up tank.

Polyelectrolyte (in concentrated liquid form) will be delivered to Site in 25 litre containers. The raw water is to be dosed with a 1 part poly : 3 parts potable water diluted solution.

A free-standing polypropylene or GRP storage tank of sufficient size to batch a 200 litre diluted solution shall be provided. As a Duty / Standby arrangement is NOT required, the total tank usable volume shall be 250 litres (ie a new dilution batch will be made whilst up to 50 litres of the previous batch is still in the tank).

While the new batch is being made-up, the Duty chemical dosing pump will continue to operate, but drawing from a 'drop-test' measuring cylinder (see details below).

In the design of the poly storage system, the following shall be taken into account:

- The tank shall be designed to hold liquid of a specific gravity equal to the undiluted poly (ie an SG of 1,20)
- The tank shall be translucent such that the liquid level can clearly be seen.
- The tank shall be marked at 10 litre intervals (with zero being at the crown of the outlet pipe);
- The tank shall have at least 100mm freeboard above the 250 litre mark;
- The internal surface of the tank shall have a smooth texture free of any irregularities.
- The tank shall be equipped with:
    - An electric-powered mixer (see details below);
    - A removable lid which effectively excludes flying insects from falling into the poly solution and which fits around the mixer shaft;
    - Two outlets (at least 20mm higher than the tank floor) which incorporates a PVC quarter-turn scour valve; one for scouring the tank and one as an offtake to the chemical dosing pumps

- The tank shall be placed on a solid pedestal at least 300mm off the floor of the dosing room.

- The outlet pipework to the dosing pumps shall include the following:
  - A removable (for cleaning purposes) graduated glass measuring cylinder with PVC quarter-turn isolating valve for performing a drop test of the dosing pump flow rate;
  - Double offtakes (each fitted with isolating valves) for the Duty and Standby chemical dosing pumps.

3.5 Poly / water mixer

The poly batching / storage tank mixer shall conform to the following requirements:

- Comprise a small electrical motor directly coupled to a shaft with mixer blades at the end;
- The motor shall be supported on a sturdy 'Rilsan' coated mild steel mounting bracket which EITHER is independent of the tank (eg attached to a wall-mounted bracket next to the tank) OR mounted on a bridging frame over the tank.
- If not mounted directly over the tank, the mounting shall be adjustable so that an optimum angle for the mixer shaft can be determined and then clamped.
- The motor shall have a flexible power chord which plugs directly into a standard 15A wall plug socket (mixer manually switched on and off at the plug socket). The motor shall include a red LED or similar operating light so it is clear to the Operator that the motor is turning.
- The stirrer shall be of a low-revving, low shear mixer blade design suitable for blending poly with water but of sufficient mixing strength to effectively blend one 200 litre batch of neat poly with potable water in about 5 minutes.
- The mixing blade and shaft shall be fabricated from 316 stainless steel or mild steel coated with Rilsan fusion-bonded nylon or similar approved.
- The shaft shall be long enough to have the mixing blade close to the bottom of the tank (but such that, if pointed vertically down into the tank, the blade does not quite reach the tank floor).
- The shaft shall comprise a sealed hollow tube sized to maximise rigidity yet minimise weight. There shall be no discernible flexure of the shaft under operating conditions.
- The bearings supporting the shaft shall be designed to take the worst-case operational loads with a bearing life of at least 10 000 hours.

3.6 Chemical Dosing Pumps

The design maximum rate of dosing shall be specified in the Project Specifications.

The chemical dosing pumps shall be a widely recognised and trusted brand which is freely available in South Africa and which has at least one well-established local agency selling and servicing and supporting the particular make and model offered. The particular make and model shall be specifically designed to dose polyelectrolyte solutions (neat and diluted).

The chemical dosing pumps and associated pipework and fittings offered shall conform to the following requirements:

- One Duty and one Standby unit to be installed;
- The chemical dosing pumps shall incorporate the following features:
    - Positive displacement diaphragm pumping with a maximum delivery head of at least 6 Bar;
    - Electronic control system that is compatible with the SCD unit which automatically adjusts the doing rate to maintain the chosen 'Zeta potential' set-point;
    - Has a manual / auto mode selector function;
    - Has a maximum delivery capacity of at least 5x the design maximum rate;
    - Has a turn-down ratio of at least 1:100;
    - Has non-return valves that can easily be removed for cleaning;
    - The electronics housing shall have an IP 65 rating.
- The electronic control systems shall include robust surge protection devices;
- Each pump shall have its own suction and delivery pipework all the way to the dosing point in the in-line static flash mixer;
- The delivery pipework from each pump shall include an approved robust pulse dampening device designed to provide a continuous flow to the in-line static flash mixer;
- The delivery pipework shall comprise small-bore plastic pipes of a type and pressure rating specifically manufactured for polyelectrolyte dosing. Where the delivery pipework passes through walls and is potentially exposed to the elements, it shall be housed inside a HDPE or similar approved sleeve of a size that allows the pipe to be pushed through from one end. All pipework shall either be attached to GMS or non-metal cable trays inside buildings or be otherwise well-supported all the way to the dosing point.
- At the dosing point, separate connections from each pump shall be provided with non-return valves (spring-loaded ball valves as per dosing pumps) such that no isolating valves at the dosing point are required and the Duty delivery line can remain in service while the other line is disconnected for cleaning / replacement.

3.7 In-line flash mixer

The in-line flash mixer shall be mounted above-ground either on the outside wall of a building or a purpose-constructed brick or concrete wall (such that it is well-supported and not vulnerable to impact from vehicle impact and the like).

The in-line flash mixer shall conform to the following requirements:

- Be designed to uniformly distribute a polyelectrolyte solution into the full body of the incoming water in less than 1 second at Design Flow;
- Be fabricated from a non-corrosive material such as stainless steel or uPVC
- Incorporate an inlet dosing pipe designed to discharge the poly solution directly into the raw water

3.8 Emergency Eye wash bowl

A standard approved emergency stainless steel eye-wash bowl shall be provided and mounted on the wall in an appropriate position next to the poly storage and make-up tank. This shall be connected to the nearest potable water reticulation. In addition to the activation valve, a stainless steel quarter-turn ball valve shall be installed in a clearly visible position next to the bowl as an isolating valve. The ball valve lever shall be visible so as to easily see whether the isolating valve is in the open or closed position.

3.9 Protection against corrosion

All equipment in contact with water or exposed to the weather shall be either made of non-corrodible materials or protected against corrosion in accordance with SPEC CP: Corrosion Protection.

4 PLANT

4.1 General

The Contractor shall provide all plant that is necessary to off-load, install, test and commission all items covered in this specification.

4.2 Handling and rigging

The plant and rigging equipment used by the Contractor for the handling and placing of filters, pumps, motors, valves and pipes shall be such that no installed equipment is over-stressed during any operation.

4.3 Temporary supports

The Contractor shall provide such temporary supports as are necessary, in the vicinity of the position of permanent supports, to ensure that pipe work, valves and filters are installed true to level and adjustment.

4.4 Testing

The equipment provided by the Contractor for testing shall include the pressure gauges, calibrated storage tank, and the necessary tools and fittings required for the performance of the tests given in 7.

5 INSTALLATION AND OPERATING REQUIREMENTS

5.1 Dosing rate range

As specified in the Project Specifications.

5.2 Dosing chemical

The polyelectrolyte that will be used in the operation of the Works shall be as specified in the Project Specifications.

5.3 Dosing equipment required

The following equipment shall be supplied, delivered and installed.

(a) 1 No. x 250 litre polyelectrolyte storage and make-up tank

(b) 1 No. SCD device with all associated sampling and flushing and drainage pipework and fittings and supports.

(c) 2 No. dosing pumps and associated wall mountings and electrical signal cabling linking it to the SCD.

(d) All pipework and fittings required for the operation of the dosing system

(e) 1 No. in-line static flash mixer with all associated mountings and fittings.

(f) 1 No. standard approved stainless steel wall-mounted emergency eye-wash bowl and all associated activation fittings and pipework and connections to the potable water reticulation system.

(g) Any other items of equipment required for the proper functioning of the dosing system.

6 TOLERANCES

6.1 General

Unless otherwise specified in the Project Specification, the terms of Clause 6 of SPEC MG: General Mechanical shall apply

7 TESTING / COMMISSIONING

The following tests shall be carried out on the equipment and materials.

7.1 Dosing pumps

A drop-test with each pump under normal operating conditions will be carried out to confirm the actual rate of dosing. The actual versus indicated rate shall be within the tolerances given in the Manufacturer’s technical data sheet.

7.2 SCD

The Contractor shall demonstrate to the Engineer that:

- The sampling point position has been optimised with respect to minimising response time yet sampling far enough downstream of the dosing point to give a correct charge reading; and

- The SCD is correctly controlling the dosing pumps to provide optimum dosing (the set-point to be correlated with a standard jar test and agreed on with the Engineer).

7.3 Mixer

The Contractor shall demonstrate to the Engineer that the mixer provided is fit for purpose under normal operating conditions in terms of successfully producing a homogenous diluted mix (without affecting the coagulation and flocculation properties of the poly by excessively shearing the polyelectrolyte polymers) and within the specified time and robustness of mounting arrangement.

8 MEASUREMENT AND PAYMENT

8.1 General

Payment will be made in terms of the relevant clauses in SPEC MG: GENERAL MECHANICAL.

PARTICULAR SPECIFICATION: WATER TREATMENT

CL: MODULAR CLARIFIERS

PARTICULAR SPECIFICATION CL: MODULAR CLARIFIERS

CONTENTS

1 SCOPE

This specification deals with the general requirements for the design, supply, delivery, installation and testing of prefabricated stand-alone modular waterworks clarifiers including flocculation conditioning.

2 INTERPRETATION

2.1 References

2.1.1 Supporting Specifications

This Specification is to be read in conjunction with the following specifications (where included in the Contract document):

(a)	SPEC MG	:	GENERAL MECHANICAL
(b)	SPEC CP	:	GENERAL CORROSION PROTECTION

2.2 Application

This specification contains clauses that are generally applicable to equipment for modular water treatment works. Interpretations of and modifications to this specification are set out in the Project Specifications which precedes this specification in the contract document.

2.3 Definitions and abbreviations

For the purposes of this specification the definitions and abbreviations given in the applicable specifications listed in 2.1.1(b) to (f) and the following definitions shall apply:

- **Floc Conditioning.**

  A zone (either as a compartment immediately upstream of the clarifier sludge blanket zone or as a single separate unit feeding all the modular clarifier units) in the treatment process where raw water, already dosed with coagulant and flocculent chemicals and flash-mixed together which has an inlet and through-flow geometry designed to cause declining intensity shear-mixing of the water in an optimum way to maximise the flocculation particle size exiting the floc conditioning zone and entering the sludge blanket zone of the clarifier.

- **Sludge Blanket Zone**

  A zone inside the clarifier which receives pre-flocculated water from the floc conditioning zone where a distinct sludge 'blanket' forms as a result of the accumulation and final stages of aggregation of still-suspended floc particles which can then settle and consolidate further in the sludge hoppers. The hydraulics of this zone is designed to keep the sludge blanket gently agitated to maximise the physical contact of incoming floc particles with larger floc particles which have already aggregated.

- **Settling Zone**

  A zone inside the clarifier with an inlet geometry and overall shape designed to cause a uniform, even vertical upflow of the body of water with a minimum of circular currents and turbulence such that floc particles tend to settle downward faster than the body of water moves upwards.

- **Upflow rate.**

  The flow of flocculated raw water passing vertically upwards inside the settling zone of the clarifier, measured as volume per planar area of the settling zone per hour.

- **Lamella Pack.**

  A prefabricated block of inclined plates suspended in the upper settling zone of a clarifier which is designed to minimise the settling time of individual floc particles and such that, on settling onto a plate, the floc particles aggregate into larger particles before rolling or sliding off the lower end of the plates and thereafter settling at a higher rate than its pre-aggregated state.

- **Sludge hoppers**.

  Inverted pyramidal or conical hoppers at the base of the clarifier settling zone where flocculation particles settle, accumulate and consolidate under gravity. The hoppers are designed to effectively drain out all the settled sludge when the sludge scour valve is opened.

2.4 Additional abbreviations

The following abbreviation shall have the meaning given:

NTU : Nephelometric Turbidity Unit

3 DESIGN, MATERIALS AND MANUFACTURE

3.1 General Performance Specification

The general design of the flocculation conditioning and clarifier units shall be to achieve a settled (clarifier output) water of turbidity which at least matches the settled (but not filtered) turbidity of a sample of the same raw water dosed with the same chemicals at the same parts-per-million rate under standard chemical dosing jar test conditions with the dosing rate being the optimum rate determined by the standard jar test method.

3.2 Flocculation Conditioning Tank or Zone

Raw water treated with coagulant and flocculent chemicals shall be conditioned to maximise the effectiveness of separating out and removing the destabilized suspended solids from the liquid.

Either a compartment immediately upstream of the clarifier sludge blanket zone or as a single separate unit feeding all the modular clarifier units shall be provided.

If a stand-alone floc conditioning tank, the tank shall be fabricated from GRP and shall incorporate the following features:

- An access ladder or stairs to the top of the tank and a tank opening hatch such that the operator can look into the tank and train a pressure hose onto the inside walls and floor to facilitate periodic cleaning.
- A means of draining the contents of the tank for periodic cleaning or inspection.
- Be of general robust construction with a useful design life of at least 50 years.
- Be UV protected such that, apart from minor discolouration over time, the tank will not significantly structurally degrade out in the open within its design lifetime.
- The outlet shall be of sufficient size to limit the flow velocity of the conditioned water to not more than 0,5m/s at Works design output.
- A separate inlet, scour and outlet pipe shall be provided.
- The inlet, outlet and scour shall be flanged and include a quarter-turn butterfly isolating valve.
- An overflow shall be provided which shall discharge into the scour drainage system.

3.3 Modular Clarifier Units

The design of the modular units shall be such that:

- The general performance specifications are achieved;
- It is of a general robust construction with a useful design life of at least 50 years.
- The main body of the tank shall be fabricated from GRP with stainless steel fittings and built-in pipework.
- The clarifiers shall be free-standing units supported on stout legs of sufficient height for the scour outlets to be above-ground.
- The main body of the tank shall be of sufficient rigidity and stiffness such that, under operating conditions, it does not have a ‘bowed’ or ‘sagging’ appearance.
- The prefabricated unit can be transported on a truck of a size which does not need Abnormal Vehicle licencing.
- The unit can be independently isolated and completely drained for inspection and cleaning purposes;
- Access hatches / blanked-off access ports are provided such that workers can enter all compartments of a drained tank.

- An access ladder or stairs to the top of the tank and a GMS or GRP walkway (with GMS handrails) along the top of the tank is provided.
- The required performance specification notwithstanding, the upflow rate at full Works design capacity (including recycled water) does not exceed 4,5 m/h.
- The settled water draw-off system shall either be a stainless steel ‘V’-notch suspended trough with adjustable levelling or a suspended pipe system with

adjustable levelling and with submerged draw-off holes of a size which ensures an even draw-off over the length of the pipe system.

- The sludge hoppers shall have sides of steepness and smoothness designed to prevent sludge hang-up.
- Each sludge hopper shall be independently manually drained by means of a quarter-turn butterfly valve discharging into an open sight-box such that the operator can visually see when the last of the consolidated sludge has passed through. Each desludging valve shall have its own sight-box. Each sight-box shall be free-draining into a common manifold leading to the sludge holding tank.
- The settled water outlet pipework shall not incorporate an isolating valve; the settled water outlet shall also serve as the overflow.

The modular units shall be pre-fabricated off-site under controlled factory conditions under an approved Quality Management Plan. Internal components (such as lamella packs) may be fitted on Site.

Any welding shall be carried out by welders who are qualified and experienced in the particular material. Certification and quality control of the welders and their work shall be as specified in SPEC GM: GENERAL MECHANICAL

3.4 Inlet / outlet / scour manifolds

Unless otherwise specified, the manifolds shall be fabricated from 'Medium Weight' flanged hot-dip galvanised mild steel piping with mild or cast steel FBE coated restrained dismantling couplings. The pipework jointing system shall be designed such that there are sufficient bolted flange joints and adjustable dismantling couplings to be able to remove all fittings such as valves without having to cut any pipes.

The pipe sizes shall be such that the design flow velocities never exceed 0,5 m/s (flocculated water) and 1,5 m/s (scour & settled water).

The pipework shall be fully supported and braced. Drawings of the proposed pipework layout shall be submitted to the Engineer for approval before fabrication. The drawings shall show where settled water samples can be drawn-off by the Operator.

4 PLANT

4.1 General

The Contractor shall provide all plant that is necessary to off-load, install, test and commission all items covered in this specification.

4.2 Handling and rigging

The plant and rigging equipment used by the Contractor for the handling and placing of tanks, valves and pipes shall be such that no installed equipment is over-stressed during any operation.

4.3 Setting out

The Contractor may use any acceptable device to control the installation and alignment of the tanks.

4.4 Temporary supports

The Contractor shall provide such temporary supports as are necessary, in the vicinity of the position of permanent supports, to ensure that pipe work, valves and tanks are installed true to level and adjustment.

4.5 Testing

The equipment provided by the Contractor for testing shall include a standard 4-jar test device and the necessary tools and fittings required for the performance of the specified tests.

5 INSTALLATION AND OPERATING REQUIREMENTS

5.1 Distribution of flow between units

The hydraulics of distributing the flow between all clarifier units shall be such that there is no discernible difference in settled water outflow between the operational units under full works capacity flow.

The method of ensuring an even distribution of flow shall not involve restrictive (turbulence-causing) orifice plates or valves or similar on the inlet pipework.

The clarifier units shall initially be installed with identical top water levels. Should it be necessary to raise or lower the settled water outlet draw-off pipework on some clarifiers to achieve a uniform distribution of flow between all units under full Works capacity conditions, this would be acceptable.

5.2 Protection against corrosion

All equipment in contact with water or exposed to the weather shall be either made of non-corrodible materials or protected against corrosion in accordance with SPEC CP: Corrosion Protection.

5.3 Floc conditioning and clarifier equipment required

The following equipment shall be supplied, delivered and installed:

- Floc conditioning tank as specified;
- Modular clarifier units as specified;
- All inlet and outlet pipework manifolds and associated supports;
- Open sight boxes for desludge outlets.
- Drainage pipework from each desludge sight box to the connection to the drainage pipeline (drainage pipeline is included in civil works).

6 TOLERANCES

6.1 General

The tolerances shall be such that the hydraulic performance as specified is achieved.

7 TESTING / COMMISSIONING

The following tests shall be carried out on the equipment and materials.

7.1 Water tightness testing

With the tanks full and outlet ends of the settled water pipeline closed, all tanks, joints and fittings will be inspected for leaks. There shall be no visible leaks and all valves must close drop-tight.

7.2 Performance testing

Each clarifier unit will be tested at its portion of full Works capacity (either separately or together) as indicated in clause 3.1.

8 MEASUREMENT AND PAYMENT

8.1 General

The payment clauses given in SPEC GM: GENERAL MECHANICAL shall apply, except for the provisions of 8.2 hereunder.

8.2 Water tightness and performance testing

No separate payment for water tightness or performance testing will be measured for payment. The costs of all such tests is deemed to be included in the installation and commissioning rates. Water for carrying out the tests will be provided free of charge by the Employer.

PARTICULAR SPECIFICATION

CP - CORROSION PROTECTION FOR WATER AND WASTEWATER WORKS

PARTICULAR SPECIFICATION CP - CORROSION PROTECTION FOR WATER AND WASTEWATER WORKS

CONTENTS

1 RESPONSIBILITY

It shall be the responsibility of the Contractor to paint all plant and equipment supplied under this Contract, with the exclusion of the items which do not require coating as defined hereinafter~~.~~

The responsibility of the Contractor covers all his equipment, painted or not painted, regarding corrosion resistance.

Any deviation from the following detailed requirements are to be clearly defined in the Tender. Unless so defined, no departure from this Specification will be allowed even for parts which may be considered as accessories (e.g. drive guards, foundation steel work, etc.)

2 DESIGN

Bearing, rolling or rubbing surfaces shall be constructed from corrosion resistant materials. Dissimilar metals in contact producing a potential difference exceeding 0,3 Volt on the galvanic series of metals and alloys in seawater shall either be insulated from each other or when a corrodible metal is welded to a corrosion resistant metal, the protective coating shall overlap onto the latter by at least 10 mm.

All copper alloys shall be zinc free.

Crevices shall be avoided whenever possible, or steps shall be taken to seal them when unavoidable. Blemish marks shall be filled and smoothed over before the application of the final external enamel coating, to achieve a pleasing effect.

Retention areas in water passages that may hold water, mud, leaves, debris, etc., shall be avoided.

2.1 Fasteners

Fasteners shall be comply with the requirements stated in SPEC MG.

2.2 Manifold and other pipes to be welded in situ

These pipes will generally be concrete encased in situ by the Civil Contractor. This means that the external surfaces of the pipes shall be prepared as defined hereinafter after welding and prior to encasement. The full specified coating shall however be applied to the external surfaces of pipes where they protrude from concrete to air, for a distance of at least 100 mm into the concrete. When directed by the Engineer, the concrete/steel pipe interface fillet shall be caulked with suitable approved mastic.

The internal surfaces shall however be factory coated to the Specification leaving 100 mm uncoated at the to-be-welded ends.
It is required that after the site-welds have been made, the full Corrosion Protection Specification shall be applied and tested.

2.3 Extent of coating required

Unless explicitly otherwise specified (e.g. for some kinds of fasteners) all surfaces of plant and equipment shall be coated, including both inside and outside of puddle pipes.

Nevertheless, all non-corrodible parts do not require coating. Pumps which are made of a material which can be considered as non-corrodible with regard to the quality of water to be handled may not require internal corrosion protection. This shall be clearly specified in the Tender, as well as the proposed non-corrodible material.

Labels and components where painting would adversely affect the operation or legibility shall not be painted.

Surfaces of all corrodible components which will normally come into contact with hydraulic fluid, oil or grease need not be painted but shall be free of rust and scale and be thoroughly clean.

3 SURFACE PREPARATION FOR ALL COATINGS

3.1 Important remarks

Mechanical pre-preparation as well as blast cleaning are required for all painted surfaces unless otherwise explicitly specified.

In the case of all wetted surfaces, the surface preparation will follow the satisfactory completion of any tests and inspections carried out on bare pipes, valves and pumps.

3.2 Mechanical pre-preparation

Welds shall be smooth and free from undercuts, protrusions and sharp edges that may protrude through the coating. Weld spatter, slag and loose scale shall be removed and sharp edges ground to a radius.

Deposits of oil, bitumen, coal tar or other contaminants shall be removed by scraping and final wiping with a rag soaked in white spirit.

3.3 Blast cleaning:

Blast cleaning shall be carried out in accordance with clause 4.3 of SANS C.O.P. 064.

Cleanliness grades required: ISO 8501-1:

- For metal spraying or epoxy coatings: SA 3.
- All other coatings: S.A. 2½.

Blast cleaned profile required:

- For metal sprayed surfaces (grit blasting only permitted): 50-100 microns.
- For Epoxy and all other coatings: 75 microns max.

Laminations, scales and occluded scale, which become visible after blast cleaning, shall be ground out, after which the area shall be blast cleaned once again. 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.

Occluded grit and hackles shall be abraded off. Dust and debris from blast cleaning shall be removed prior to coating to achieve a residual dust and debris level not exceeding 0,1% when determined by SANS Method 769.

3.4 Special cases

The external surfaces of steel pipes to be encased in concrete shall be:

- abrasive blast cleaned;
- coated with epoxy coat to DFT 175-200 microns.

The external surfaces of steel pipes to be buried in soil shall be thoroughly wire brushed prior to being treated as specified in clause S.16.4.

Copper tubing and sections of pump and motor shafting exposed to air shall be thoroughly cleaned to a bright finish and covered with an oil resistant lacquer.

4 COATING MATERIALS AND APPLICATION

4.1 Epoxy:

Internal wetted surfaces of all pumps, pipes, specials and valves, and the exterior of all pipework and equipment mounted in underground chambers (valves, venturi elements etc.) but excluding non-corrodible surfaces where painting would adversely affect the operation of the equipment, shall be epoxy coated with an approved epoxy.

Various acceptable application methods are specified hereafter.

Epoxy paint containing coal tar will not be acceptable.

4.2 Epoxy and polyurethane top coat:

All surfaces of pipework and equipment normally exposed to air and located within the main body of the Pump Station shall be coated with an approved epoxy coat and recoatable polyurethane finish.

After surface preparation, one coat of an approved epoxy shall be followed by one coat of an approved recoatable polyurethane finish before dispatching from the Works. One further finishing coat shall be applied after erection on Site.

4.3 Galvanised Surfaces:

Internal wetted surfaces as well as surfaces exposed to air may be galvanised in accordance with SANS 763.

Surfaces to be galvanised shall first be degreased.

Galvanised surfaces shall receive an etching primer of zinc oxide to SANS 910 or calcium plumbate to SANS 912 before one coat of universal undercoat and two coats of an approved enamel paint are applied.

All threads that are cut in galvanised pipe shall be coated with a suitable rust preventive compound immediately after cutting and before assembling the pipework.

Galvanised surfaces which are damaged during transport or erection shall be repainted with an approved cold galvanising process. Aluminium painting will not be acceptable.

4.4 Steel pipes buried in soil:

The external surfaces shall be thoroughly wire brushed, primed with a suitable petrolatum tape primer and followed with at least one layer of an approved petrolatum tape (Densotape or equal). This shall be followed by a further layer of PVC tape wrapping with not less than 50% overlap.

4.5 Electrical equipment:

Transformers shall be coated in accordance with SANS 780.

Electric motors and regulators shall be coated in a manner in keeping with the high standard of this Specification and shall be acceptable to the Engineer. Details of materials and procedures shall be provided together with the Tender offer. Baked enamel finishes will be preferred.

Control consoles and switchgear panels shall be baked enamel.

5 APPLICATION OF EPOXY PROTECTIVE LINING

The directions laid down by this Specification and the paint Manufacturer for the mixing and curing, the application of solvents, the permissible working air temperature and humidity, overcoating times and dry film thickness shall be strictly adhered to. Certified records of material and operation shall be kept and produced for inspection when required by the Engineer.

Blast cleaned surfaces shall be coated as soon as possible after completion, inspection and approval of the surface. The time interval between cleaning and coating shall in any case not exceed the following:

- 4 hours when relative humidity is below 70%
- 2 hours when relative humidity is between 70 and 85%

Coating shall not take place when the relative humidity exceeds 85%, nor when the steel temperature is less than 2°C above dew point.

Each coating shall be uniform, smooth and glossy. The application shall be free of all tears, runs, sags, wrinkling, bubbles, blisters, pimples, spikes, orange peel, pinholes, holidays or dust particles.

Flange faces shall be treated on the machined surface with a film thickness not greater than 90 microns. Other parts of the flange and especially the throat shall be treated with the full system. All crevices shall be sealed with an approved water resistant sealer.

All internal site-welded joints shall be made good (i.e. mechanical pre-preparation and blast-cleaning) and the entire internal surface shall be retested for thickness and pinholes to the Specification.

The Tenderer may quote for any of the following systems, indicating in his Tender, which system is offered:

- Epoxy powder applications: One coat. Dry film thickness shall be not less than 400 microns for linings and 300 microns for coatings. Handling of coated equipment is not permitted within 8 hours of completion of the coating.

- Solvent-free epoxy application: One or two coats. Each coat shall be a different colour from the previous coating. Total dry-film thickness shall be not less than 300 microns for linings and 250 microns for coatings. Handling of coated equipment is not permitted within 16 hours of completion of the coating.

- Solvent-borne high-build epoxy application: Minimum of 2 coats, each coat shall be a different colour from the previous coating. Thickness of any one coat shall be not less than 85 microns nor more than 150 microns. Total dry-film thickness of both linings and coatings shall be not less than 300 microns. Handling of coated equipment is not permitted within 7 days of completion of the coating.

NOTE:

All coating thicknesses shall be measured by means of an approved calibrated eddy-current instrument within 72 hours of the final coat being applied.

All coatings and linings shall be tested for corrosion-protection integrity (absence of pinholes) by carrying-out a direct current wet-sponge 'holiday' detector test or high voltage spark test.

The above requirements apply to both Shop as well as Site applications of epoxy linings including site-repaired coatings.

6 HANDLING AND TRANSPORTATION OF PAINTED ITEMS

Coated components shall be handled with due regard to the relatively soft nature of organic coatings and appropriate precautions shall be taken. The use of ropes, wire ropes or chains, without suitable padding, is expressly forbidden. Balks of timber shall be used to support the components on soil, concrete or other hard surface and to separate items from each other. When loading onto vehicles, precautions shall be taken to support and chock the components to prevent movement. Components shall be firmly lashed or chained with padded lashing, supported on sawdust bags. The area of padded surfaces shall be adequate to prevent damage to the coating.

In order to protect the internal coating system of pipes, specials and valves, open ends are to be completely blanked off by sturdy blank flanges, not just plastic sheet alone, and are to be clearly marked:

"DO NOT REMOVE UNTIL FINAL INSTALLATION"

Plastic sheeting alone will not be acceptable.

Items will be inspected on arrival at the Contractor's end-delivery point and any repairs necessary shall be at the cost of the Contractor. Such repairs shall comply with all requirements of this Specification. Should the Engineer decide that there is severe damage to the coatings due to handling and transportation, the Contractor shall return the equipment to his workshops for recoating.

7 FINISHING COATS

7.1 Colours

In general, the colours as recommended in SANS code of practice 0140 part III for identification colour marking shall apply. Identification colours shall be painted completely or in bands as required in clause 6.1. of SANS code of practice 0140 part III as directed by the Engineer, with particular emphasis on pipework.

Individual Supplier's usual colours will be considered for proprietary items.

The following system and/or safety colours are preferred and cannot be changed without the Engineer's agreement in writing:

Item	Colour	Specification SANS 1091
Electric Motors	Light Beige	G29
Fan cowlings for TEFC motors	Signal Red	A11
Pumps/control valves for raw water	Apple green	H29
" For chemtreated water	Middle blue	F07
Pumpset coupling guard	Signal Red	A11
Pipework for raw water	Brilliant Green	H10
" for treated water	Verdigris green	E22
Baseplates	Black	
Overhead travelling cranes	Golden Yellow	B49
Sheave block for EOT crane	Golden yellow / black chevron	B49
Isolating valves for raw water	Brilliant green	H10
" for chemtreated water	Arctic Blue	P28
Handwheels for all valves	Golden Yellow	B49
Low voltage panels (in and outdoor)	Light orange	B26
MV panels (in and outdoor)	Electric Orange	G12
UPS	Light orange	B26
LV distribution kiosk/mini sub	Light stone	C37
Standby electric equipment	Signal red	A11

Protruding equipment and/or hazardous overhead structures shall be painted with golden yellow/black chevrons to attract attention.

Other external final colours of the main plant and any other equipment which have not been specified shall be decided by the Engineer after discussion with the Contractor.

7.2 Appearance:

Particular attention shall be given to the exterior finish of all visible plant. Special consideration shall be given to produce a neat arrangement convenient and easily accessible for cleaning. Baked enamel finishes with chromium plated, stainless steel or brass trim when applicable are preferred.

All damaged coatings of installed equipment shall be made good to the original Specification. Full additional finishing coats may, if justified, be required by the Engineer.

8 INSPECTION

8.1 Inspection by the Contractor

The minimum inspection to be carried out by the Contractor shall be that which is necessary to ensure compliance with all clauses of this Specification, since he will be held responsible for non-compliance in any respect and shall be required to repair any defect to the satisfaction of the Engineer.

8.2 Inspection by the Engineer

The Engineer has the right to inspect any item covered in the Contract in accordance with clause 35 of the General Conditions of Contract, and may appoint either the SANS or other alternate inspection body to act on his behalf.

It is required that due notice be given to the Engineer of impending cleaning and first coat operation in regard with the painting of the main equipment, as well as for witnessing final coating thickness and pinhole detection tests.
All the tests shall be carried out by the Contractor at his own expense and in the presence of the Engineer or his appointed Representative and to his complete satisfaction. The Employer reserves the right to appoint the SANS or other inspectorate to inspect the epoxy linings on his behalf and at his own expense over and above the Contractor's routine inspection.

PARTICULAR SPECIFICATION

GP: GENERAL PUMPS

PARTICULAR SPECIFICATION: GENERAL PUMPS

CONTENTS

1 TYPE AND ARRANGEMENT OF PUMPS

Pump types are specified in the Project Specification.

Arrangements incorporating multiple pump units coupled in series to achieve the duties specified in the particular specifications will not be favourably considered unless otherwise specified.

Variable speed motors shall be supplied only when it is a specific requirement in the Project Specification.

The arrangement of impellers shall be such as to reduce the residual axial thrust to a minimum. Designs incorporating a double suction to balance thrust will be preferred.

Pumps incorporating balance discs and/or balance drums are not preferred for raw water.

The orientation of the suction and delivery pipes shall be generally in accordance with the Tender drawings. The layout shall be designed to facilitate maintenance whilst being designed for minimum losses and no air traps.

The proposed arrangement of the pumpsets and associated pipework is shown on the tender drawings.

2 PUMP CHARACTERISTICS

The pumps shall have stable, non-overloading characteristics.

The Tenderer shall submit with this Tender for each pump offered the following characteristic curves:

With respect to flow:

- total head;
- power demand;
- efficiency;
- net positive suction head (NPSH) requirements, critical and 3% "head loss", relative to pump shaft centre line, in the case of horizontal spindle pumps;

With respect to speed:

- torque requirements rated in absolute units.
- Where variable speed pumps are required, the pump characteristic curves submitted for approval shall include a range of curves for different speeds and which indicate the maximum and minimum speeds possible.

Alternatively, NPSH requirements related to 3% drop in head may be given, if preferred, as long as the method of presentation is clearly stated.
These characteristic curves are to be submitted with water flows stated in litres per second covering the full possible pump operating range.

Pump shaft rotational speed shall not exceed 1 500 r.p.m unless explicitly stated in the Project Specifications.

Specific intake velocity, S, (defined hereunder) shall under no circumstances exceed the value of 160 per impeller inlet, unless detailed and acceptable justification is given.

$$S = \frac{n \times Q}{N_{sh}^{3/4}}$$

Q = capacity in m^3/s (if double entry impeller, equals half pump capacity)

Nsh = absolute suction head in metres (Nsh = Ha - Hs - Po)

Ha = atmospheric pressure at the elevation of the pump in metres of water

n = rotational speed in revolutions per minute

Hs = difference in level of the highest point of the impeller entry above the water level on suction side, increased by the head losses in the suction line in metres of water.

Po = vapour pressure in metres of water.

The Contractor may be called upon to provide further curves at the request of the Engineer, especially for starting and stopping analysis, in connection with surge analysis in the rising mains.

The efficiency curve shall be flat over a wide range in order to provide efficient working with various pump operating conditions. It shall conform to the requirements of the Project Specification.

2.1 PUMPING RATES

Unless specified to the contrary, the proposed pumps shall be able to operate without perceptible signs of cavitation in the full range of heads specified, pumpsets running singly or in parallel.

3 IMPELLERS

All impellers shall be cast in stainless steel or bronze as indicated in the Project Specification. Alternative materials may be considered by the Engineer.

The castings shall be free of blow-holes and other defects. No welding, burning, filling or plugging of defective castings shall be permitted without prior approval being obtained from the Engineer in writing, following an inspection of the defects.
Impeller shrouds and blades shall be of adequate thickness after they have been dressed, the minimum thickness being equal to : 7,00 (mm) for impeller diameters less than 350 mm and 0,00625 x diameter of impeller (mm) + 5 mm for impeller diameters equal to or greater than 350 mm.

All water passages are to be finished smooth to a template or NC machine finished.

All impellers shall be fitted with replaceable wearing rings of gunmetal or bronze. These rings, which shall be "L" cross-section, shall be secured to the impeller with non-corroding screws and mechanically locked.

Each impeller shall, after final machining and dressing, be independently statically balanced and the completely assembled rotating element with coupling half shall be dynamically balanced.

The critical speed of the rotating element shall be considerably higher (25%) than the running speed.

4 PUMP SHAFT, SLEEVES AND DIFFUSERS

Pump shafts shall be of an approved material, to EN26 or equivalent and of sufficient dimensions to transmit the power to which they will be subjected without undue torsional or bending stresses and deflection.

The shafts shall be stress-relieved after initial machining, and ground to final size. The manufacturer shall take special care to avoid sharp radii. Shaft failures due to corrosion are common and the manufacturer shall indicate which steps he has taken to prevent the occurrence of pitting corrosion in pump shafts.

The shafts shall be suitably designed for the reception of the impeller which shall be adequately secured to the shaft in such a manner as to be readily removable without damage to either the shaft or the impeller.

The Contractor shall ensure that both the critical speed and torsional oscillation characteristics of the combined pump and motor rotating elements are satisfactory for all possible conditions of operation.

The shafts shall be adequately protected with replaceable sleeves of an approved bronze or other similar approved non-corrodible material at all areas where wear and/or corrosion could possibly be expected. These sleeves shall be readily removable without causing damage to either the shaft or the sleeves.

If separate diffusers are used, they shall be cast in an approved zinc-free bronze or stainless steel and finished smooth all over.

5 PUMP CASING

The pump casings shall be manufactured in normal SG Iron to grade GGG or stronger non-corrodible approved material as may be specified in the Project Specification.

The casings shall be double flanged with flanges in all respects as required for the valves and bolt holes drilled off-centre; also stiffened with ribs as required at all points of high stress.

No welding, burning, filling or plugging of defective castings shall be permitted without the Engineer's permission in writing, following an inspection of the defects.

The inspection and testing of castings and test bars shall be in accordance with BS 3100.

The dimensions and drillings of the suction and discharge flanges integral with the pump casings shall be to BS 4504 (according to design pressures specified).

The pressure rating of the delivery flanges shall be at least equal to the maximum suction static pressure, plus the pump shut-off pressure. The minimum pressure rating of the flanges shall be 1 MPa (Table 10).

All pump casings shall be hydrostatically tested at the Manufacturer's workshop and in the presence of the Engineer or his Representative.

Particular care must be exercised in designing a pump casing which will resist the tendency to crack through the cutwater or guide passage walls during the pressure tests and the Tenderer is to indicate clearly in his tender the design features incorporated in his pump to ensure that this requirement is satisfied.

6 PUMP BEARINGS AND LUBRICATION

6.1 Bearings and Lubrication

The bearings in the pump casing together with its lubricating systems shall be suitable for the particular circumstances. The particular type and system offered by the Tenderer shall be fully specified.

6.2 Safety Instrumentation

Bearing temperature and vibration sensors shall be provided if stipulated in the Project Specification.

6.3 Type of bearing

The pump rotating element shall be positively located in the axial direction by means of a thrust bearing:

- In the case of horizontal spindles bearings may be either journal or rolling bearings;

- Vertical spindle pumps shall be provided with:
  - cutless rubber line-shaft bearings enclosed in a tube and provided with separate filtered "through-flow" lubrication water;
  - conventional journal or rolling type thrust, top and bottom bearings;

- All bearings shall be suitable for shaft rotation in both directions;

- Preferably the same type of bearing will be chosen for motor and pump; if not, the necessary allowance shall be made when aligning pump and motor.

6.4 Cooling of lubricating oil (if applicable)

Adequate provision shall be made for the cooling of oil for bearings, particularly as the pumps may run continuously in ambient temperatures of the order of 40^{o}C. The bearing metal temperatures shall not exceed 60^{o}C during continuous operation. The cooling of the oil may be natural or by forced air circulation or by water circulation through coolers mounted either in the bearing pedestals or separate water coolers with forced oil circulation.

The oil cooler shall be easy to clean out. Full details of the oil cooler design shall be included in the Tender offer.

6.5 Lubrication

All internal surfaces in continuous contact with the lubricating oil such as oil reservoirs, piping, etc, shall be thoroughly cleaned either chemically or by shot blasting and protected by a method to be approved by the Engineer until such time as the system is charged with oil. No site welding of oil circulating pipes will be permitted.

Circulation oil lubrication systems incorporating pumps, when required, shall include:

- Two 100% duty motor driven oil pumps;
- Two 100% rated full-flow oil filters;
- Duplicate pressure relief valves;
- Oil pressure relays;
- Enclosed oil reservoir with level indicator and oil filter and drier breather;
- All necessary piping, valves, gauges, relay switches, alarms etc.

The entire lubricating system shall be fail safe with alarms set to indicate automatic change-over to the stand-by unit.

Selection of duty pump shall be made by a manual selection switch.

7 GLANDS AND SEALS

7.1 Reliability

Reliability of pump seals is of prime importance. Pumps incorporating low pressure glands where the pressure at the glands does not exceed the main suction supply pressure will be preferred to pumps with shaft glands exposed to higher pressures or mechanical seals.

7.2 Glands

Low pressure glands of the conventional stuffing box pattern utilising packing rings on each side of lantern rings will be acceptable for the first stage of the pumps. Lantern rings shall be easily removable. The shaft sleeves shall be ground with a polished finish on the wearing surface, and the gap between the sleeve and the follower shall be such that the packing will not be extruded into the gap. Make and type of packing shall be to the approval of the Engineer.

7.3 Water to the seals

It will be the responsibility of the Contractor to provide for filtration if the quality of the water necessitates filtration.

7.4 Mechanical seals

If mechanical seals are offered, they shall be balanced and proved to be suitable for the water pumped. Spare wearing components shall be supplied and delivered when the pump is installed, the cost being included in the price of the pump.

7.5 Supply details

The Tenderer shall supply with his Tender, full details of all pump seals or glands incorporated showing clearly all proposed materials, finished clearances, etc.

8 PUMP VENT AND DRAIN FITTINGS

Bronze vent cocks shall be provided and fitted at all local high points on each pump casing. These cocks shall be of adequate size to enable the entrapped air to be released freely. Copper drain pipes shall be neatly led from priming cocks, gland and casing drain points to a suitable main tundish. Galvanised drainage pipework of adequate size shall be provided and installed to collect the waste water from each pumpset and to lead it to the drain leading to the pumphouse sump. Drain pipework shall be fitted with T sections at every bend to enable rodding in the event of a blockage occurring.

9 DESIGNATION AND INFORMATION PLATES

Information plates: each pump shall be provided with a substantial information plate, preferably chromed or stainless steel, securely fastened to the pump casing in a readily visible position, and clearly and indelibly marked with the following details:

- Maker's name, pump type, serial number,
- Year of manufacture
- Rated duty of pump in litres per second,
- Head in metres at rated duty,
- Pump speed in rpm,
- Mass of upper casing in kg, (for horizontal split casing pumps,)
- Mass of lower casing in kg, (for horizontal split casing pumps,)
- Mass of complete rotating element in kg,
- Mass of completely assembled pump in kg.

<u>Letters and figures shall be engraved, or embossed, NOT STAMPED</u>.

Number plate: in addition, each pumping unit shall be provided with a chromium plated or stainless steel number designation plate not less than100 mm square indicating "1", "2", etc., mounted in a position readily visible from the control console area. Pumps are normally numbered from the loading bay of the pump station (No 1 closest to the loading bay) but number order shall be confirmed by the Engineer.

PARTICULAR SPECIFICATION

LK VALVE INSTALLATIONS

PARTICULAR SPECIFICATION: LK VALVE INSTALLATIONS

CONTENTS

1 SCOPE

This Specification covers valve installations on medium pressure pipelines of bore generally up to 1 000 mm but may also be used for pipelines of greater bore, for transporting and controlling cold water (at a temperature not exceeding 50 °C) or sewage under working pressures as specified but not exceeding 4,0 MPa. It includes for butterfly valves of bore up to 2 000 mm.

Interpretations of and variations to this specification are set out in the Specification Data.

2 NORMATIVE REFERENCES

2.1 Supporting specifications

Where this specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

- Specification Data;
- SANS 1200 Series of Standardized Specifications;
- SANS 1200 A or SABS 1200 AA, as applicable;
- SANS 1200 L;
- Standards listed in Appendix A, and
- the following specifications may form part of the Contract:

SANS 1200 D or SANS 1200 DA, as applicable;

- SANS 1200 DB;
- SANS 1200 G or SABS 1200 GA, as applicable;
- SANS 1200 LB.

3 DEFINITIONS AND ABREVIATIONS

3.1 Definitions

The definitions set out in the applicable of the specifications listed in 2.1, and the following shall apply:

Anti-vacuum air valve

A valve that admits large quantities of air at low induction pressure to prevent the formation of vacuum in a flexible wall pipeline when a break occurs or a negative pressure is induced by water hammer.

Double office air valve

A valve that releases and admits air at low pressure during filling or emptying a pipeline, and has a small lever controlled orifice to release air under high pressure.

Lot Except where otherwise defined in (and within the limits of the scope of) an SANS or BS specification listed in Appendix A, a lot is not less than one nor more than ten valves of the same size, design and method of operation from one manufacturer submitted at any one time for inspection and testing.

Reflux valve

A valve that minimizes reflux action and reduces water hammer in rising mains. It may be of one of the following types:

- Single sloping swing door for valves of nominal bore up to 400 mm;
- Double sloping swing doors for valves of nominal bore greater than 400 mm and up to 800 mm;
- Multiple sloping swing doors for valves of nominal bore greater than 800 mm;
- Tilting disc for all valves of nominal bore up to 1 200 mm in rising mains where low hydraulic resistance is a requirement; or
- Recoil type for valves of nominal bore up to 600 mm in rising mains in situations where abnormally rapid reversal of flow is likely to occur.

Single large office air valve

A valve that admits and releases large volumes of air at low pressure during draining or filling the pipeline.

Single small office air valve

A valve that releases small volumes of air under high pressure during operation of a pipeline.

Sleeve-type jet dispersion valve

A valve that controls a scour outlet of a high pressure pipeline.

3.2 Abbreviations

The abbreviations set out in the specifications listed in 2.1 and the following shall apply:

MFB	Metropolitan Fire Board
BSP	British Standard Pipe Thread
ISO	International Standards Organization
ANSI	American National Standards Institute
PN	Nominal Pressure, i.e. maximum permissible gauge working pressure. (Applicable to butterfly valves)

3.3 Explanation of terms

3.3.1 **Materials.**

In the context of this Specification the term materials covers both the basic materials used in the manufacture and fabrication of a valve, and the valve itself as a finished product that is to be installed and commissioned .

3.3.2 **Compliance with standard valve specifications.**

Each valve of nominal bore greater, or for use at a working pressure higher than those covered by the applicable details of SANS 191 or SANS 664 or SANS 665 shall, for quality of materials and fabrication workmanship, be deemed to comply generally with the same standards in such a manner that the valve is designed for a life of 40 years and the manufacturer would be prepared to guarantee its satisfactory performance for 5 years, if called upon to do so.

4 *REQUIREMENTS*

4.1 Materials - The valves

4.1.1 **Gate valve or resilient seal valve**

a) **General**

Except as otherwise specified in 4.1.2 in the case of a valve for the control of sewage, a gate valve or resilient seal valve shall be of the non-rising spindle type, and of the nominal bore, class, gate type, and working pressure scheduled, shall comply with SANS 191 (for a cast steel valve) or SANS 664 (for a waterworks pattern valve) or SANS 665 (for a general purpose type valve), as relevant in terms of Table 1 below, the relevant requirements of 4.1.2 to 4.1.4, and the Specification Data.

Table 1 - Gate valve details

1	2	3	4	5	6
Class	Nominal bore mm	Pressure MPa		Body etc. materials	Quality of valve - applicable specification subject to 3.3.2
		Working	Operating & Differential		
10	50 to 600	1,0	As per SD* or schedule, but not exceeding 1,0	Cast iron	SANS 664
				Cast iron	SANS 665
16	50 to 600	1,6	As per SD* or schedule, but not exceeding 1,6	Cast iron	SANS 664
	exceeding 600 up to 1 000			Cast iron	SANS 665
25	50 to 1 000	2,5	As per SD* or schedule, but not exceeding 2,5	Cast iron	SANS 665
	50 to 350			Cast steel	SANS 191
	exceeding 350 up to 1 000			Cast steel	See SD*
40	50 to 350	4,0	As per SD* or schedule, but not exceeding 4,0	Cast iron	SABS 191
	exceeding 350 up to 1 000			Cast steel	See SD*

*Specification Data.

b) **End connections**

A valve shall be provided with double flanged or double spigoted or double socketed end connections, as billed. Unless otherwise billed, it shall be supplied complete with all jointing material such as insertions, rings, packing's, bolts, nuts and washers etc. as necessary for the type of connection billed.

In the case of flanged valves, the flanges of classes 10 and 16 valves and nominal bore up to 600 mm shall conform to SANS 664. The flanges of larger valves of classes 10 and 16 and all valves of classes 25 and 40 shall conform with BS EN 1092 and, except where blank flanges are billed, shall be drilled in accordance with the relevant requirements of SANS 1123. Where the flange size falls beyond the range of BS EN 1092, mating dimensions shall be in accordance with ISO standard TC 5 with thicknesses adequate to withstand closed-end test pressures. Tapped holes are unacceptable. The front face of all flanges shall be fully machined and, in the case of valves of classes 25 and 40 and nominal bore 450 mm and more, the back of each

flange shall be spot faced.
Flanged valves shall be supplied complete with bolts, nuts and gaskets for joining up to adjacent mating flanges. Bolts shall be of sufficient length for at least two screw threads to protrude outside nuts when assemblies are fully tightened.

Where a valve of nominal bore up to 450 mm is to be installed in a chamber, unless adequate provision for removal of the valve has been made in the pipe layout for the chamber, one end connection shall be such that a removable type coupling can be fitted, and the coupling shall be provided. In the case of a valve of nominal bore greater than 450 mm the end connections shall comprise one flanged adaptor, one plain ended spacer pipe of length not less than the valve diameter, and one removable type coupling as a separate item.

Where a valve is to be used as a replacement in a pipeline fitted with flanges drilled to BS 10, the appropriate bolt circle diameter, number of bolts, and size of bolt holes shall be as specified in the Specification Data.

c) **Manner of operation**

- Unless otherwise specified in the Specification Data, a valve shall be closed by turning the spindle in a direction that is clockwise when seen from above the spindle
- A valve shall be so designed that it can be opened or closed against whichever is the lower of the billed working pressure or the applicable differential pressure given in column 4 of Table 1, with an effort on a hand wheel not exceeding 250 N in the case of valves of bore up to 300 mm, and not exceeding 400 N in the case of larger valves, unless otherwise stated in the bill or required in terms of the Specification Data.
- Except where a hand wheel is billed, a valve of nominal bore not exceeding 300 mm for a working pressure not exceeding 1,6 MPa, shall be fitted with a cap.
- A valve of nominal bore 300 mm or more for use at a working pressure greater than 1,6 MPa but not exceeding 2,5 MPa, shall be fitted with a ball bearing spindle thrust collar, and close machined channel guides and shoes, and machined spur gearing having an advantage of

Nominal bore, mm	**Mechanical advantage**
300	2:1
375	2,5:1
450 and greater	3:1

- Where so billed, a valve of nominal bore exceeding 300 mm shall be fitted with a by-pass valve (cast integrally with the body of the main valve or attached, as billed) of bore area 10 % to 15 % of that of the main valve and arranged to operate in the manner set out in the Specification Data.

- A valve of nominal bore exceeding 300 mm for use at a working pressure greater than 2, 5 MPa but not exceeding 4,0 MPa may, subject to bullet two and bullet four above, be fitted with a hand wheel or shall be fitted with an actuator that complies with 4.1.3 (c)(i), and is of the type (and uses the pressure supply) specified in the Specification Data.

d) **Design**

i) **Lugs**

The lugs on the gate and the spindle of a valve of nominal bore exceeding 300 mm shall be machined.

ii) **Gland packing**

A gate valve of nominal bore exceeding 400 mm shall have a gland that is so designed that it can be repacked under working pressure without shutting off the water supply.

iii) **Auxiliary requirements**

- The design of the valve guides and gate shall be such that pressure may be applied to the gate from either side.

- The design of the guides of a valve of nominal bore not exceeding 300 mm shall be such that it can be installed in any position.

- Unless otherwise shown on the drawings or billed, the design of the guides for a valve of nominal bore exceeding 300 mm shall be such that the valve can be installed in an upright position.

- In addition to complying with bullet one and bullet two or three above, as relevant, a valve shall be provided with such inspection holes, drains, and other auxiliary requirements as are specified in the Specification Data.

iv) **Valve trim**

Except where a gun metal/bronze or stainless steel trim (Type B or Type C of SANS 664 or Tables 1(a) or 1(c) of SANS 665, as applicable), is billed, each valve shall have an all iron trim.

v) **Seat rings**

A valve of nominal bore 300 mm and larger shall have seat rings that are pinned position

4.1.2 Wedge gate (slide valve) for sewage control

A gate valve for the control of sewage shall be of the wedge gate type, suitable for the working pressure billed, and comply with 3.1 (except as required in terms of bullet one to eight below) and capable of operating in the manner required in terms of the Specification Data:

- The valve shall be of flanged type and shall have a rising spindle;
- the wedge gate shall be constructed of ANSI 316 stainless steel or as approved ;
- the spindle shall be constructed of EN 45 B (BS 970) stainless steel or as approved;
-
- the body and traverse seal shall be made of nitrate rubber or as approved;
- a resilient body seal shall ensure drop tightness from zero to maximum working pressure in either direction;
- the internal body contours shall be such that deposits are flushed out during valve closure;
- built-in scrapers that clean the valve blade shall be fitted to both sides of the body; and
- the body shall have a straight through passage such that no valve pockets or clean doors are necessary.

4.1.3 Butterfly valve

a) **General**

A butterfly valve for working pressures not exceeding 2,5 MPa (PN 25) shall comply with the relevant requirements of BS 5155, and 4.1.3 (b) to 4.1.3 (c)(iii), as applicable, and capable of operating in the manner required in terms of the Specification Data. A butterfly valve for working pressures exceeding 2,5 MPa shall be manufactured from the same materials, and be of the same quality as a valve that complies with BS 5155 and 4.1.3 (b) to 4.1.3 (c)(iii), as applicable, shall comply with the requirements of, and capable of operating in the manner required in terms of the Specification Data.

Where a butterfly valve has a preferred flow direction from a control point of view (see 4.1.3 (c)(i)) a suitable arrow shall be cast on the body.

b) **End connections**

A valve shall be provided with double flanged or wafer end connections, as billed.

The flanges shall conform to BS EN 1092 and, except where blank flanges are billed, shall be drilled in accordance with the relevant requirements of SANS 1123. Flanges shall be thickened at points where tapped holes are necessary. The front face of all flanges shall be fully machined and, in the case of valves of PN ratings greater than 16 and nominal bore greater than 450 mm, the back of each flange shall be spot faced.

Where a valve of nominal bore up to 450 mm is to be installed in a chamber, one end connection shall be such that a removable type coupling can be fitted, and the coupling shall be provided. In the case of a valve of nominal bore greater than 450 mm the end connections shall comprise one flanged adaptor, one plain-ended spacer pipe of length not less than the valve diameter, and one removable type coupling as a separate item.

Where a valve is to be used as a replacement in a pipeline fitted with flanges drilled to BS 10, the appropriate bolt circle diameter, number of bolts, and size of bolt holes shall be as specified in the Specification Data.

c) **Manner of operation**

i) **General**

Except that where the design and construction details of a valve are such that it has a preferred flow direction (such as the need for the seal retaining ring to be on the downstream side for adjustment), a butterfly valve shall be suitable for flow in either direction, and shall be suitable for use as a regulating valve in that when tested for disc leakage at a pressure equal to the operating pressure (see Column 4 of Table 1), there shall be no sign of leakage or weeping past the gate, and when tested for disc efficiency the leakage rate shall not exceed the appropriate value given for gate efficiency (mutatis mutandis), in SANS 665. Also, when operating at maximum velocity, there shall be no gate flutter.

ii) **Actuator operated.**

Where a butterfly valve is billed to be operated by an actuator using a designated power source, the actuator shall not be an integral part of the main body but shall be a separate unit bolted to the main body in such a manner that water leaking past the main shaft seal is prevented from entering the actuator.
The actuator shall comply with Section II of AWWA C 504, and shall be capable of withstanding opening and closing torques that are at least 30 % in excess of those necessary under the working conditions and using the source of power specified in the Specification Data.

An actuator shall be supplied complete with hand wheel that can be installed horizontally at a height that provides for reasonable operation in the situation shown on the drawings. The hand wheel shall comply with the relevant requirements of SANS 664, and, in addition, it shall be fitted with an accurate indicator to show clearly the fully open and closed positions and the intermediate open positions, with acceptably embossed markings.

iii) **Design**

- Main shaft

A butterfly valve of nominal bore not exceeding 450 mm shall be suitable for installation with the main shaft in any position. A butterfly valve of nominal bore exceeding 450 mm shall be suitable for installation with the main shaft horizontal or vertical, as billed or shown on the drawings.

The main shaft shall be so offset from the centerline of the disc that it does not pass through the seal.

- Disc and seat

The disc shall be of a single casting and of a hydrofoil section such that the maximum combined stresses in the disc do not exceed 20% of the minimum yield stress of the material used, when the unbalanced (differential) pressure specified in Table 4 (5.1.2 (a)) is applied to either side of the disc.

The profiles of seats shall be smooth and continuous and shall provide adequate "lead-in" for the resilient seal during closure of the disc.

Seals and seats shall be so designed that they are prevented from becoming loose or permitting the passage of water under seals or seats during all conditions of operation and test.
A replaceable stainless steel or bronze or rubber seat shall be fixed to the body, and a resilient rubber or neoprene seal, that can be replaced and adjusted on Site, shall be fixed to the edge of the disc.

- Bearings and seals

Self-lubricating sleeve type bearings shall be fitted in the hubs of the valve body. Other lubricating points, if any, shall be fitted with nipples or grease-gun lubrication.

Each valve shall be fitted with at least one adjustable thrust bearing set to hold the disc securely concentric with the body seat or seal.

In the case of valves of nominal bore greater than 1 000 mm and PN ratings greater than 16, the seal shall comprise an approved fully contained rubber "0" ring. The shape of the groove shall comply with DIN 2514.

4.1.4 Fire hydrant

a) **General**

A fire hydrant shall be of the underground or above-ground or pillar type, as billed, shall comply with the relevant requirements of Part 1 of SANS 1128, and 4.1.4 (a) to 4.1.4 (d). Where an underground type is billed, it shall be provided with a Class 16 gate, rising spindle and captive stopper.

A fire hydrant shall be supplied complete with all jointing material such as insertions, bolts, nuts, and washers and, in the case of an underground hydrant, a flanged closure pipe of such length that the hydrant can be installed at the depth below the cover of the hydrant chamber specified in SANS 1200 L.

An above-ground type valve shall be Class 16, flanged, of the pattern billed, or shown on the drawings, and comply with 4.1.1 (c), as relevant, except that it shall be anti-clockwise opening.

b) **End connections**

The inlet end connection of a hydrant shall be flanged as specified in 4.1.1 (b). Its outlet end and components shall be as specified in Part 1 of SANS 1128, be compatible with one another and, in the case of extensions to exiting installations, with the Employer's existing firefighting equipment as described in the Specification Data.

The single or double (as billed) outlet connection of an underground hydrant shall be a screw or bayonet type, as billed. In the case of a bayonet type the outlet size between hooks shall be 108 mm or 120 mm, as billed.

The outlet connection and the separate outlet coupling of an above-ground hydrant shall have a 65 mm instantaneous connection integrally cast with the body or other connection, as billed. The inlet of the adaptor shall be of the type billed.

c) **Method of operation**

The operating device on a hydrant valve shall be of the fixed wheel or tamper proof key type, as billed.

d) **Design**

Except where another design is shown on the drawings, or other requirements are specified in the Specification Data, the design of a fire hydrant shall comply with the relevant requirements of SANS 1128. A blank cap shall be provided with each fire hydrant.Air valve for a water main

4.1.5 **Air Valve**

a) **Water main**

An air valve for use on a water main shall be of the type and pattern billed, and shall comply with Table 2 for the relevant range of working pressures.

1	2	3	4
Working pressure MPa	**Type**	**Pattern**	**Ball diamet**
up to 0,7	Single, small orifice	float	50
up to 1,6			80
up to 2,5			100
2,5-4,0		lever	100-200
2,5-4,0		float	100-200
up to 4,0	Double (or multiple) orifice	2 (or more) floats	100-200
up to 4,0	Double (or multiple) orifice	1 leverand 1 (or more)	100-200

Unless otherwise billed or specified in the Specification Data, each air valve shall be supplied, as applicable with

- an isolating cock for working pressures up to 1,6 MPa; or
- for working pressures up to 2,5 MPa, a screw down type isolating valve fitted with a bronze spindle (with or without bevel gears) and spindle cap or hand wheel (as billed) or for operation in the manner specified in the Specification Data, or
- For working pressures above 2, 5 MPa, a flanged isolating gate valve that complies with the relevant requirements of 4.1.1.

b) **Sewer rising main**

Subject to the requirements of 4.1.5 (d) (ii) and 4.1.5 (e) (ii), an air valve for use on a sewer rising main shall comply with 4.1.5 (a).

c) **End connections**

An air valve shall be supplied complete with end connections (and all necessary jointing material, nuts, bolts, etc.) billed or shown on the drawings. The end connections shall comply with 4.1.1 (b), mutatis mutandis.

d) **Manner of operation**

i) **Water main**

An air valve shall be capable of operating automatically under the operating pressure and conditions specified in the Specification Data. In the case of a single small orifice air valve, it shall be capable under the same circumstances, of automatically releasing, air entrapped in the pipeline.

ii) **Sewer rising main**

The operation of an air valve on a sewer rising main shall be such that the sewage does not come into contact with the balls or valve seats. To achieve this, a large stainless steel float shall be fitted with a rod that is suitably sleeved into the body of the valve in such a manner that

- when the air is expelled and the level rises in the float chamber, the rod pushes the ball upwards until it seats firmly in the large orifice; and
- as gas and air accumulates in the valve body, the water level is depressed , the float drops and the small orifice comes into operation to release the air pressure that is in the valve body.

e) **Design**

i) **Water main**

The body for all types of air valve for use on a water main shall have been successfully tested to not less than twice the working pressure, and shall, for working pressures up to 2, 5 MPa, be manufactured from cast iron that conforms with the relevant requirements of BS EN 1561 for Grade 14, and for working pressures exceeding 2, 5 MPa, be manufactured from cast steel. The balls and seating shall be manufactured from materials that are compatible with the body and with themselves, and are such that the seating wears faster than the ball. Where dissimilar metals are used for the balls and seating, the metals shall be such that the potential difference exceeds
0,3 volts.

Each double or multiple orifice air valves shall be

- flanged; and
- fitted with a suitable drain cock to release the pressure inside the valve when the isolating valve is closed during the time when the float is sealing the large orifice ; and
- provided with cast iron shield plates so designed as to prevent the entry of dirt when the large orifice is open.

ii) **Sewer rising main**

The valve body shall be constructed of close-grained cast iron, and shall be so contoured that there are no corners or rough surfaces to which solids may adhere. The head casting shall be specially strengthened and dimensioned to receive a vertical vent pipe, if required subsequently.

Two wash-down sludge plugs for cleaning and inspection shall be provided.

Operating mechanisms shall be of high quality ANSI 316 S16 stainless steel or as approved, and shall be totally enclosed. The large and small or if ice sealing components may be manufactured from vulcanite and polyurethane elastomer, or such other materials as are approved.

The seat profiles of the large and small orifices shall be such that the valve is gas-tight at atmospheric pressure.

The valve seats shall be readily accessible for cleaning and inspection on removal of the cover bolts.

The stainless steel float shall be so shaped as to allow a substantial margin of stability in the handling of sewage gases.

Comprehensive back-washing facilities shall be provided for all sealing surfaces of the operating mechanism, and facilities shall be provided for complete flushing of the air chamber and passage- ways by high pressure sprays of water.

An isolating valve of the type billed shall be provided.

4.1.6 Pressure relief valve

a) **General**

A pressure relief valve shall be of the nominal bore and class, and shall operate at the pressure(s) billed. For quality of materials and construction workmanship, it shall comply with the requirements of SANS 191 or, SABS 664, and of 3.3.2 and 4.1.1, as applicable, in addition to complying with 4.1.7 (b) to 4.1.7 (d).

b) **End connections**

End connections shall be fitted with a right angled outlet flanged connection that is drilled and complies with 4.1.1 (b)

c) **Manner of operation**

A pressure relief valve shall be so designed and fabricated that it performs in the manner and fulfills the requirements set out in the Specification Data. The spring of a spring loaded valve shall be reliable in operation.
The valve shall have been tested and be guaranteed, for precision adjustment of the specified set pressure.

d) **Design**

The body shall be of Cl or bronze, as billed.

The valve spindle shall be made of EN 56 B to BS 970 (or as approved stainless steel.

The valve nozzle, disc, disc holder and guide shall be made of monel (or as approved).

The spring shall be made of plated high quality carbon steel. The disc and nozzle sealing surfaces shall be precision lipped to ensure perfect valve tightness.

4.1.7 Control valve

a) **General**

A control valve shall be of the diaphragm or other approved type, and of the nominal bore, class, and working pressure billed. In the case of a diaphragm type of nominal bore within the range 50 mm to 300 mm for class 10 or 16; it shall comply with the relevant requirements of BS 5156. A control valve of nominal bore greater than 300 mm or of a class higher than 16 shall, for quality of materials and construction workmanship comply with the requirements of SANS 191 or SANS 664, and of 3.3.2 and 4.1.1, as applicable. In addition, all valves shall comply with 4.1.8 (b) to 4.1.8 (d).

A control valve shall have a hydraulically operated, pilot controlled diaphragm type single seat globe or other approved valve. A globe valve of nominal bore within the range

50 mm to 450 mm for class 10 or 16 or 25 shall comply with the relevant requirements of BS 5152.

b) **End connections**

A control valve shall be supplied with the end connections billed or shown on the drawings. The end connections shall comply with 4.1.1 (b), mutatis mutandis.

c) **Manner of operating**

A control valve shall be so designed that no surface water can be drawn into the pilot system or main valve at any time and that it performs in the manner and fulfills the requirements set out in Specification Data.

d) **Design**

A control valve shall be so designed that it shuts without inducing water hammer, and is capable of operating smoothly at low flows. It shall be fitted with single removable bronze seats and discs of synthetic rubber of rectangular cross section. The discs shall be retained on three sides by disc retainers.

All necessary repairs shall be possible without removing the valve from the pipeline.
A valve shall have external packing glands or stuffing boxes.

4.1.8 Rate of flow control valve

a) **General**

A rate of flow control valve shall be of the diaphragm or other approved type, and of the nominal bore, class, and working pressure billed. For quality of materials and construction workmanship it shall comply with the requirements of SANS 191 or SANS 664, and of 3.3.2 and 4.1.1, as applicable.

Except where the design of the valve is such that the valve, differential pressure powers the diaphragm, a thin edged orifice plate shall be supplied to provide actuating differential pressure. (NOTE: This shall be installed in an orifice flange located downstream of the valve.)

Pilot control shall be by means of a double acting diaphragm or other approved valve that complies with 4.1.8 (a).

b) **End connections**

A control valve shall be supplied with the end connections billed or shown on the drawings. The end connections shall comply with 4.1.1 (b), mutatis mutandis.

c) **Manner of operation**

Subject to the limits and tolerances specified in the Specification Data, a rate of flow control valve shall be so designed that, regardless of fluctuations in the up-steam pressure, it maintains the specified constant rate of flow at the downstream pressure specified in the Specification Data, shuts without water hammer, and is capable of operating smoothly at low flows.

The pilot control shall be designed to close when the actuating differential pressure increases beyond the spring setting.

d) **Design**

A control valve shall be so designed that it shuts without inducing water hammer, and is capable of operating smoothly at low flows. A globe type valve shall be fitted with a single removable bronze seat and disc of synthetic rubber of rectangular cross section. All necessary repairs shall be possible without removing the valve from the pipeline.

Where a larger stem stroke is required to reduce sensitivity under operating conditions, the valve shall be fitted with a V-port instead of a disc.

A valve shall have no external packing glands or stuffing boxes.
Valves shall be manufactured to conform to the requirements of BS 1655 and BS 5793 as applicable or as approved.

High quality valves consisting only of a stainless steel body and an elastomeric liner are an acceptable alternative design.
Where specified in the Specification Data, the pilot control valves shall be fitted with an electrically operated solenoid valve.

4.1.9 Check valve

a) **General**

A check valve shall be suitable for the working pressure, and of the nominal bore and class billed. Unless specifically billed as a diaphragm type valve, it shall be a gate type valve that complies with the relevant requirements of SABS 144 or SABS 191 or SANS 664, and of 3.3.2 and 4.1.1, as applicable, in addition to complying with 4.1.9 (b) to 4.1.9 (d).

b) **End connections**

A check valve shall be supplied with the end connections billed or shown on the drawings. The end connections shall comply with 4.1.1 (b), mutatis mutandis.

c) **Manner of operating**

A check valve shall hold the pressure constant over the demand range and pressure conditions, be of the no-slam type, and fulfill the requirements set out in the Specification Data.

d) **Design**

The door on the body shall be fitted with a bronze face closing on a corresponding bronze seating in the body.

The door suspension lugs shall be hinged on a stainless steel EN 57 B (conforming to BS 970) spindle supported in trunnion bearings.

In the case of a diaphragm type valve, it shall comply with 4.1.8 (a) and 4.1.8 (d). In the case of a wafer type spring check valve, it shall have discs and resilient seats of either 316, stainless steel or other acceptably corrosive resistant material.

4.1.10 Pressure-reducing and pressure-sustaining valve

a) **General**

A pressure-reducing and a pressure-sustaining valve shall be suitable for the working pressure, and of the nominal bore and class billed. It shall comply with the relevant requirements of SANS 191 or SANS 664, and of 3.3.2 and 4.1.1, as applicable, in addition to complying with 4.1.10 (b) to 4.1.10 (d).

A pressure-reducing shall have a pilot-control that is a direct-acting adjustable, spring loaded, normally open diaphragm valve.

A pressure-sustaining valve shall have a pilot-control that is a direct-acting, adjustable spring- loaded, normally closed diaphragm valve.

b) **End connections**

A pressure-reducing and pressure-sustaining valve shall be supplied with the end connections billed or shown on the drawings. The end connections shall comply with 4.1.1 (b), mutatis mutandis.

c) **Manner of operation**

The pressure-reducing or pressure-sustaining valve shall maintain the specified constant downstream pressure, regardless of fluctuations in demand within the range, and at the inlet and maximum downstream pressures specified in the Specification Data.

When the upstream pressure becomes equal to the spring setting of the pressure-sustaining control, the valve shall throttle to maintain the specified constant inlet pressure.

If the downstream pressure is greater than the upstream pressure, the valve shall close automatically to prevent return flow.

The pressure-reducing pilot shall close when the downstream pressure exceeds the spring setting. The pressure-sustaining pilot shall open when the upstream pressure exceeds the spring setting. The control system shall include a fixed orifice ejector and an adjustable-opening speed control.

4.1.11 Sleeve-type jet dispersion valve

a) **General**

A sleeve-type jet dispersion valve shall be of the sliding sleeve, inverted cone, jet dispersing type with acceptable reduction drive and hand wheel operation. It shall be suitable for installation horizontally or at an angle of 45°

b) **End connections**

The valve shall have flanges of the same thickness and drilling as those of the outlet valve that is to be controlled.

c) **Manner of operating**

The valve shall be operated by a stainless screwed spindle, a hand wheel, and a thrust head mounted on a trunnion for horizontal mounting or cast into a wall, in which case the sleeve lever linkage shall be operated with a watertight gland.

Where the gland is cast into the wall, the lever operating linkage shall be designed to accommodate movement restraints that may be due to casting in.

Where so required in terms of the Specification Data valve operation controls shall be integral with the valve body.

A valve and control shall be so designed that its operation is dependable when exposed to the weather and sunlight, and when non-operative for extended periods of time.

A valve shall close by clock-wise rotation of a hand wheel on which arrows and the words "TO OPEN" and "TO CLOSE" shall be cast to indicate the direction of closing and opening.

d) **Design**

The valve body shall be of cast-steel with a shrunk-on stainless steel sleeve on the portion of the body that does not contain the water ports and on which the sleeve slides. The water port web edges on which the sleeve slides shall have machined weld-deposited stainless steel faces to prevent moisture getting between the facing and the webs and causing corrosion. The sliding sleeve shall be of cast-steel with two (i.e. front and rear) renewable annular zinc-free bronze sliding surfaces and a stainless steel seal seating on to a renewable rubber ring. This end rubber sealing ring in the cone of the valve body shall be out of the water-way and positively secured in position by stainless securing elements, and the rubber seal shall be readily replaceable on Site.

The back rubber water seal shall also be replaceable on Site and carried either in the sliding sleeve or, in the case of seals that rely on water pressure for water tightness, shall be carried on the valve body.

A valve shall be so designed and constructed that it is drop-tight when closed.

Operating gear and linkage shall be of corrosion resistant materials.

All lubricating points shall be provided with nipples for grease gun lubrication.

4.1.12 Other types of valve

Other types of valves shall comply with the requirements of the Specification Data.

4.1.13 Body marking and facilities for handling and mounting

a) **Body marking**

The following information shall be legibly and indelibly cast or embossed on each valve

- the size or nominal bore of the valve ;
- the class or working pressure of the valve .

b) **Lifting eyes**

Each valve of mass 75 kg and more shall be furnished with acceptably robust lifting eyes so placed as to be suitable for lifting the valve in a horizontal or vertical position, as appropriate.

c) **Mounting feet**

Unless otherwise stated in the Specification Data, the body of a socketed or a double-socketed type valve of nominal bore up to 600 mm, and of every valve of nominal bore greater than 600 mm shall be furnished with two robust mounting feet, one on either side of the gate. The feet shall be designed for direct grouting or for bolting as shown on the drawings, billed or specified in the Specification Data.

d) **Protection against damage during transit to, and on site**

The body ends shall be sealed in the manner specified in SANS 665, and the jointing surfaces shall be protected against damage before dispatch to the Site and while being moved, stored, handled and installed on Site.

4.1.14 **Protection against corrosion**

a) **General**

i) **Prevention of electrolysis**

- Between metals used to fabricate valve. Where the construction of the valve is such that it is impossible to avoid dissimilar metals of which the potential difference exceeds 0,3 volts, suitable insulation materials shall be used on the contact faces between such dissimilar metals.
-
- Valve in cathodically protected pipeline of large diameter. Where a pipeline of nominal diameter 450 mm or more is being given cathodic protection, the Contractor shall ensure that such cathodic protection measures are also applied to any valves that he installs in the pipeline.

ii) **Where protection not required**

Except where specifically billed and required in terms of the Specification Data, internal corrosion protection shall not be provided on cast iron valves.

- of nominal bore up to 300 mm; and
- of nominal bore greater than 300 mm that are to be used, in terms of the Specification Data, for the conveyance of non-aggressive water.

iii) **External corrosion protection scheduled**

Where corrosion protection of the outside surface of a valve is designated or billed, the valve shall, after proper cleaning, be given whichever of the following treatments is billed:

- Bitumen/coal tar coat. A cold applied approved mineral bitumen or coal tar coat that complies with BS 78 and is of dry film thickness not less than 300 IJm.

- Bituminous aluminum. Coated in accordance with the relevant requirements of SANS 802 with bituminous aluminum to provide a dry film thickness of not less than 300 IJm.

- Galvanised. Galvanised in accordance with the relevant requirements of SANS 121 or SANS 32, as appropriate.

- Zinc (or aluminum) spray plus epoxy. The external metal surfaces shall be grit blast cleaned to at least SIS Standard SA 3 and zinc (or aluminum, as billed) spray coated to a thickness of at least 150 1-1m in accordance with the requirements of SANS ISO 2063. The zinc coating shall be further protected with one prime coat and two coats of an approved high build epoxy tar paint that complies with the relevant requirements of SANS 801, to a total film thickness of not less than 280 IJm

- Epoxy painted. The external metal surfaces shall be grit blasted to SIS Standard SA 3 and an approved epoxy paint that complies with the relevant requirements of SANS 801 applied immediately as a primer followed by two further coats not less than 6 h and not more than 24 h after the previous coat to provide a total film thickness of not less than 250 IJm.

- Sintered epoxy. Clean as for bullet four and five above, and a solvent-free sintered epoxy powder applied in one coat by the use of arc-spray machines to provide a dry film thickness of not less than 450 IJm.

b) **Internal corrosion protection of large valves**

The vulnerable internal metal surfaces of a valve shall be given corrosion protection if the valve has a cast steel body or has a cast iron body and is to be installed to control aggressive water and provided also that a particular internal corrosion protection is billed and is identified in the Specification Data. Such protection shall comply with whichever of bullet one to five below is billed or identified in the Specification Data or with such other specification as is acceptable as a means of providing adequate protection of the valve against corrosion caused by water of the composition set out in the Specification Data, and is approved as being equal to that billed. Internal protection may be applied before the valve has been tested at the manufacturer's works in terms of 5.1.2 (a).

- Zinc (or aluminum) spray plus epoxy. The exposed internal cast steel surfaces shall be grit blast cleaned to at least SIS Standard Sa 3 and zinc, or aluminum, as applicable, spray coated to a thickness of at least 150 IJm in accordance with the requirements of SANS ISO 2063. The zinc (or aluminum) coating shall be further protected with one prime coat and two coats of an approved non-toxic and non-tainting high build epoxy tar paint that complies with the relevant requirements of SANS 801, to a total film thickness of not less than 280 IJm.

- Epoxy painted. The exposed internal cast steel surfaces shall be grit blasted to SIS Standard SA 3 and an approved non-toxic and non-tainting epoxy paint that complies with the relevant requirements of SANS 801 applied immediately as a primer followed by two further coats not less than 6 h and not more than 24 h after the previous coat to provide a total film thickness of not less than 260m.

- Sintered epoxy. Clean as for bullet one and two above and apply a solvent-free, non-toxic and non-tainting sintered epoxy powder in one coat by the use of arc-spray machines to provide a dry film thickness of not less than 450 m.

- Plastic coated. Clean as for bullet one and two above and apply an approved plastic coating of thickness not less than 50 mm to all internal surfaces except plug or disc faces.

- Nickel plating. The exposed internal surfaces of cast steel shall be nickel plated in accordance with the recommendations of an approved manufacturer.

4.1.15 **Marking to identify for contract**

Before dispatch from the manufacturer's works the body of each valve shall be clearly marked to identify it with the drawings or billed in the manner required in terms of the Specification Data, and in such a way that the marks remain until the valve is installed.

4.1.16 **Concrete**

The concrete used for pedestals, or bedding or other supports shall be of the strength specified, billed or given on the drawings, and shall comply with the relevant requirements of SANS 1200 G or SANS 1200 GA as applicable.

4.1.17 **Bedding**

Bedding materials and procedures shall be of the class billed or given on the drawings, and shall comply with the relevant requirements of SANS 1200 LB.

4.2 Plant

The terms of Clause 4 of SANS 1200 L shall apply where relevant.

4.3 Methods and procedures

4.3.1 **Setting of valves and associated specials**

a) **General**

i) Unless otherwise shown on the drawings or required in terms of the Specification Data, gate valves, fire hydrants and air valves shall be set upright and butterfly valves shall be set with the main shafts horizontal. Other valves shall be set as shown on the drawings or ordered.

ii) Each valve, complete with associated specials, shall be correctly set, placed in position, bedded as specified in SANS 1200 LB to the class appropriate to the pipeline, or where so billed, supported on concrete as specified in 4.3.2 and 4.3.3, and as the work proceeds, properly jointed to their respective pipes.

iii) In the case of a valve inside a chamber:

- the removable type coupling (provided in terms of 4.1.1 (b) or 4.1.3 (b), as applicable) shall be fitted on one side of the valve;
- a clear space of width at least 450 mm or the nominal bore of the valve, whichever is the larger, shall be provided on both sides and above a valve;
- a clear space of at least 300 mm shall be provided under a valve.

iv) In urban, industrial and similar areas, each valve and associated specials shall, subject to 5.2.2, be located in the position shown on the drawings or as otherwise directed, and pipe lengths shall be so arranged that the closure piece when coupling a valve into a pipeline is not less than 500 mm in length.

v) In open country areas, where so approved before pipe laying commences, a valve may be located to suit the pipe lengths.

vi) An underground type fire hydrant shall be installed at a level that ensures that the top of the threaded outlet is not more than 400 mm nor less than 50 mm below the level at which the top of the hydrant cover is to be set. A double-flanged distance piece shall be used when necessary to ensure compliance with this requirement.

vii) In the case of an air valve, a double-flanged distance piece of suitable length shall be used when necessary to ensure compliance with any depth requirement given on the drawings.

4.3.2 Jointing

a) **Flanges**

In the jointing of valves with flanges, special care shall be taken to align, grade, and level the valves to avoid straining of the flanges. All bitumen and paint shall be removed from the face of each flange immediately before jointing.

Insertion pieces that comply with the applicable requirements of Sub clause 3.8.3 of SANS 1200 L and 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 evenly in opposite pairs to ensure uniform bearing on the insertion. Care shall be taken to avoid damage to the internal surface of the valves during assembly of the pipeline and installing of the valve(s).

b) **Other end connections**

Each end of the valve shall be thoroughly cleaned by brushing and wiping immediately before being jointed. All rubber rings and seals shall be carefully inspected after being placed in position and before the joint is closed to ensure that they have not suffered any cuts, tears, or other damage, and are not in any other way defective. Only the lubricant recommended by the manufacturer shall be used for sleeve-type couplings and rubber insertion rings of AC pipes. Grease derived from petroleum products shall not be used for connections to PVC pipe joints. Connections to an uPVC pipeline shall be made in accordance with the manufacturer's instructions. Connections to an AC pipeline shall be made in accordance with the manufacturer's instructions.

4.3.3 Keeping valves clean

Every reasonable precaution shall be taken to prevent the entry of foreign matter and water into the valve(s). At the close of each day's work or at any time when work is suspended for a significant period, the open en of the last laid valve shall be plugged, capped, or otherwise tightly closed until laying is recommenced.

4.3.4 Anchor/thrust blocks and pedestals

When billed, terminal valves, under major valves, and where otherwise directed, anchor/thrust blocks and pedestals shall be constructed (and reinforced, if any) to the dimensions ordered or shown on the drawings. Anchor/thrust blocks and pedestals shall be constructed of strength concrete of grade 20 MPa

The concrete shall be well punned round the base or mounting lugs, as applicable and, if in trenches, against the undisturbed faces and bottom of the trench. Backfilling behind or under thrust faces will not be permitted. Excess excavation shall be replaced with strength concrete of grade 20 MPa at the Contractor's expense unless an item is billed to cover payment for over break. Care shall be taken to leave the bolts on the valve accessible. No anchor/thrust blocks and pedestals shall be concreted until the approval of the Engineer has been obtained.

4.3.5 Holding down bolts, straps, clamps, etc.

Where and as billed the Contractor shall supply and install holding down bolts, straps, clamps, or other devices that are shown on the drawings for anchoring the valve to the valve pedestal or other concrete structure, as applicable.

All bolts, straps, clamps, etc., shall be protected against corrosion by use of approved protective materials.

4.3.6 Making good damage

a) **Before satisfactory completion of initial test (see 5.1.4 (a))**

Each valve shall be thoroughly cleaned and carefully examined for damage and defects in the valve and corrosion protection, if any, immediately before installing. Should any damaged or defective valve be installed, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer. Should any damaged or defective corrosion protection be disclosed the affected area shall be thoroughly cleaned and then re-protected as specified in 4.1.14 at the Contractor's expense and to the satisfaction of the Engineer.

b) **After acceptance**

Except where the Contractor is barred by special requirements in the Specification Data from working on an accepted valve in a pipeline that is being operated by the Employer, the Contractor shall liaise with the Engineer in regard to acceptable arrangements for carrying out his responsibilities in terms of 4.3.6 (b) and 5.1.4 (b) until the end of the defects liability period.

4.3.7 Commissioning

After installation, the Contractor shall commission each valve under normal conditions of flow, and he shall satisfy himself that each valve performs in the manner, and fulfils the requirements over the full range of operating conditions specified in the Contract.

5 *COMPLIANCE WITH REQUIREMENTS*

5.1 Testing

5.1.1 Test certificate

The Contractor shall make suitable arrangements with the manufacturer to ensure receipt by the Engineer of a manufacturer's test certificate in which it is certified that all valves in the lot have been inspected and tested for compliance with the 5.1.2 and the applicable specification. The actual pressures used during the tests and the result of each test shall be stated in the certificate.

5.1.2 Test requirements

a) **At manufacturer's works**

Before dispatch to the site, valves shall be tested at the manufacturer's works in accordance with the requirements of Table 4 below, as applicable.

The proof tests required in terms of columns 3 and 4 of Table 4 shall be carried out on samples selected in terms of the sampling procedure specified in the applicable standard specification. Where, in terms of 4.1.14 (a)(ii), the exposed surfaces of the inside of a valve are to receive identified treatment for protection against corrosion, the valve may be tested as set out above before treatment, and again after it has been dismantled, treated and re-assembled.

Table 4- Test requirements

1	2	3	4	5	6	7
Class and Working pressure MPa	Nominal bore mm	Proof test on sample to check design of valve at		Gate efficiency and performance test on each valve at	Applicable standard specification for tests	
		Test Pressure MPa				
		On body	On gate for drop tightness	Operating & differential	Gate	Others
10	50 to 600	2,0	1,5	As stated in SO or billed, but not exceeding 1,0	SANS 664	See 5.1.3
1,0	exceeding 600 to 1000				SANS 665	
16	50 to 60	3,2	2,4	As stated in SO or billed, but not exceeding 1,6	SABS 664	See 5.1.3
1,6	exceeding 600 up to 1000				SANS 665	
25	50 to 1000	5,0	3,8	As stated in SO or billed, but not exceeding 2,5	SANS 665	See 5.1.3
2,5	50 to 350 exceeding 350 up to 1000				SANS 191 Specification Data	
40	50 to 350	8,0	6,0	As stated in SO or billed, but not exceeding 4,0	SANS 191	See 5.1.3
4,0	exceeding 350 up to 1000				Specification Data	

On site

In addition to the test requirements of 5.1.1 and 5.1.2 (a), each valve shall be:

- inspected for flaws or damage on delivery to the Site, and again immediately before installation.
- subjected to commissioning tests as specified in 5.1.4 and 5.1.5, as applicable.

5.1.3 Applicable test specifications for other than gate valves

Except where otherwise specified in an applicable standard specification listed below, each valve of whatever type shall be inspected and have its body tested as specified in SANS 191 or SANS 664 or SANS 665, as applicable, for the specified class or working pressure given in Column 5 of Table 4.

Type of valve	Applicable standard Specification for tests
Butterfly Fire hydrant	BS 5155 SABS 1128
Air valve Diaphragm Globe	Specification Data BS 5156 BS 5152

5.1.4 Commissioning (or field) test on site

a) **Initial test**

After installation and compliance with 4.3.5, each valve (and actuator if installed) shall be subjected to a commissioning (or field) test in the presence of the Engineer to prove the ability of the valve (and actuator if installed) to operate in the manner and over the full range of normal flow and operating conditions specified in the Contract.

b) **Maintenance checks**

After the commissioning test has been completed to the satisfaction of the Engineer, the Contractor shall, from time to time during the Defects Liability Period make such checks and adjustments to mechanisms as are necessary, in the opinion of the Engineer.

5.1.5 Testing by-pass valve arrangements

By-pass valve arrangements shall be subjected to and pass the tests ordered at the same pressure as the main valve that is by-passed by such arrangements.

5.2 Tolerances

5.2.1 Manufacture

a) **Body dimensions**

The dimensions of the body of each valve and its component parts shall comply with the relevant tolerance requirements of Table 3 below and of the applicable standard specification for the valve (see Table 1).

1				**2**
Face-to-face dimension, mm				**Tolerance, mm**
		Up to and including	200	± 1
Above	200	up to and including	400	±2
Above	400	up to and including	600	±3
Above	600	up to and including	800	±4
Above	800	up to and including	1000	±5

b) **Flanged and couplings**

Flanges shall be subject to the following tolerances:
Outside diameter of flange
Thickness of flange
Diameter bolt circle
±2mm
± 1 mm
±1mm
Couplings shall be subject to the tolerances specified in the appropriate standard specification.

5.2.2 Installation

A valve shall be installed and located in a pipeline within the tolerances specified for the pipeline in terms of SANS 1200 L.

5.2.3 Commissioning

After commissioning each valve shall perform in the manner, and within the limits and tolerances required in terms of the Specification Data.

6 *Void*

7 *Void*

8 *MEASUREMENT AND PAYMENT*

8.1 Basic principles

8.1.1 General

a) Except as provided for in (c) below, the various operations involved in the installation of a valve will be dealt with as an extra-over the payment for supplying, laying, bedding, etc. of the pipeline in which (or onto which) the valve is installed/attached, i.e. no deduction from the overall length of the pipeline will be made for valves (see Sub clause 8.2.1 of the SANS 1200 L).

b) Generally the supply and delivery of a valve will be billed separately form the operations necessary to install and bed or support, and to commission such a valve.

c) In the case of short pipe runs (see Sub clause 8.2.5 of SANS 1200 L), where the quantity of valves and specials are, for instance, of a similar magnitude to or more than those of the stated lengths of straight pipes, the operations of installing, setting and bedding each valve will be regarded as, and scheduled separately from the operations of laying and bedding etc. the adjoining length(s) of the pipe(s) or specials.

8.2 Billed Items

8.2.1 Supply and deliver valve

(type, size, working pressure, and other relevant data in terms of Clauses 4.1.1 to 4.1.10 of Specification LK, as applicable, stated)

Unit: .... number (No.)

A separate item will be billed for each type, size, etc. of valve and each type of end connection or coupling.

NOTE: All valves may be listed in a separate Bill "X" (that includes couplings and may include specials), a summary of which is to be carried to an item in the main bill.

The rate, which shall be subject to 8.1, shall cover the cost of providing, delivering, and offloading the valve on Site as directed.

8.2.2 Install, bed and field-test small valve (of nominal bore of up to 300 mm)

(type, size, working pressure, etc., as relevant, stated)

Unit: .... Number (No.)

Separate items will be billed for each group of valves (depending on mass and location or circumstances, or both, of installation) , and for each type and size of valve .

The rate, which shall be subject to 8.1, shall cover the cost of providing packing, bolts, etc. for flanges, if any, and of taking delivery, handling, installing, bedding, and field testing the valve , complete with couplings together with the cost of any additional cutting, turning and jointing of pipes required to locate the valve exactly.

In the case of an underground type fire hydrant, the rate shall cover also the cost of the supply, (except where billed under 8.2.1), fitting and installation of the necessary flanged distance piece(s) regardless of any variation in their total length(s) caused by variations from the specified minimum depth or depth of cover over the main pipeline that arise from the Contractor's manner of laying that pipeline.

NOTE: Unless specific provision is made in the bill, no separate payment will be made for the supply and fitting of any additional joints and jointing materials which may be required for the connection of shortened pipe lengths.

8.2.3 Provide and deliver removable type couplings

(details stated)

Unit: .... number (No.)

Separate items may be billed for each size and type of removable coupling required in terms of Clauses 4.1.1 (b) and 4.1.3 (b) of Specification LK.

The rate shall cover the cost of supplying and delivering to Site the coupling complete with all necessary rings, packing's, bolts (of sufficient length for at least two screw threads to protrude outside nuts when assemblies are fully tightened), washers and nuts.

8.2.4 Install, bed and test, medium and large valve

(nominal bore more than 300 mm) (type, size, working pressure, etc., as relevant, stated)

Unit: .... number (No.)

The rate, which shall be subject to 8.1, shall cover the cost of the provision of each valve, and the cost of the handling, fixing, and bedding and, except where separately billed, of testing and of commissioning the valve.

No extra payment over and above the rate will be made in respect of any additional cutting, turning and jointing of pipes required for the location of a valve, special, etc., where a precise position is given on the drawings. In such an event, unless specific provision is made in the bill, no separate payment will be made for the supply and fitting of any additional joints and jointing materials which may be required for the connection of shortened pipe lengths.

8.2.5 Test and/or commission valve(s)

Unit: .... number (No.)

(Only applicable to a single or group of large valve(s) or isolated valve(s) or power operated valve(s) testing or commissioning, (or both), of which is a separate operation to installation, and billed separately). Separate items may be billed for the initial test (Clauses 5.1.4.1 of Specification LK) and for the maintenance checks in terms of Clause 5.1.4.2 of Specification LK.

The rate shall cover all costs of labour, material, equipment, and specialist supervision for whatever numbers of visits are required to commission and prove the valve(s) to the satisfaction of the Engineer.

8.2.6 **Concrete valve pedestals (concrete strength or mix stated)**

Unit: ....number or cubic metre (No.) or (m3)
Where valve pedestals are the same size and shape they will be billed by number, the size being stated, or they will be billed by volume and the number will be stated. In either case dimensions or reference to a drawing will be given.

Where so billed the volume of a pedestal will be calculated from the dimensions stated, specified or given on the drawings. Steel reinforcement, if required, will be measured separately in terms of Sub clause 8.3 of SANS 1200 GA, as applicable.

8.2.7 **Holding down bolts, nuts, and washers, complete with straps/clamps, etc.**

Unit: ....Sum or No

Where all holding down bolts, straps/clamps and other anchoring devices are detailed on the drawings, they may be measured as a sum or by number of sets of similar size, design and complexity. Where details are not given at tender stage holding down bolts will be measured by mass (number stated) and straps/clamps separately by mass.

The rate shall cover the cost of provision of the bolts, nuts, washers, straps, clamps, etc. or sets of clamps complete with nuts, etc., as applicable, and the cost of boxing out pockets where required, casting or grouting in, and anchoring the valve securely in position, and corrosion protection.

APPENDIX A. APPLICABLE STANDARDS

References is made to the applicable edition (see Sub clause 2.2 of SANS 1200 A or SANS 1200 AA, as applicable) of the following standards:

ANSI 316

AWWAC 504

BS10 :	Flanges and bolting for pipes, valves and fittings
BS 78:	Cast iron spigot and socket pipes (vertically cast) and spigot and socket fittings
BS 970:	Wrought steels for mechanical and allied engineering purposes
BS 1655:	Specification for flanged automatic control valves for the process control industry (face- to-face dimensions)
BS 5152:	Cast iron globe and globe stop and check valves for general purposes
BS 5155:	Cast iron and carbon steel butterfly valves for general purposes
BS 5156:	Screw down diaphragm valves for general purposes
BS 5793:	Industrial-process control valves
BS EN 1092:	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories. Steel flanges
BS EN 1561:	Founding. Grey cast irons
SANS 32:	Internal and/or external protective coatings for steel tubes
SANS 121:	Hot dip galvanized coatings on fabricated iron and steel articles - Specification and test methods
SANS 144:	Metallic oxide coatings - Measurement of coating thickness - microscopical method
SANS 191:	Cast steel gate valves
SANS 664:	Cast Iron Gate valves for waterworks
SANS 665:	Cast Iron Gate valves for general purposes
SANS 801:	Epoxy-tar paints
SANS 802:	Bituminous aluminum paint
SANS 1123:	Steel pipe flanges
SANS 1128:	Firefighting equipment Part 1 Components of underground and above ground systems
SANS 1200A :	Civil engineering construction : General
SANS 1200AA :	Civil engineering construction :General (small works)
SABS 1200 D:	Civil engineering construction: Earthworks
SABS 1200 DA:	Civil engineering construction: Earthworks (small works)
SABS 1200 G:	Civil engineering construction: Concrete (Structural)
SABS 1200 GA:	Civil engineering Construction: Concrete (small works)
SABS 1200 L:	Civil engineering construction: Medium-pressure pipelines
SABS 1200 LB:	Civil engineering construction: Bedding (pipes)

SANS ISO 2063:	Metallic and other inorganic coatings -Thermal spraying -Zinc, aluminum and their alloys
SIS 05 59 00:	Pictorial surface preparation standards for painting steel surfaces

PARTICULAR SPECIFICATION: WATER TREATMENT AND PUMPING PLANT

MG: GENERAL MECHANICAL

PARTICULAR SPECIFICATION WATER TREATMENT AND PUMPING PLANT MG: GENERAL MECHANICAL

CONTENTS

1 SCOPE

This Specification covers general technical requirements for mechanical plant and equipment for water treatment and pumping plant.

2 INTERPRETATION

2.1 Supporting Specifications

The following South African National Standards are referred to in this specification:

- SANS 62
- SANS 200
- SANS 533
- SANS 719
- SANS 936/7
- SANS 989/992
- SANS 1034
- SANS 1062
- SANS 1123
- SANS 1186
- SANS 1200H
- SANS 1217
- SANS 1315
- SANS 1431
- SANS 1465
- SANS 1700
- SANS 1804
- SANS 10044
- SANS 10104
- SANS 10160
- SANS 10108
- SANS 60034-5
- SANS 61241

The following British Standards are referred to in this specification:

- BS 970
- BS 1400
- BS 1452
- BS 1490
- BS 2789
- BS 3100
- BS 3790
- BS 4515
- BS 4872

- BS 7854
- BS EN 681
- BS EN 1092
- BS EN ISO 23936

  The following ISO standards are referred to in this specification:
- ISO Sa3
- ISO 4184
- ISO 8501
- ISO 10816

3 DESIGN

3.1 Submission of Contractor's Documents

The Contractor's Documents to be submitted are listed in the tender document.

Where FIDIC is the applicable General Conditions of Contract:

- FIDIC General Condition 5 states that the Contractor is responsible for the design of the Works.

- FIDIC General Condition 5.2 describes the Contractor's responsibility in submitting the Contractor's Documents to the Engineer for review.

3.2 Hazardous Locations

Equipment which is to be installed in areas zoned 0,1 or 2 for gasses and/or zoned 20, 21 or 22 for dusts in terms of SANS 10108, shall be designed to comply with the requirements of that Standard.

3.3 OHS Act and Safety

In addition to the safety requirements to be complied with during the construction of the Works on Site, the Contractor is responsible for ensuring that all equipment supplied and the complete installation complies with the Occupational health and Safety Act, Act 85 of 1993, and the regulations promulgated thereunder.

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

Equipment which is potentially dangerous shall be designed in accordance with a relevant South African or international Standard.

Hazards must be avoided or guarded to the satisfaction 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 marked accordingly.

The Contractor shall cover all unsafe gaps and openings left in structures after installation.

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.

3.4 Design Principles

Mechanical engineering design shall ensure safety, robust construction, reliability, durability, prevention of avoidable corrosion, neatness as well as ease of maintenance and operation. Design shall, as applicable, be based on:

a) The full range of duties which can be reasonably anticipated;

b) The maximum pressure or vacuum which can be produced by pumps, blowers and compressors under all conditions including blocked or closed inlet and outlet circuits;

c) Conservative service and safety factors based on approved standards or 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 for large items of equipment before repair or major part replacement;

f) Prevention of serious damage from normal operational problems such as blockages, blinding, jamming, seizure, malfunction and, as far as is practical, maloperation (assuming that these occurrences cannot be avoided by good design).

g) The power and torque transmitted by the driver system under full load and stalled conditions;

h) Machines with non-overloading characteristics shall be selected wherever possible; eg: motors shall be sized so that they cannot be overloaded by the driven machine.

3.5 Fail Safe Operation and Protections

Where damage can occur from normal operational or other foreseeable problems, plant, equipment and systems must be designed to be fail safe; i.e. must have built in redundant elements, or be fail-to-safe; i.e. must return to a safe condition where no further damage can be done in the event of a failure, malfunction, 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, must be incorporated.
Protections shall:

a) Be directed at the source of the problem, limit forces to safe levels and act quickly enough to prevent damage (electrical thermal type overloads are inadequate);

b) Stop or prevent from starting all equipment at risk;

c) Activate an alarm with a labelled indicator on the control panel whenever a protection operates;

d) Operate reliably after long inactive periods exposed to corrosive and dirty conditions.

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

3.6 Moving Parts

The following general requirements apply not only to machines but to all equipment with moving parts such as headstocks, extension spindles, swivelling davits, heavy duty hinges, pivots and the like:

a) All rotating or swivelling shafts, pins and the like, shall be adequately supported, guided and restrained by lubricated or self-lubricating bearings, collars and/or bushes.

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. Raw sewage and sludge shall be regarded as abrasive.

d) All applications associated with wastewater shall be regarded as corrosive and materials of construction shall be selected to suit.

e) Susceptibility to fatigue failure shall be minimised by proper design and manufacturing procedures. Sharp changes in section and welding shall be avoided in components subject to fluctuating stress.

f) The locking of nuts and pins in position shall be done to the approval of the Engineer.

g) Wearing parts shall be designed for ease of removal and replacement.

3.7 Arrangement and Mounting

The arrangement and general design shall take the following requirements into consideration:

a) Lifting eyes, lugs, hooks, etc., shall be provided on heavy or large items to facilitate handling.

b) Castings or fabrications shall have machined pads for seating and be mounted on either soleplates or baseplates 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.

e) With plant and equipment to be mounted on or against concrete or brick structures built by others, provision shall be made for adjustment in the mechanical design. Any special accuracy requirements must be specified on the Contractor's Documents.

3.8 Prevention of Corrosion

Prevention of corrosion shall be carried out in accordance with SPEC CP.

3.9 Generally

All materials used in the manufacture and construction of plant and equipment shall be new, unused and shall be the best of their respective kinds. The Contractor shall ensure that the materials are selected in accordance with the best engineering practice to suit the working conditions and the extremely corrosive environment.

3.10 Steel

Structural steel shall comply with the requirements of SANS 1431 of the 300 W or 350 W series and shall be legibly marked with the maker's name or trade mark and identification marks.

3.11 Stainless Steel

The grade of stainless steel to be used shall be as specified. Unless otherwise specified, rolled material shall be supplied with a matt, annealed and pickled or otherwise de scaled surface finish. For wrought steels, the equivalent BS 970 grade may in each case be used.

A manufacturer's test certificate shall be provided for each batch of stainless steel giving details of the material analysis and any mechanical tests carried out on the material. Each stainless steel item supplied shall be clearly and permanently marked with the grade of stainless steel and cross referenced to the applicable test certificate.

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.

3.12 3CR12

This is the titanium stabilised, 12 % chrome steel as produced by Columbus Stainless, South Africa.

3CR12 shall always be supplied with an annealed and pickled finish. 3CR12, in cases where it is to be coated, shall be suitably abrasive blasted to ensure adherence of the prime coat.

3.13 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

Particular attention shall be paid to cleanliness, soundness and neat fettling and dressing of castings. Surfaces shall be smooth and irregularities caused by mould washaways, and the presence of porosity, 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 and welding will not be permitted on cast iron castings.

Castings shall be heat treated to provide optimum corrosion resistance and toughness combined with reasonable machinability. In particular stainless steel castings shall be heat treated so as to ensure that all carbides are in solution, to ensure optimum grain size, and to provide maximum corrosion resistance.

The Contractor shall provide a test certificate for each casting or batch of castings, except for those made of grey cast iron, giving details of the material analysis, the heat treatment and any mechanical tests carried out.

5 FABRICATION OF STEELS

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 hollow spaces. 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 SANS 1431 Grade 300W steel.

All surfaces shall be accessible by blast and spray equipment. Practical requirements for providing accessibility for surface preparation and coating shall be taken into consideration. Features which would prevent access to blast material and coating application shall be removed.
Edges shall be rounded so as to be suitable for the coating system to be applied.

The requirements of the clause “Corrosion Protection” shall be followed 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

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 Duplex and 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. These include the following:

BS EN 1011	Arc welding carbon and carbon manganese steelwork.
BS 4677	Arc welding austenitic stainless steel pipework.
BS 2633	Class 1 Arc welding of steel pipework.
BS 2971	Class II Arc welding of steel pipework.
BS 806	Design and construction of ferrous piping in connection with land boilers (used for arc welding specification of all pipe flanges).

Welders shall be experienced 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.

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 INSTALLATION

7.1 General

The Works shall comply with the following:

a) When erected and installed, the plant and equipment shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order

b) The Contractor shall provide all foundation bolts, supports, hangers, brackets, etc. required for the support and fixing of equipment.

c) The Contractor is responsible for grouting work associated with the equipment and pipework to be provided in terms of the Contract.

d) The use of more than three shims in the alignment of equipment will not be permitted. Machined spacers shall be prepared where necessary. Shims and spacers shall be of a corrosion resistant material such as stainless steel.

e) Corrosion protection requirements shall be carefully attended to and the relevant paragraphs of sub-clause "Paint Application" in the clause "Corrosion Protection”) must be noted. All mating faces must be coated before and sealed after assembly.

f) A small amount of a nickel based, anti-seize compound shall be applied along the full length of fastener threads before the nut is applied.

g) Crevices which are formed between two metal surfaces shall, prior to final fastening, be filled with a suitable formable packing, Denso tape or equivalent, or with a suitable mastic or sealant.

7.2 Alignment of Shafts

Shafts for drives with an output above 150 kW shall be aligned to the driven shaft as follows:

a) Final alignment shall be done after installation and before commissioning and shall be checked in the presence of and to the approval of the Engineer. Alignment shall be sufficiently accurate to ensure that no initial 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.

c) The use of pourable epoxy resin chocks (Epocast 36, Chockfast or equivalent) shall be acceptable. If pourable chocks are used, the baseplate feet do not have to be machined but each machine foot shall be provided with a screw for vertical alignment. The chock thickness shall not be less than 20 mm.

8 CIVIL AND BUILDING WORK

8.1 General Duties

The Contractor shall be responsible for building in of 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 to provide the related information in Contractor's Documents timeously.

8.2 Puddle Pipes

The Contractor shall install and build in all puddle pipes and other pipework required to pass through walls of structures unless otherwise specified.

For this purpose, the Contractor shall provide the details of box-outs required in the structure for the pipes in the Contractor's Documents. As stated elsewhere, puddle flanges shall be of the same dimensions as standard flanges and the box-out shall be designed accordingly.

Upon receiving access to the Site, where pipes pass through concrete walls, the Contractor shall install the pipework and shall grout the pipes into the structure using a suitable non-shrink grout approved by the Engineer. The Contractor shall provide a water tight installation and shall be responsible for rectifying any leakage at the puddle pipe.

Where pipes pass through brick walls, the Contractor shall build these in achieving a finish to match the surrounding wall.

8.3 Baseplates, Pipe Supports, Etc.

The design requirements for baseplates and pipework supports are specified elsewhere in the specification

The Contractor shall be responsible for grouting of baseplates, pipe supports, plinths, etc. required for installation of the equipment. This includes any metallic structure which is mounted onto a concrete surface.

8.4 Grouting

8.4.1 General Duties

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.

8.4.2 Approval of Grouting Materials and Methodology

The method proposed for anchoring and grouting equipment into concrete structures shall be submitted to the Engineer for approval and shall incorporate the details of the non-shrink grout proposed. The material used for grouting 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

8.4.3 Building in of Pipework

Pipework shall be firmly secured and checked for movement before shuttering is built. The profile of the soffit shall be prepared so that pockets of air and water will not form on the top surface of the grout. At this point, the Engineer shall be called to inspect the pipe, the cleanliness of the wall penetration and the profile of the soffit. The “letter box” spout shall ensure that at least 100 mm of head is applied to the grout once the pour has been completed and shall also allow entry of a poker vibrator during the pour. The pipework shall be checked a second time for movement after the shuttering is built.

The grout mix and pour shall be done in the presence of the Engineer unless otherwise required.

8.4.4 Grouting of Baseplates, Pipe Supports, etc.

Grout shall be applied only after each anchor fastener has been tested for integrity.

9 PIPE SUPPORTS

Pipe supports to be manufactured from low carbon steel and hot dipped galvanised.

10 STEEL PIPEWORK

10.1 General

Steel pipework shall comply with the following:

a) Pipework shall be joined using bolted flanges.

b) Raised face flanges shall be provided for pipework of PN 25 and higher.

c) Stainless steel and 3CR12 pipes shall be to ASTM A312, ANSI B36.19 or ANSI B36.10 or equivalent.

d) Pipes and fittings shall be neatly installed, straight to line and level and adequately supported.

e) Pipework shall be supported above floor level on supports, racks or wall mounted and shall not be mounted directly on the floor.

f) Pipework shall be configured and provided with couplings and/or bends to allow easy dismantling and disassembly of all pipework without damage to the pipework or pipe supports.

g) Provision shall be made for draining all sections of pipework and for venting where required.

h) These shall be mounted in horizontal lengths of pipework unless this is not feasible.

i) Pipework incorporating couplings shall be correctly anchored to withstand thrust. If the physical configuration does not provide axial restraint of pipework, the couplings shall be provided with harnesses to restrain thrust.

j) 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.

k) Bends, tees and bifurcations shall be kept short; i.e. they shall not be welded to length of straight pipe because this would prevent correct finishing (and inspection) of internal welding.

l) Bends shall preferably be of the smooth radius type.

m) 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.

n) Convergences shall preferably be of swept tee formation rather than tee pieces.

o) Bifurcations on the suction side of centrifugal pumps shall be of swept formation.

p) Pipe couplings shall be provided where misalignment or dismantling must be allowed for and for possible pipe movement from settlement or other cause. The coupling shall have the same or higher pressure rating than the pipework in which it is installed.

q) 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

r) 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. Where harnesses are required, these shall incorporate three tie bars or more. Stainless steel and 3CR12 pipework shall be provided with stainless steel couplings or, where approved by the Engineer, cast iron couplings protected with fusion bonded epoxy. Low carbon steel pipework shall be provided with low carbon couplings protected by fusion bonded epoxy. All fasteners, including studs welded to flanges, shall be of stainless steel.

s) 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.

t) Stainless steel bellows type couplings shall be of EN Grade 1.4401 (316), or better, and shall incorporate stainless steel fasteners. The coupling shall incorporate two stainless steel flanges.

u) Reducers shall have a maximum angle of divergence of 10º unless otherwise shown on the drawings. They shall not have more than two longitudinal weld seams.

v) 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.

w) Flange drilling shall be "off centre" unless required to match an existing flange which is drilled otherwise.

x) 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.

y) Flanged nozzles shall be provided for the installation of gauges, transmitters, drain pipes, cooling water take offs, air release valves, etc. These shall be designed so that the pipework corrosion prevention system can be applied. 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 equipment installation.

z) Carbon steel pipework may be provided with small diameter, EN Grade 1.4401 (316) stainless steel nozzles/nipples which are welded into the pipework. These shall be designed so that the pipework corrosion prevention system can be applied correctly to the carbon steel surfaces and shall overlap onto the stainless steel surfaces.

aa) Nozzles on the suction side of pumps shall be designed and positioned to provide minimum interference with the flow path.

bb) 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.

cc) The puddle pipe shall be a short, 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.

dd) The puddle flange shall be of the same diameter and thickness of a normal flange and shall be positioned in the central plane of the wall. It may be of carbon steel.

ee) The surface not protected by the concrete shall receive the full corrosion protection system and the coating shall extend about 50 mm into the concrete. The area in contact with the concrete shall be largely uncoated. The uncoated area shall be abrasive blasted to promote bonding.

ff) Puddle pipes shall be cast into structures only after the Engineer has approved the Contractor’s proposed method statement for the grouting process

10.2 Requirements for Pump Suction Pipework

The following additional requirements apply:

a) Two mechanical couplings or one rubber tyre type coupling shall be provided on the pump's suction pipework.

b) Pump suction pipework shall comply with good hydraulic design.

c) The pipework on the suction side of pumps shall be sized to ensure that the flow speed is no higher than 1,5 m/s.

d) High points shall be avoided and suction pipework shall be level or shall slope upwards toward the pump. Air leaks shall be avoided/ prevented. Reducers shall be of the eccentric type.

e) Flow straightener shall not be used if there is a probability that the straightener will capture solids.

10.3 Additional Requirements for Pump Discharge Pipework

The following additional requirements apply:

a) Two mechanical couplings or one rubber tyre type coupling shall be provided on the pump's suction pipework.

10.4 Pipework for Flow Meter Chamber

The following additional requirements apply:

a) The pipework within the flow meter chamber shall be provided with a flange adaptor on each side of the flow meter.

b) The pipework shall also make allowance for one downstream isolation valve which is specified elsewhere.

10.5 Pump Suction Bell-Mouths

The following additional requirements apply:

a) 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.

b) The bell mouth shall be provided with an elliptical (i.e. not segmented) profile.

c) The bell mouth may be of glass reinforced plastic, EN Grade 1.4401 (316) stainless steel or of cast iron.

10.6 Fabrication of Steel Pipework

Fabrication shall comply with the Clauses 5 : FABRICATION OF STEELS and 6 : WELDING of this Specification. Welding shall achieve full penetration without crevices and both internal and external runs shall have a neat profile. An internal root run shall be provided where feasible.

10.7 Fabrication of Duplex Stainless Steel Pipes

Duplex stainless steel pipes shall be fabricated in a production facility dedicated to automated production of pipework using mechanised welding procedures; i.e. it shall not be fabricated by the Contractor (or the Contractor's sub-contractor) from plate.

10.8 Corrosion Protection

Corrosion protection shall comply with Specification CP.

10.9 Site Works

The Contractor shall make allowance for the misalignment of other pipework to which the Contractor's pipework is to be connected.

10.10 Inspections

The Contractor shall make all arrangements and carry all costs for the Engineer to inspect the pipework after fabrication but before any corrosion protection.
The following actions are required:

a) Pre-manufacturing meetings and 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. Where dispute arises regarding acceptance of welds, the requirements of SANS 10044 Part 3 shall be complied with.

e) Paint thickness measurements.

f) Reporting on inspections.

10.11 Testing Requirements

All welds shall be tested for cracks using the dye penetrant method.

Pipelines which are not fully visible and/or below ground shall be pressure tested to 1.5 time's maximum working pressure for at least 15 minutes without pressure loss. This shall be done before covering up the pipeline in any way where applicable and shall be witnessed by the Engineer.

11 BASEPLATES

11.1 General

Equipment and drivers shall not be mounted directly onto a concrete base without the use of either a baseplate or soleplate.

Driven equipment and their drivers shall be mounted on common cast iron or fabricated steel baseplates of rigid construction. Common baseplates shall be provided for direct coupled and for belt driven machines.

In applications where baseplates are not practical, machined soleplates, suitably fixed and grouted into the concrete plinths, shall be provided

The Contractor shall provide the baseplate, anchor fasteners and chemical anchor for securing the fasteners.

11.2 Design Requirements

Baseplates shall prevent pooling of water and shall be grout filled or shall be provided with drain holes in all side members.

The baseplate shall incorporate machined mounting pads at the support and fixing positions of each item of plant and equipment to be mounted on the baseplate. On fabricated baseplates this machining shall be done after fabrication, stress relieving (if applicable) and hot-dip galvanizing are complete. The thickness of the mounting pads shall be not less than 1,25 times the diameter of the holding down bolts. The pads shall not be provided with threaded holes for machine screws but shall be drilled for inserting through bolts and adequate provision shall made for reaching the nut with a suitable spanner. In the period between machining and installation of the equipment, the machined surface shall be protected against corrosion by a removable coating. After installation, a non-hardening compound, Tectyl or equivalent, shall be applied to exposed machined surfaces and to the crevice formed at the foot of the equipment. The above design may be suitably modified if the Contractor uses a pourable resin based chocking system. Such chocks shall be at least 15 mm thick.

At least two diagonally opposed jacking screws shall be provided for belt tensioning in the case of belt driven units. Direct coupled motors above 10 kW shall be provided with jacking screws for horizontal alignment and direct coupled motors above 150 kW shall be provided with jacking screws for vertical alignment as well. Jacking screws shall be of EN Grade 1.4401 (316), or better. Drilled and tapped flat plate is not acceptable for jacking points. A jacking point shall consist of a suitable hot rolled steel section welded to the baseplate and with a captured machine nut to accept the jacking screw.

11.3 Fabrication

Fabrication shall comply with the clause “Fabrication of Steels” and welding shall comply with the clause “Welding”.

Baseplates shall be manufactured of either:

- hot rolled steel sections.
- bent plate (with the overall length not more than 200 X plate thickness).

Practical requirements for providing accessibility for surface preparation and coating shall be taken into consideration. Inaccessible pockets shall be avoided. Hollow spaces which cannot be accessed by blast and spray equipment shall be avoided or shall be welded closed. All such hidden surfaces shall not be permitted.

Inspections of carbon steel fabrications will generally be done after fabrication is complete.

11.4 Materials

Baseplates shall be fabricated from Grade X42 steel.

11.5 Corrosion Protection

Steel baseplates shall be hot dip galvanized.

The requirements of the clause "Corrosion Protection" shall be followed if the item is to be hot-dip galvanised. Designs shall provide proper access for safe and proper entry of the zinc into open spaces so that subsequent drilling at the galvaniser's yard is avoided

11.6 Fasteners

Anchor fasteners shall be of EN Grade 1.4401 (316), or better. Fasteners shall comply with the clause "Fasteners".
A minimum of six anchors shall be provided for pumps with an inlet of DN 150 and smaller.
Eight or more anchors shall be provided for pumps with an inlet larger than DN 150.

Pumps with an inlet of DN 100 or smaller shall have anchor bolts of at least 12 mm. Pumps with an inlet larger than DN 100 shall have anchor bolts with a diameter no less than 12 + (Ø-100)/25.

11.7 Installation

Not more than three shims may be used at any point and these must be made of a corrosion resistant material.
Concrete surfaces under baseplates shall be scabbled before the baseplate is placed and shall be blow clean using compressed air immediately before grouting.

Baseplates shall be designed and grouted to eliminate collection points for water or dirt. Except where otherwise approved in writing by the Engineer, all baseplates on concrete plinths shall be fully grouted in. Grouting holes must be provided on baseplates having a continuous top plate. Tapped holes and fixing setscrew protrusions shall be suitably protected. The material used for grouting shall be a non-shrink, cementitious grout (ABE Duragrout 1000, or equivalent). ABE Epidermix 324, or equivalent, is acceptable if the Contractor's design requires an epoxy grout to be used. The initial grouting shall be overseen by the grout supplier's technical representative.

Preliminary alignment of equipment mounted on baseplates shall be done at the factory to ensure that the baseplate has been correctly manufactured, but final alignment shall always be done on Site after installation and grouting has been completed. Alignment shall be accurate and to the approval of the Engineer and a final alignment check witnessed by the Engineer must be carried out by the Contractor prior to start up.

11.8 Inspections

The Contractor shall arrange for the Engineer to inspect the fabrication of the baseplate before it is hot dip galvanised

12 MACHINE GUARDS

Guards shall comply in all respects with the Occupational Health and Safety Act of 1993 as amended and the following points shall also be noted:

Guards are required to cover all moving or revolving components of machinery. Guards which do not adequately cover moving protrusions such as keys, lock nuts, lockwashers, setscrews, etc., or irregularities such as keyways, will under no circumstances be accepted. Guards shall be neatly and rigidly constructed and fixed and shall not vibrate or cause noise during operation.

Where expanded metal or similar mesh is used, the mesh opening shall not permit a circular object 10 mm or larger to penetrate.

Mesh shall not be used for chain guards but on belt drives the side of the guard most conveniently sited for inspection shall be constructed of expanded metal or similar. Mesh should similarly be used in other situations where inspection or ventilation is required

Guards shall completely enclose drives and shall entirely prevent a person from touching any moving protrusion. Allowance must be made for adjustment on belt guards or where adjustment will be required. It shall be possible to remove the guard easily for maintenance purposes.

Guards shall preferably be fabricated of 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.

13 SHAFT COUPLINGS

Shaft couplings shall be selected to reduce transmission of misalignment forces and of torsional oscillations between the driving and 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 in all cases where this will assist maintenance.
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.

14 BEARINGS

14.1 Operation

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.

Rotational bearings shall be designed to rotate in either direction unless the design prevents reverse rotation.

14.2 Design Life for Rolling Element Bearings

Ball and roller bearings shall generally be selected for a design life of 100 000 – 200 000 hours; i.e. the bearing manufacturer's category for machines required to work with a high degree of reliability 24 hours per day.

For shaft sizes above 50 mm, the L-10 bearing life shall be 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.

14.3 Plain Bearings

Plain bearings; i.e. bearings also referred to as "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.

Run down, including run down after a power failure, shall be managed without damage to the bearing.

14.4 Bearing Choice

Bearings shall be chosen primarily to suit the equipment manufacturer's requirements and the plant's design conditions but the following guidelines shall be considered:

a) Greased lubricated bearings are generally acceptable for units with power ratings up to 100 kW.

b) Units with power ratings between 100 kW and 1 000 kW shall preferably be provided with rolling element bearings.

c) Units with high speed shafts, with power ratings above 1 000 kW and with high temperature applications shall preferably be provided with plain bearings (oil film type).

14.5 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:

Ttrip = Tequilibrium + (40ºC -Tambient) + 10ºC. This assumes that the bearing is operating correctly.

15 GUARD RAILS

15.1 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.

15.2 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.

15.3 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 just prior to final tightening of nuts.

Where kickplates are required by legislation, these shall extend to 150 mm above the walkway level.

15.4 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 must also be complied with:

a) The structural design shall be done in accordance with the requirements of SANS 10104.

No opening in guard railing installed in public places shall allow the passage of a ball of 100 mm diameter.

15.5 Carbon Steel Guard Rails

Fabrication and welding shall comply with the clauses “Fabrication of Steels” and “Welding”. The guard rails shall be hot-dip galvanised in accordance with the clause “Corrosion Protection”.

Designs shall provide proper access for safe and proper 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.

15.6 Stainless Steel and 3CR12 Guard Rails

Fabrication and welding shall comply with the clauses “Fabrication of Steels” and “Welding”.

15.7 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.

16 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 made and fully banded before any corrosion protection is done. The edges of removable grid access covers must also be fully banded.

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. 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

17 FASTENERS

17.1 Standards

Bolts and nuts shall be hexagon head type complying with SANS 1700 with threads of the coarse pitch series.

17.2 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.

17.3 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.

17.4 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.
Submerged anchors shall be secured with chemical anchor designed for submersion.

17.5 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.

17.6 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.

17.7 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 shall be cleaned off.

17.8 Thread Projection

Bolt threads shall project no less than 3 threads 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.

17.9 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.

18 SIGNAGE

18.1 General

All signs as specified below shall be installed prior to commissioning.

18.2 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.

18.3 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

19 PERFORMANCE ACCEPTANCE TESTING

The complete system shall be tested for compliance with the specified requirements for the operation and control system over a period of at least three consecutive days.

The works shall operate in accordance with the clause “Operation and Control” and the Contractor shall demonstrate this to the Engineer.

The Works shall be tested as specified in the Project Specifications or in FIDIC General Conditions (where this is the applicable General Conditions of Contract). Testing shall precede the start of the Trial Operation Period.

20 COMMISSIONING

20.1 General

The Contractor shall advise the Engineer when instructions may be given to the Building Contractor to execute any necessary screeding and finishing around the Works. Contractors shall allow a reasonable period in their installation programme for this work to be done and no compensation for delay in the commencement of testing and commissioning shall accrue to the Contractor during such period.

20.2 Preparation

Installation work shall be complete and approved by the Engineer prior to commissioning.
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.

20.3 Starting Up and Testing

The Contractor shall arrange for the Engineer to be present at initial start up and also for any 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.

20.4 SCADA System

During commissioning of a new installation which incorporates SCADA as part of the control system, 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.

20.5 Commissioning

When all tests have been completed to the satisfaction of the Engineer, the Works shall be commissioned. Unless the Engineer states otherwise, the complete plant, including all control functions and control systems shall be commissioned as a unit and the process performance requirements shall be achieved during normal operation.

Once the Works has been commissioned to the satisfaction of the Engineer, the Trial Operation Period shall start and shall consist of a continuous period of operation free from trouble. During the Trial Operation Period, the Contractor shall carry out all necessary servicing and any adjustments required. The plant staff will assist the Contractor in operating the Works during this period. The Contractor shall train the operational staff in the starting, operating and stopping of the Works, and shall train the maintenance staff on the routine maintenance requirements.

20.6 Commissioning Report

A comprehensive commissioning test report, including the SCADA system commissioning procedure and schedule of alarm messages, shall be submitted by the Contractor prior to issue of the Taking-Over Certificate and shall be inserted in the Manual.

20.7 Inspection

At the end of the Trial Operation Period, an inspection shall be done by the Contractor and the Engineer for the purpose of taking over the Works in terms of Clause 10 of the General Conditions of Contract.

20.8 Defects Liability

Refer to Clause 11 of the General Conditions of Contract for the Contractor's responsibility during the 365 day Defects Notification Period.

20.9 Trial Operation Period

The Trial Operation Period for the Works shall be 28 days unless otherwise specified in the Appendix to Tender or Project Specifications or as scheduled in the Bill of Quantities.

21 OPERATING & MAINTENANCE MANUAL

21.1 Submission of Manual

Two hard copies of the draft manual shall be made available to the Engineer for comment and approval at least 4 weeks prior to commencement of commissioning tests.

Six hard copies, each with an e-copy on enclosed CD of the final approved version shall be provided prior to the start of the Trial Operating Period.

21.2 General Requirements

The Manual shall comply with the following:

- Be for the works as a whole;
- Shall be in English
- The Manual containing the various Manufacturers' original documents shall be marked 'Original' and all the others shall be marked 'Copy 2', 'Copy 3', etc
- The Manuals shall be presented in hard plastic binders which have four-ring lever-arch holders. A laminate coated label on the spine of each file shall indicate Project name, Contractor's name, Contract Number, O&M Title, Volume No and Date.
- Sections shall be provided with labelled plastic separator sheets.
- Manufacturers' product brochures, where covering a range of products, shall be marked to show which particular model has been installed.
- Reduced-size drawings shall be of a size that the text can still be easily read.
- Cross-referencing is acceptable to avoid duplication.

21.3 Format and Contents

The Manual shall be set-out generally as follows:

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	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	Operating System	Description of the operating system containing: Start-up, adjustment, operating and shut-down procedures for manual and automatic operation - Emergency operating procedures - Process verification - Settings, setpoints, protection, alarms and trips. This document shall be suitable for using as a Training Manual.
2.2	Commissioning	Commissioning results.
3	**Maintenance Schedule**	
	Maintenance and Lubrication	Schedule of routine maintenance for all **mechanical**, **electrical**, **instrumentation** and **control** equipment, broken down in daily, weekly, monthly, annual periods, etc. The schedule shall be all-inclusive but may refer to manufacturer's standard manuals in other parts of the Manual. The schedule shall include **all** lubrication periods, lubricants and capacities.
4	**Mechanical Equipment**	
4.1	Mechanical Equipment Item 1 (e.g. Pumps)	- The make, model, serial number, description, size, design range, performance data, motor and drive details and supplier's details of the item. - Dimensioned drawing. - A photograph of the nameplate. - Manufacturer's operating and maintenance manual. - Operating curves, test results, etc.
4.2	Equipment Item 2 (e.g. Mixers)	Ditto
4.3	etc.	Ditto
5	**Electrical Equipment**	
5.1	Elec. Equip. Item 1 (e.g. MCC Panels)	As for 4.1 above; *PLUS:* Control and electrical details, including logic sequence, circuit diagrams and software, as applicable - Electrical reticulation drawings - Equipment overall dimensions - Wiring diagrams - Switchboard layout drawings - SLDs.
5.2	Elec. Equip. (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:* Circuit diagrams of instrumentation systems and of individual instruments - Installation arrangement - Normal operating range - Calibration procedures.
6.2	Equip. Item 2 (e.g. level)	ditto
7	**Control**	
7.1	Identifying Information	Make and model of PLCs, transmitters, HMIs, computers, etc.; copied from the Equipment List.
7.2	I/O List	Cross-referenced listing of all I/Os used.
7.3	SCADA	Colour prints of SCADA mimic screens, control faceplates, sequences and trend screens. Schedule of alarm messages and TAG lists. File structures, lists and naming conventions.
7.4	Program	An annotated program listing. CDs containing all software. Loop and logic diagrams for each PLC. System control diagram and logic sequence chart.
7.5	Documents	Schedule of cable terminals. Copy of SCADA hardware diagnostic mimic.
8	**Documents**	
8.1	Drawings	All as-built Contractor's drawings, including MFDs, P&IDs, electrical panel construction drawings, etc.
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	List of spares provided in terms of this Contract - Certificate of electrical compliance - Corrosion protection systems used - Coating supplier's data sheets and coating repair procedures.

22 TRAINING

22.1 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 starting, operating and stopping of the plant and shall train the Employer's maintenance staff on the maintenance requirements and procedures.

The Contractor shall also provide each trainee with printed copies of the Operating and Training Manual which forms part of the Installation, Operation and Maintenance Manual.

22.2 Operational and Maintenance Tuition

The Contractor shall provide the following tuition to 4 operational staff members and 4 maintenance staff members (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. The instructions described in (a) above shall also be provided in printed form for each Operator.

c) If the specified control system is SCADA based, the tuition shall include instruction on the SCADA system.

22.3 Electrical Engineering Staff Tuition

The Contractor shall provide the following tuition (as applicable to the Contract):

a) Control system software instruction.

b) Detailed overview of 11 kV protection and settings (if applicable).

c) Tuition on setting of 11 kV protection (if applicable).

d) Motor protection relay and settings.

e) Overview of PLC programming for the purposes of making changes and re loading programs if PLCs are replaced.

f) Overview of SCADA system.

22.4 Certificates

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.

23 PAYMENT

23.1 General

For the purposes of payment, the work scheduled in the mechanical portion of the Bill of Quantities is grouped into the following categories:

- Design and submission of documentation for approval;
- Fabrication / manufacture / procure
- Delivery and off-loading on Site;
- Installation;
- Commissioning;
- Supply of O&M manuals;
- Trial Operating Period;
- Training;
- Storage;
- Servicing Visits;
- Spares

Please note that all Preliminary and General costs are scheduled in the Civil Works section of the Bill of Quantities.

23.2 Design and submission of documentation for approval

Unit: .... Sum
The tendered sum shall cover the cost of the design of the Works and the provision of the Contractor's documents for approval.

23.3 Fabrication / manufacture / procure

Unit: ....No or Sum

The tendered rate or sum shall cover the cost of the supply of the goods, testing as specified and as required by Act No. 85, provision of test certificates certifying compliance of the goods with SANS, IEC, ISO or BS standards, corrosion protection, if designated and not scheduled separately, and supply of all special tools and keys specified. The tendered rate shall include the cost of witness testing by the Engineer where this is required in terms of the Scope of Work.

Payment for supply of the relevant equipment will not be effected until the draft copies of the related sections of the Operation and Maintenance Manuals have been submitted.

23.4 Delivery and off-loading on Site

Unit: .... Sum

The tendered rate or sum shall cover the cost of delivery of the goods and offloading (including any cranage costs) at the delivery point stated in the Scope of Work or at the Site.

Where a rate or sum has been tendered for delivery of goods which are then stored, the Engineer at his sole discretion may certify an amount for partial or full payment of the relevant item, if in the Engineer's opinion such a payment is justified by reason of the transportation of such goods to their place of storage

23.5 Installation

Unit: .... Sum

The tendered rate or sum shall cover the cost of all necessary site oriented activities such as handling at the Site, storing, sorting, erecting, all painting, pre-commissioning tests (unless scheduled separately), including all costs of transport of personnel and their erection gear to Site, and the cost of all materials. Where pipes are required to pass through walls of structures constructed by others, and where openings have been provided for this purpose, the installation sum shall include for building/grouting the pipe into the wall and finishing to match the surrounding structure. Where items of equipment are to be grouted in (such as for anchors and pumpset base plates), the installation sum shall include for such work.

23.6 Commissioning

Unit: .... Sum

The tendered rate or sum shall cover the cost of pre-commissioning and commissioning tests, including putting the whole of the Works into operation, and including all costs of transport to and from the Site, and Site accommodation of personnel and their gear. The cost of process chemicals required for production of any product of the Works (such as coagulants and chlorine), shall be borne by the Employer.

23.7 Supply of O&M manuals

Unit: .... Sum

The tendered rate or sum shall cover the cost of preparing and submitting the required number of O&M Manuals in the required format to the Engineer.

23.8 Trial Operating Period

Unit: .... Sum

The tendered rate or sum shall cover the cost of trial operation tests, including all costs of transport to and from the Site, and Site accommodation of personnel and their gear. The cost of process chemicals required for production of any product of the Works (such as coagulants and chlorine), shall be borne by the Employer.

23.9 Training

Unit: .... Sum

The tendered rate or sum shall cover the cost of training the Employer’s operating and maintenance staff as set out in clause 22.

23.10 Storage

No separate payment will be made for storage. All costs associated with the need to temporarily store equipment shall be deemed to be included in the scheduled rates.

23.11 Corrosion protection and painting

No separate item is included in the Bill of Quantities for the cost of surface preparation, supply and application of the corrosion protection material, site repairs to paintwork, the provision of inspection equipment and the cost of the Contractors quality surveillance and his independent inspectorate. The total cost of corrosion protection as specified above shall be included in the cost of supply of the item.

23.12 Servicing Visits

Unit: .... No of Visits

The tendered rate or sum shall exclude the cost of providing lubricants but shall cover the cost of any servicing visits and operations specified. Payment of 95% of the tendered amount will become due monthly on a pro rata basis or after each visit, as the case may be. The remaining 5% will be regarded as Retention Money and paid at the end of the Defects Notification Period.

23.13 Spares

Unit: ....No or Sum

The tendered rate or sum shall cover the cost of the supply and delivery of the specified spares.

PARTICULAR SPECIFICATION: WATER TREATMENT

PF: PRESSURE FILTERS

PARTICULAR SPECIFICATION: PF: PRESSURE FILTERS

CONTENTS

1 SCOPE

This specification deals with the general requirements for the design, supply, delivery, installation and testing of downflow single sand media pressure filters for the production of potable water.

2 INTERPRETATION

2.1 References

2.1.1 Supporting Specifications

This Specification is to be read in conjunction with the following specifications (where included in the Contract document):

(a)	SPEC MG	:	GENERAL MECHANICAL
(b)	SPEC GP	:	GENERAL PUMPS
(c)	SPEC CP	:	CORROSION PROTECTION

2.2 Application

This specification contains clauses that are generally applicable to mechanical engineering construction. Interpretations of and modifications to this specification are set out in the Project Specifications which precedes this specification in the contract document.

2.3 Definitions and abbreviations

For the purposes of this specification the definitions and abbreviations given in the applicable specifications listed in 2.1.1(b) to (f) and the following definitions shall apply:

- **Filtration rate**

  The flow of filtered water passing through the filter, measured as volume per surface area of filter per hour.

- **Filter media**

  Sand or treated glass media conforming to the effective size and particle uniformity coefficient specified.

- **Effective size (D_{10})**

  The size (read from a sieve analysis) for which 10 percent of the filter media grains are smaller by weight.

- **Uniformity Coefficient**

  A measure of the size range of the filter media grains. Calculated from the ratio of D60 divided by $\mathbf{D_{10}}$, where $\mathbf{D_{60}}$ is the size (read from the sieve analysis) for which 60% of filter media grains are smaller by weight.

- **Backwash cycle**

  The system used for cleaning the filters by means of a reverse flow of water and/or air.

- **PLC**

  A Programmable Logic Controller is used to control the automated filter and backwash process.

- **STP**

  Standard Temperature and Pressure (25° Celsius and 1,0 Bar)

- **NTU**

  Nephelometric Turbidity Unit

3 DESIGN, MATERIALS AND MANUFACTURE

3.1 Design rate of flow

The design maximum and minimum range of flows are given in the Project Specifications.

It should be noted that the raw water inflow will be augmented with recycled water drawn from the supernatant overflow from a sludge settling and holding tank. The latter receives flows from the clarifier desludging hoppers and spent backwash water from the filters. The recycled water is added upstream of the flow regulating valve and, being pumped from a balancing tank, is intermittent in nature. Being upstream of the flow regulating valve, the rate of flow through the dosing point and clarifiers is, however, constant (except when minor adjustments are made to balance works output with demand).

The flow of settled water into the balancing tank feeding the filters will thus be constant and effectively equal to the daily water demand plus the daily volume of backwash water (the nett loss of liquid from the waterworks is limited to that lost with dewatered sludge and thus effectively minimal as a percentage of the daily flow).

3.2 Design Overview

The filter system shall be designed to operate as follows:

- Unless otherwise specified in the Project Specifications, the filters shall operate automatically on a fixed flow rate basis (ie stop / starting according to water level in settled water balancing tank).

- Unless otherwise specified in the Project Specifications, at least 3 pressure filter units shall be provided (depending on the daily volume of settled water to filter) but with the proviso that the individual filter units shall not exceed a filtration capacity of 50 m^3/h at the specified design loading rate (the latter criterion will govern the number of units for a works larger than about 3 Ml/d).
- The water for backwashing shall be drawn from filtered water; either as a separate backwashing pump drawing from the filtered water delivery pipe into each filter in turn or by diverting the pressurised filtrate from several other filters through the filter being backwashed (ie no separate filter feed pumps and backwash pumps).
- Unless otherwise specified in the Project Specifications, the filtration design loading rate shall not exceed 6,0 m/h with all filters in operation.
- Filter washing shall be by means of a reverse flow of air followed by water. The backwash system shall be designed to efficiently and effectively dislodge and flush-out all filtered solids embedded throughout the full width and depth of the media bed.
- Unless otherwise specified in the Project Specifications, the air scour loading rate shall be within the limits of 25 m/h to 35 m/h at 25^{o}C and 30 kPa.
- Unless otherwise specified in the Project Specifications, the backwash water loading rate shall be within the limits of 20 m/h to 25 m/h.
- All filters shall be backwashed once a day.
- A rinse cycle after backwashing is not required.
- The filter and backwash cycle shall be controlled by means of a PLC.
- All filter inlet / outlet / backwash / scour valves shall be electrically-actuated quarter-turn ball valves. The PLC shall be programmed to raise an alarm if any of the actuated valves does not open or close fully (ie actuators to provide an appropriate positioning signals to PLC).

3.3 Filter media

Apart from an optional gravel support layer, the filter media shall be a single layer at least 800mm in depth.

Sand media shall be clean hard sand with a uniformity co-efficient not greater than 1,4 and effective size between 0,5 mm and 1,0 mm unless otherwise stated in the Project Specifications.

Prior to delivery of the filter media, a 10 kg sample shall be submitted to the Engineer for approval; together with a grading analysis carried out by an accredited laboratory. The media shall not be delivered to Site until such approval has been received. Such approval shall not relieve the Contractor of his obligation to provide filter media that complies with the specification.

3.4 Pressure vessels

Pressure vessels shall be designed to withstand the pressure developed in the system and shall be capable of withstanding twice the shut-off head of the filter supply pumps or washwater pumps whichever is the greater. Vessels shall have dished ends and all connections to the vessel shall be flanged. The vessels shall be fitted with pressure gauges mounted in an appropriate position for ease of Operator reading and shall accurately reflect the internal pressure each side of the media.

The pressure vessel shall contain flanged access ports above and below the filter floor and of sufficient size for adequate access into the upper and lower chambers.

The pressure vessels shall be free-standing units supported on 4 stout legs of sufficient height for easy access to a lower chamber access port and for the pipework connecting multiple filters to pass under the filters where appropriate.

The lowest point in the filter vessel shall include a flanged port for emptying the vessel.

The highest point shall include a flanged port for fitting an double-acting air valve.

Unless otherwise specified in the Project Specification, the pressure vessel and filter floor inside shall be fabricated from GRP.

Welding shall be carried out by welders who are qualified and experienced in the particular material. Certification and quality control of the welders and their work shall be as specified in SPEC MG: GENERAL MECHANICAL

3.5 Filter floor and nozzles

Filter floor shall consist of a robust false floor plate with holes for inserting and securing polypropylene purpose-designed nozzles. The nozzles and their spacing shall be designed to provide a uniform draw-off of filtered water and positive control of backwash water and air and shall provide an even distribution of washwater and air scour over the whole filter area. The slots in the nozzles shall be tapered (non-clogging wedge profile to create slots) with outer edge of slot 0,2mm width or as otherwise specified in the Project Specification. The nozzle spacing shall not exceed 150mm c/c.

The filter floor with the nozzles in place shall be designed to quickly purge all remaining air under the filter floor and in the nozzles before or at the commencement of the wash water flushing phase.

Great care shall be taken at all stages of fabrication, testing and commissioning of the entire filtration system to ensure that the interior of the filter vessels, pipe manifolds and supply tanks are kept free of fine grit and debris so as to avoid dirt being lodged in the inside the nozzle wedge-shaped slots on first start-up of the backwash pumps. The system feeding the underside of the filters shall be thoroughly flushed with clean water before water is forced up through the nozzles in backwash mode.

3.6 Air Blowers

Compressed air for air scour shall be provided by electrically powered, double-belt driven Roots-type positive-displacement air blowers. These shall incorporate the following features:

- One Duty and one Standby unit shall be provided.
- The delivery manifold shall incorporate an adjustable pressure-relief blow-off valve upstream of the unit isolating valve.
- An air pressure gauge on the blower delivery manifold shall be provided. This shall be marked with the design operating air pressure and design blow-off air pressure.

- Each blower unit shall be enclosed in a sound-attenuating hood which limits the sound pressure (measured 10m away) to less than 90 dB.
- Air scour manifolds shall incorporate an anti-flooding device to safeguard the compressors from water ingress.
- Provision shall be made for bleeding of air from the air scour piping at the start of air scour to prevent transient high velocities developing in the filter bed.

3.7 Filter feed and backwash pumps, pipework and flow meters

The filter feed and backwash pumps shall incorporate the following features:

- One Duty and one Standby unit shall be provided.
- Conform to the general requirements of Spec GP.
- Variable speed drive controlled or other means to achieve design flow rate.
- Maximum speed of 1450 rpm.

The filter system shall be fitted with pressure gauges and transducers that shall indicate the inlet pressure to the filters, the outlet pressure and the head loss across the filter bank.

An electro-magnetic flow meter to measure the rate of flow of filtered water shall be provided together with an integrator and recorder for recording and integrating the rate of flow. This shall be fitted to the filtered water rising main to the chlorine contact tank or as indicated on the P&ID.

An electro-magnetic flow meter to measure the rate of flow of backwash water shall be provided together with an integrator and recorder for recording and integrating the rate of flow. This may be fitted to the backwash water rising main to the head of works.

3.8 Filter inlet / outlet / scour manifolds

Unless otherwise specified, the manifolds shall be fabricated from 'Medium Weight' flanged 304SS piping with mild or cast steel FBE coated restrained dismantling couplings. The pipework jointing system shall be designed such that there are sufficient bolted flange joints and adjustable dismantling couplings to be able to remove all fittings such as valves without having to cut any pipes.

The pipework shall be fully supported and braced. Drawings of the proposed pipework layout shall be submitted to the Engineer for approval before fabrication. The drawings shall show where filtered water samples can be drawn-off by the Operator.

3.9 Air compressor for pneumatic actuated valves (if specified in Project Spec)

Compressed air for pneumatically actuated valves on the pressure filters shall be provided by electrically powered, double V-belt driven, air cooled reciprocal motion positive-displacement air compressors.

As the backwashing sequence of the filters cannot practically be done manually without the use of the pneumatic actuators, the air compressors feeding the actuators are 'mission critical' elements and therefore shall be selected and installed to be as robust and reliable as possible.

These shall incorporate the following features:

- One Duty and one Standby unit shall be provided.
- The free-standing modular units shall be heavy-duty, robust industrial-grade machines manufactured by an approved, recognised reputable manufacturer and which is readily available and supported locally.
- The maximum pressure that the compressor can deliver shall be at least 50% higher than the pressure the actuator manufacturer recommends for optimal operation.
- The compressor shall be sized to operate for no longer than 10 minutes (accumulative running time) per complete backwash cycle per filter.
- The air compressor operating speed shall be less than 75% of manufacturer's rated maximum speed.
- The air receiver volume shall be sized to provide seamless operation of the actuators for one complete backwash cycle where the motor cut-out pressure does not have to exceed 1 Bar above the pneumatic actuator operating pressure.
- The suction manifold shall include one large capacity washable air filter unit per cylinder.
- The air receiver shall incorporate:
    - A protective pressure-relief blow-off valve;
    - An air pressure gauge;
    - An adjustable pressure switch to regulate the electrical motor to automatically keep the pressure in the air receiver between selected upper and lower limits.
    - An adjustable pressure-regulating valve (to set a constant delivery pressure to the valve actuators) complete with downstream pressure gauge;
    - A device to ensure that only dry air enters the compressed air reticulation pipework;
    - A device which automatically drains all water condensation from the air receiver;
    - An in-line filter on the compressed air delivery which removes solid particles greater than 0,1 micron in size complete with clearly visible indication when the filter element needs replacing.
    - A normally-closed electrical solenoid actuated isolating valve that only opens when the filter controlling PLC calls for pneumatic actuation (this is to prevent excessive running time of the compressor should minor leaks develop on the air reticulation system).

Reticulation pipework between the compressors to the filters shall be fabricated from Grade 304 or 316 stainless steel. Short sections of flexible (non-metallic pressure piping) shall be used between the air receiver and the fixed-in-place compressed air reticulation and between the latter and the pneumatic actuators.

4 PLANT

4.1 General

The Contractor shall provide all plant that is necessary to off-load, install, test and commission all items covered in this specification.

4.2 Handling and rigging

The plant and rigging equipment used by the Contractor for the handling and placing of filters, pumps, motors, valves and pipes shall be such that no installed equipment is over-stressed during any operation.

4.3 Setting out

The Contractor may use any acceptable device to control the installation and alignment of the filters, pumps, etc.

4.4 Temporary supports

The Contractor shall provide such temporary supports as are necessary, in the vicinity of the position of permanent supports, to ensure that pipe work, valves and filters are installed true to level and adjustment.

4.5 Testing

The equipment provided by the Contractor for testing shall include the pressure gauges, calibrated storage tank, and the necessary tools and fittings required for the performance of the tests given in 7.

5 INSTALLATION AND OPERATING REQUIREMENTS

5.1 General

Unless otherwise specified in the Project Specification the terms of SPEC MG General Mechanical shall apply.

6 TOLERANCES

6.1 General

Unless otherwise specified in the Project Specification, the terms of SPEC MG General Mechanical shall apply.

7 TESTING / COMMISSIONING

The following tests shall be carried out on the equipment and materials.

7.1 Filter feed and backwash pumps

The pumps shall be tested in accordance with SPEC GP: General Pumps.

7.2 Backwash air blowers

The air blowers shall be tested after installation to demonstrate their compliance with the specification.

7.3 Air compressors

The air compressors shall be tested after installation to demonstrate their compliance with the specification.

7.4 Operation of the filters

For commissioning acceptance, the Contractor shall demonstrate to the Engineer that the filter system as a whole:

- Successfully goes through the 'as-designed' full backwashing sequence for each filter in all three modes (full auto, partial auto and manually controlled);
- The turbidity of the filtered water consistently remains below 1 NTU over a 24h period where the incoming settled water turbidity is maintained between the limits of 3 NTU and 8 NTU by manipulation of the chemical dosing settings or as otherwise agreed with the Engineer.

7.5 Filter and washwater pipework (Pressure test)

After installation of all filter piping, each of the filter pipework manifolds (filter feedwater, filter backwash feed water, filtered water outlet, spent backwash water outlet pipework shall be tested as follows:-

The system shall be filled with water and all outlet valves on the filters shall be closed. The filter feed pump shall be run. Any leaks which occur in the piping shall be repaired at the Contractor's expense. This shall be repeated for the backwash feed water pipework.

7.6 Air scour piping

During operation of the air blowers all joints shall be examined for leaks by means of a soap test. Any leaks shall be repaired at the Contractor's expense.

7.7 Testing of filter effluent quality and operation

During the commissioning and running in period the plant shall be run at the nominal design loading. Composite samples of the filter influent and effluent shall be taken and the time period between backwashes and washwater consumption shall be monitored to demonstrate that the filter effluent and filter operation complies with the specification.

8 MEASUREMENT AND PAYMENT

8.1 General

Payment shall be in terms of the relevant clauses of SPEC MG: GENERAL MECHANICAL, except for the provisions of 8.2 hereunder.

8.2 Water tightness and performance testing

No separate payment for water tightness or performance testing will be measured for payment. The costs of all such tests is deemed to be included in the installation and commissioning rates. Water for carrying out the tests will be provided free of charge by the Employer.

PARTICULAR SPECIFICATION

QB GENERAL BUILDING MATERIALS AND WORKMANSHIP

PARTICULAR SPECIFICATION: QB GENERAL BUILDING MATERIALS AND WORKMANSHIP

CONTENTS

1 SCOPE

This Specification covers the requirements for materials and workmanship in the construction of general building work. Materials and construction techniques required by the Bill of Quantities or the Drawings which are not covered by a Clause in this Specification shall be supplied and constructed strictly in terms of the appropriate Clause or Clauses of the Standard Building Regulations.

2 NORMATIVE REFERENCES

National Standard Building Regulations

3 REQUIREMENTS

3.1 Alterations

Tenderers are advised to visit the site prior to tendering and satisfy themselves as to the nature and extent of the work to be done, also examine the condition of all existing buildings as no claim will be entertained on the grounds of ignorance of the conditions under which the work was to be executed.

3.1.1 MATERIALS FROM ALTERATIONS

Unless otherwise stated, all materials from alterations will become the property of the Employer and items described as "removed" shall mean removed from the site. All these materials, together with all rubbish and debris must be carried away and the site left clean and unencumbered.

Items described as to be re-used or to be handed over to the Employer are to be dismantled where necessary and stacked on site where directed, and the Contractor will be responsible for their removal and storage until required, and shall make good all items missing, damaged or broken at his own expense.

Unless otherwise described, no materials from the alterations shall be re -used in any new work without the written approval of the Employer.

In taking down and removing existing work, particular care must be taken to avoid any structural or other damage to the remaining portions of the buildings.

3.1.2 NOTICE OF DISCONNECTIONS

The Contractor is to give ample notice to the Employer regarding any disconnections necessary prior to the removal or interruption of electrical or telephone cables, water supply and sanitary services, etc.

3.1.3 DUST

The Contractor is to allow in his rates for taking all precautions necessary to prevent any nuisance from dust whilst carrying out the works.

3.1.4 SHORING

Rates for shoring are to include for the use and waste of all props, needles, wedges, braces, nails and screws, etc., required and for all cutting, notching, framing and fitting, maintaining in position for the required periods and removing at completion. All shoring is to be executed in a manner approved by the Employer.

3.1.5 MATCHING EXISTING WORK

The terms "make good" or "making good" to existing work as described in the items shall mean making good with materials to match, all joined to existing.

3.1.6 FORMING NEW OPENINGS, ETC., IN EXISTING WALLS

Rates for items of forming new or altering existing openings are, unless otherwise stated, to include for the following: -
(a) Breaking out for and inserting adequate lintels over the new openings (except where stated in the items as being below an existing beam, slab or lintel), to the approval of the Employer. The lintels are to be of in-situ concrete Class C, or of pre cast prestressed concrete or of brickwork in 1 : 3 cement mortar, with a minimum bearing of 230 mm at each end and suitably reinforced, and rates are to include for all necessary formwork, turning pieces, etc., and for wedging and pinning up to existing brickwork over in 1 : 3 cement mortar.
(b) All shoring and propping required.
(c) Facing up jambs in new brickwork in cement mortar properly bonded to existing.
(d) Building up the portions of the openings stated in the items in new brickwork in cement mortar properly bonded to existing.
(e) Formwork for concrete sills and thresholds where required.
(f) Making good only to the finishes as stated in the items. (Note: - The making good of paint finishes has been measured separately).
(g) Forming rounded angles, throats on external plastered soffits, mitres, etc., where required in all new plaster, render and granolithic finishes.
The supply, building in, fixing, etc., of all windows, doors, frames, etc., to the newly formed openings and the removal of all existing windows, doors, frames, etc., from openings to be altered, have been elsewhere measured.

3.2 Materials

All materials shall be of that quality and possess those properties best suited to the purpose for which they are used.

3.2.1 DRAINLAYER

The Specifications dealing with sewers, stormwater, manholes and catchpits, and bedding shall apply or in the event of no such specifications being specified, then SANS 1200 LB, LD and LE shall apply.

3.2.2 EXCAVATOR

In addition to the Specification dealing with general excavation and trench excavation the following shall apply or in the event of no such specifications being specified, then SANS 1200 D and DB shall apply.

3.2.2.1 Filling

Filling shall be clean sand or approved sand with little or no clay content.

3.2.2.2 Hardcore filling

Hardcore filling shall be 150 mm thick unless otherwise specified and shall be formed with hard broken stone or brick of 75 mm maximum size, blinded with sand or dry sub-soil.

No clay, rubbish, tins, wood or vegetation or other debris shall be used in the filling.

3.2.3 CONCRETOR

In addition to the specification dealing with concrete, or if no such specification is provided or specified in SANS 1200 G or GA, the following shall apply.

3.2.3.1 Polythene sheeting

Polythene sheeting shall comply with SANS 952, type C, 0,25 mm thick. All joints shall be overlapped and sealed by pressure-sensitive tape.

3.2.3.2 Prestressed concrete lintels

Precast concrete lintels are to have been manufactured in an approved factory, of mix 35 MPa/6,7 mm strength concrete, reinforced with steel wire not less than 4 mm diameter, tensile strength 1300 to 1380 MPa stressed to not less than 900 MPa. The number of reinforcing wires in concrete lintels for the various spans shall be as set out below:

Width of opening (m)	**Reinforcing per half brick soffit width**
Under 1,8	2 x 4 mm HT wire
1,80 to 3,00	3 x 4 mm HT wire

Such lintels shall be not less than 60 mm deep and suitably roughened, indented or shaped to give a good bond between the lintel and the mortar for the first course of brickwork above.

3.2.4 MASON

3.2.4.1 Masonry units

All masonry units used on the Works shall comply with SANS 227 and SANS 1215. They shall be of either burnt clay or concrete free from cracks, stones, unground lumps of material or lumps of lime or other defects and when two are struck together shall give a clear ringing sound. Face bricks shall be hard-burnt and the colour shall be subject to approval. The degree of efflorescence shall be nil.

Masonry units shall be obtained from an approved manufacturer and the Contractor shall submit to the Engineer sample units which if approved will be retained by him as standards. Sampling shall be carried out in accordance with Section 6 of SANS 227 and SANS 1215. The Engineer shall have the right to reject any consignment from which units taken at random are not equal in all respects to the standard. The delivery and removal of which shall be solely at the Contractor's cost.

Except where otherwise stated on drawings or in the Bill of Quantities, NFX (non-facing extra) bricks complying with the SANS 227 Specification for general purpose (special) class of masonry units shall be used.

Bricks for lintels, and for those parts of the structure where chases are required to be cut, shall not contain cavities or perforations.

3.2.4.2 Sills

Where external sills are required to be of masonry, the units shall be glazed burnt clay face bricks or concrete units laid on edge.

Internal sills shall be fibre cement board, 10mm thick, laid flat and protrude from edge of wall by 10mm.

3.2.4.3 Mortar

Lime shall be best quality pressure hydrated type A2P and shall comply with SANS 523. It shall be well slaked and properly hydrated. Cement for mortar shall comply with SANS 50197-1 as specified for concrete.

The sand shall be clean pit sand free from clay or other impurities, and shall comply with the requirements of BS 1199 and shall be properly screened and washed if directed by the Engineer.

The water shall be approved quality fresh water.

Unless otherwise specified, the mortar for masonry shall be composed of one part of lime to six parts of sand with 10% (of volume of sand and lime) of cement added immediately before use and thoroughly mixed.

3.2.4.4 Wall ties, wall reinforcing and wall-plate anchors

Wall ties shall be 3,50 mm galvanised steel wire ties equal to the "modified PWD Type" or "Butterfly" type wall ties and shall comply with the requirements of SANS 28.

Reinforcing for lintels and other brickwork where ordered shall be either hard drawn steel wire of 572 to 695 N/mm² ultimate strength or mild steel, both complying with SANS 920. (See also 4.3.4.4).

Wall-plate anchors shall consist of 32 mm wide by 1,6 mm thick galvanized hoop iron 1,5 m long and anchored at least 5 courses before wall plate level .

3.2.4.5 Damp proofing

Damp proofing shall consist of one layer of fabric complying with SANS 248, type GH (33,5 kg per 9 m²).

3.2.4.6 Air bricks

Air bricks shall be approved terra cotta or concrete, with vermin proof copper/PVC gauze at back, built in on the outside face of walls. On the inside face 225 x 150 mm square pattern fibrous plaster air gratings with vermin proof copper/PVC gauze at back shall be built in.

3.2.5 CARPENTER AND JOINER

3.2.5.1 Construction timber

All timber used shall be of good sound quality thoroughly seasoned, straight, sawn square and free from sap and reasonably free from shakes, large, loose or dead knots, sapwood and wany edges.

Unless otherwise specified, all timber work for constructional purposes shall be in "merchantable grade" timber, complying with the requirements of SANS 1783-2, except that no finger joints within 500 mm of the end of any member, and not more than one finger joint per 3 m length will be accepted. Timber shall be ordered in the nominal cross sectional dimensions and to the nearest 0,3 m length in which it is to be used, except that finger jointed timber made according to SANS 10096 will be permitted.

Timber for brandering shall comply with the requirements of SANS 1783-4.

All softwood timber shall bear the mark of the South African Bureau of Standards.

All timber shall be treated against insect and other wood damaging infestation according to the recommendations of the Department of Entomology, SANS 673 and SANS 10005.

All timber to be built into walls and wall plates shall, in addition to the above, receive two coats of Solignum, carbolineum or other approved wood preservative or be wrapped in 250 micron polythene sheeting.

3.2.5.2 Joinery timber

The type of timber shall be as approved by the Engineer prior to the commencement of manufacture.

All timber used for joinery shall be best quality, specially selected, treated against insects as specified in 4.1.5.1, and shall be of good sound quality, well kiln dried and free from sap, large loose or dead knots, shakes, wany edges or other defects or blemishes such as flower grain. Solid shelving shall comply with SANS 1783-3.

The glue used shall be compatible with the treatment applied against insect attack and shall comply with SANS 1349. In the case of external doors an approved waterproof glue shall be used.

3.2.5.3 Timber doors, door frames and windows

All timber doors, door frames and windows shall be of stout design and construction and of the type billed.

a) External doors

Standard type external doors, shall be of hardwood, and, unless otherwise dimensioned on the drawings, shall be 2 032 x 813 x 45 mm single leaf, framed, ledged and braced and, except for vertical V-jointing, flush on the outside. The stiles and top rail shall be 140 x 45 mm, middle rail 140 x 23 mm and bottom rail 215 x 23 mm. Bracings shall be 115 x 23 mm. Door panels shall consist of 95 x 22 mm vertical boarding, tongued and grooved and V-jointed on the outside. Panels shall be tongued into slots in stiles and top rails and countersunk-screwed with brass screws to middle and bottom rails and bracings.

Where softwood timber Z type doors are billed they shall be made to the overall dimensions shown on the drawings, ledged and braced and, except for vertical V - jointing, flush on the outside. The top rails shall be 165 x 45 mm, the middle and bottom rails shall be 165 x 23 mm, and braces 115 x 23 mm. Door linings shall be 95 x 22 mm, tongued and V-grooved, and shall be countersunk screwed with brass screws to rails and braces.

The jambs and head of standard size external frames shall be 95 x 70 mm, while the sill shall be 95 x 45 mm with both a dripmould and groove for the weather strip cut in. All frames shall be rebated.

3.2.5.4 Ceilings

Ceilings shall be 6,4 mm thick gypsum ceiling board complying with SANS 266, and shall be fitted to brandering of 38 x 38 mm or other approved dimensions depending on the truss/rafter spacing.

Cove cornices shall be fitted to all ceilings. For gypsum board ceilings the cornices shall be 75 mm gypsum cove cornices.

Joints between ceilings boards shall be covered with 25 mm half-round hardwood cover strips.

3.2.5.5 Roofing

The type of roofing shall be as scheduled or shown on the drawings.

IBR pattern galvanized deep-fluted sheets and fittings shall be 0,63 mm thick before galvanizing.

Fascia and barge boards shall be of 225 x 15 mm pressed fibre cement, unless timber boards are scheduled or shown on the drawings.

3.2.5.6 Roofing underlay

Where indicated or shown on the drawings, roofing underlay shall be yellow under-tile polythene sheeting complying with SANS 952, type C, 0,25 mm thick.

3.2.6 IRONMONGER AND SMITH

3.2.6.1 Ironmongery

Ironmongery shall be of the strongest manufacture and best finish. "Bakelite" or similar plastic furniture will not be accepted. Unless billed as prime cost items, samples of each item of ironmongery shall be submitted for approval before any particular item is ordered and fixed.

Barrel bolts shall be 150 mm. Hinges for internal and inward opening doors shall be 100 mm loose pin brass or steel butts depending on the material to which they are to be fixed. Hinges for outward opening external timber doors shall be "Parliament" or projection type fixed with 50 x 12 gauge brass screws. All external doors shall be fitted with three hinges.

Brass screws shall be used for fixing ironmongery to hardwood. Unless otherwise specified, screws shall be of metal similar to the article to be fixed in the case of metal frames, doors or windows.

Locks for external doors shall be fully rebated heavy quality, 3 lever mortice with bronze or chromium plated furniture. All locks shall be provided with two keys, and all locks shall differ so that the key of any lock will open no lock other than the one to which it belongs.

All outward opening doors shall be fitted with eyes and corresponding 100 mm brass hooks shall be fitted to the walls for holding the doors open. A suitable stop shall be fitted to prevent the door knob from damage against the walls.

All Z-type doors shall be fitted with brass handles and black japanned rimlock with 2 keys. They shall be fitted with 2/250 mm mild steel Tee hinges.

3.2.6.2 Steel windows and doorframes

Windows shall be constructed of suitable approved malleable mild steel and of approved medium universal profile. They shall be provided with adequate lugs for fixing to brickwork and be complete with all fittings. They shall comply with the requirements of SANS 727 for Steel windows and Steel doors.

Steel doorframes shall be of approved profile manufactured from annealed mild steel 1,60 mm in the case of single rebated or 1,25 mm in the case of double rebated frames complying with SANS 727. The whole frame shall be welded into a rigid unit. The specified number of 100 mm loose pin steel hinges for the type of door to be hung shall be welded on to each frame. Frames shall also be fitted with an adjustable plate with mortar guard suitable for mortice lock.

3.2.7 PLASTERER, PAVIOR AND TILER

3.2.7.1 Plaster

Plaster for walls shall be prepared by mixing one part lime to five parts dry sand. Immediately before use one part cement shall be thoroughly mixed with twelve parts of the above lime/sand mix.

Plaster for rendering to concrete surfaces, beams and manholes shall be composed of one part cement to three parts sand.

3.2.7.2 Glazed ceramic floor tiles

Glazed floor tiles shall comply in all respects with SANS 1449 and SANS 10107. They shall have a thickness of not less than 2,24 mm and shall be laid on a cement screed using a rubber base adhesive emulsion in accordance with the manufacturer's instructions.

3.2.7.3 Glazed ceramic wall tiles

Glazed wall tiles shall be best quality of approved manufacture, comply with SANS 22 and SANS 10107 and be 4,75 mm thick, true and regular in shape and free from cracks and all other defects. All arrises shall be cushion edged.

3.2.8 PLUMBER

3.2.8.1 Plumbing and drainage

All materials used for plumbing and drainage shall comply with the Standard Building Regulations.

Water piping shall be in copper, the piping and valves conforming to SANS 460 and SANS 226 respectively.

Unless otherwise billed, chrome-plated bibcocks shall be heavy pattern with polished bodies to the finish billed or ordered by the Engineer.

Both the laboratory and kitchen sinks shall have 40 mm PVC-U traps and waste pipes with cleaning eyes fitted to each bend and trap and complying with SANS 967. Vent pipes shall be 110 mm PVC-U pipes to SANS 967.

Fittings for fixing waste and vent pipes to walls shall consist of approved pressed steel holderbats plugged to walls.

Drain pipes and fittings shall comply with SANS 791 for PVC-U. Unless otherwise billed, sewer and drain connections shall be uPVC.

Where specified, billed or shown on the drawings, the following shall apply:

a) The hot water cylinder shall be a horizontal combination type, bearing the SANS mark, of 90 litres capacity unless otherwise specified, and shall be installed on brackets sufficient to carry the mass of the filled geyser. The Contractor shall allow for all items, excluding the electrical connection, to install the cylinder.

b) The kitchen sink shall be of standard stainless steel single bowl type, bearing the SANS mark, and fitted with grid, plug, chain and screwed union for waste trap and pipe. The sink shall be inset into counters.

c) The lab sink shall be of standard stainless steel double bowl type, bearing the SANS mark, and fitted with grid, plug, chain and screwed union for waste trap and pipe. The sink shall be inset into counters.

If a hot water system is being installed, two 13 mm chrome-plated bibcocks shall be fitted to the sink. If no geyser is being installed, one 13 mm bibcock shall be fitted, with provision made for a future hot water bibcock.

3.2.8.2 Sanitary fittings

Sanitary fittings shall comply with SANS 497 and shall be subject to selection and approval.

3.2.8.3 Rainwater goods

Unless otherwise stated or approved, rainwater goods shall be fabricated from aluminium sheeting.

3.2.9 GLAZIER AND PAINTER

3.2.9.1 Glazing

Unless otherwise stated, windows up to 300 mm maximum dimension shall be glazed with 7,32 kg/m² (9,76 kg/m² up to 500 mm maximum dimension) clear sheet glass of the best quality of its kind, free from bubbles, waves, air holes, scratches or other defects and conforming to BS 952 "Ordinary Glazing Quality". Obscure figured and texture glass shall be the best of the respective kinds described and approved. Obscure glass shall be used at windows to showers and toilets.

Polished plate glass, if specified, shall be "Glazing for Glazing" quality, conforming to BS 952.

3.2.9.2 Paints, stains, etc.

All paints and stains, etc, or materials used in their preparation, shall be of the best quality of their respective kinds and shall comply with the relevant SANS specification. The paints and stains, etc, their colours and shades, shall be approved as to brand and manufacture, and the Contractor shall submit samples in their respective colours to the Engineer, for approval, when called upon to do so.

3.3 Methods and Procedures

3.3.1 EXCAVATOR

3.3.1.1 General

The depth of excavation shall be such that the top of the concrete foundations are not less than 150 mm below existing ground level. Trenches and holes shall be excavated to the dimensions of the foundations shown on the drawings or to such other depth as directed in order to ensure a firm foundation.

Bottoms of foundations shall be level and the sides trimmed to full width. The bottoms of trenches shall be stepped in masonry/block course dimensions as required.

Foundation trenches shall have been inspected and approved by the Engineer before the concrete is poured.

3.3.1.2 Filling under floors

The filling under floors shall be constructed in layers of thickness not exceeding 200 mm before compaction, watered and compacted to 93% (100% in the case of sand) of modified AASHTO maximum dry density.

3.3.1.3 Hardcore filling

Hardcore filling shall be levelled and thoroughly compacted by ramming, to receive the concrete floor.

3.3.2 CONCRETOR

In addition to the Specification dealing with concrete the following shall apply.

3.3.2.1 Polythene sheeting

Before casting the floor slab a polythene sheeting complying with 4.1.3.1 hereof shall be laid on the compacted hardcore or fill.

3.3.2.2 Prestressed concrete lintels

Regardless of whether the width of prestressed units are full or half brick or 150 mm they shall be laid to the full width of the bricks in the wall.

3.3.3 MASON

3.3.3.1 Masonry

All brick foundation walls, superstructure walls, piers and the like shall be built to the various lengths, heights and thicknesses shown and figured on the drawings with masonry units as described and unless otherwise specified, built in English bond. Where thicknesses of 110, 220, 280 and 330 mm are shown on the drawings they are regarded as nominal and are subject to adjustment to suit the masonry units approved for any particular project.

No false headers shall be built in and none but whole masonry units shall be used except where legitimately required to form bond. Burnt clay bricks shall be well soaked in water immediately before being laid and the course of bricks last laid shall be well wetted before laying a fresh course upon it. Concrete units shall not be wetted and if the stockpile has been exposed to rain, the units shall only be used once they have dried out.

Masonry shall have the joints flushed up at every course solid throughout the whole width of each course and all to be laid on a solid bed of mortar.

All walls shall be carried up regularly so that no part of the walling is more than 1,3 m higher than the adjoining work except as shown on the drawings.

Mortar joints to masonry generally shall not exceed 10 mm in thickness. The joints of all walls intended to be plastered or tiled shall be raked out as the work proceeds to form a key for plaster.

Where facing and pointing is specified, the walls shall be faced with facing units as specified and, unless otherwise specified, built in stretcher bond in 3:1 cement mortar, and pointed with a neat recessed joint formed with a steel jointing tool well pressed into the joints as the work proceeds. Unless otherwise indicated on drawings or billed, the face masonry shall be tied back to the walling with wire ties at the rate of 6/m^2. The face work shall be protected by pasting paper over exposed surfaces, or by other means approved by the Engineer. On completion, the face shall be cleaned down with spirits of salts, wire brushed and finally washed down with ammonia and water.

Ventilators, gratings, dowels, corbels, ties, ends of timber, and slips for fixing joiner's work shall be built in as the work proceeds.

3.3.3.2 Mortar

The mortar shall be mixed in small quantities, with the materials mixed dry on a proper platform with water added gradually through a fine rose and the mixture turned over until the ingredients are thoroughly incorporated. It is essential that mixing platforms shall be well cleaned and stale mortar removed before any batch of mortar is prepared for mixing. Mortar shall be used within 2 hours of cement being mixed in.

3.3.3.3 Cavity walls

Cavity walls shall have the inner and outer skins tied together with ties 1 m apart horizontally in every fourth course with alternate rows staggered.

Mortar droppings shall be carefully gathered up on laths supported on the ties and the laths shall be removed and cleaned at every fourth course. Openings shall be left at the bottom of walls as required for cleaning, and afterwards built in and made good. The wire ties shall be cleaned of all mortar droppings. Vertical dry joints for drainage shall be left at every third brick in the bottom course.

Cavities at jambs and ends of walls shall be built solid for a depth of 110 mm and cavities below sills or at heads of walls shall be built solid for three courses of masonry.

Doors and windows shall be provided with damp proof courses to sills and jambs.

3.3.3.4 Masonry lintels

Masonry lintels shall be formed of masonry units complying with the same specifications as those of the wall in which the lintel is being formed except as specified in 4.1.4.1. They shall be properly bonded longitudinally and be bedded in 1:3 cement mortar. At each reveal, the end unit of the bottom course shall have a bearing of at least half its width.

Masonry lintels shall be reinforced for their full length and shall be formed at least of the minimum number of courses, all as set out in Table A, below.

Masonry lintels shall be formed on rigid temporary supports which shall be left in position for seven days or such longer period as the Engineer shall order.

Prestressed concrete lintels are to comply with 4.1.3.2.

Masonry shall be built in 1:3 cement mortar with all joints filled solid with mortar. Lintels shall have a bearing of not less than 225 mm on each side of the opening.

Table A

Type of Lintel	Width of opening m	Min. No. of brick courses over lintel	Reinforcing per half unit soffit width
Brick Reinforced	under 1,50	4	3/3,15 mm HT wire
	1,50 to 2,25	6	3/6 mm Mild Steel or 3/3,15 mm HT wire
	2,25 to 3,00	8	4/3,15 mm HT wire
Concrete Prestressed	under 1,80	Beam + 3	(See 4.1.3.2 hereof)
	1,81 to 3,00	Beam + 4	(See 4.1.3.2 hereof)

3.3.3.5 Window sills

Where specified, masonry units shall be laid to a uniform slope, true to line and level, and solidly bedded in 3:1 cement mortar with damp proofing, all as shown on the relevant drawing. Joints which shall not exceed 9 mm in width shall be neatly pointed.

Internal sills shall be constructed of 10mm thick fibre cement board set in 3:1 mortar and laid true to line and level. All sills shall be kept free from cement and other stains, and shall be cleaned off on completion.

3.3.3.6 Damp proof course

Damp proofing in the walls shall be laid without any longitudinal joints, and lapped 150 mm at all end joints and intersections. Damp proofing shall be kept 10 mm back from the external face of walls and pointed in cement mortar.

Damp proofing under floors shall be laid with 150 mm laps at all joints in both directions.

Damp proofing in cavity walls shall be stepped up one course over a cement mortar triangular fillet in the bottom of the cavity.

Where brickwork rests on concrete the damp proofing shall be sealed to the concrete with hot bitumen.

Doors and windows shall be provided with damp proofing to sills and joints.

3.3.3.7 Separation of concrete from masonry - jointing

Concrete slabs and beams, including lintels, shall be separated from masonry by covering the contact bearing surfaces with 0,56 mm thick galvanised steel sheet bedded on a levelled up 3:1 cement mortar before the concrete is cast. The sheet iron shall be lapped not less than 25 mm at joints and intersections.

Unless otherwise specified or shown on drawings, 12 mm impregnated soft board shall be placed against the end of masonry where in contact with the sides of concrete columns and walls.

3.3.4 CARPENTER AND JOINER

3.3.4.1 Carpentry general

Timber work shall be neatly executed and finished and all jointing shall be accurately cut and well fitted together.

Timber shall be of sizes specified or stated on drawings and shall be framed, checked, lapped, spiked and/or bolted together and as detailed below unless otherwise specified.

Wall plates shall be halved at junctions and angles. Purlins, battens, etc., shall be bevelled at junctions, and in all cases the joints shall be placed over a point of support and well spiked.

Where splices are necessary in rafters, ties or ceiling joists, the timbers shall be lapped at least five times the width of the timber and securely spiked. Splices in timber wider than 114 mm shall be bolted with at least three 9,5 mm bolts and washers, in addition to spiking.

Except where framed, or where bolts are specified to be used, all intersections and passing of constructional timbers shall be adequately spiked and where possible clinched in addition.

A patented nail system and factory made jointing techniques for roof trusses will be permitted with the written prior approval of the Engineer.

Roof trusses shall be set up at the centres indicated on the drawings, or as instructed by the Engineer, on 114 x 38 mm timber wall plates, and securely strapped down with mild steel straps, with one end wrapped around and spiked to the foot of the truss and purlin, and the other end built sufficiently far into the brickwork to preclude any risk of the finished roof being blown off.

3.3.4.2 Joinery

All joinery shall be well manufactured, all necessary framing, scribing, notching, mitring, fittings etc. being properly executed. All framed joints shall be pinned in addition to being glued. No portions of panels shall be glued. Nailing, where necessary, shall be done on the surrounding mouldings and in the most concealed manner.

All items shall be constructed of the timber specified, or approved by the Engineer in writing, and shall comply with the finished size dimensions as shown on the detail drawing.

The Engineer reserves the right to reject any joinery which is considered to be below the required standard, either because of the timber used or the quality of workmanship.

3.3.4.3 Timber doors and windows

Door frames shall be of profile suitable for the walls in which they are to be fixed, and shall be secured to walls with three lugs to each jamb. The feet of frames shall be firmly strutted and fixed solidly to floors complete with GI weatherproofing strips, as shown on the drawings.

Softwood doors and frames shall be knotted and primed before fixing.

All doors shall be hung plumb and level, so as to swing freely, and shall be stained, oiled or painted two coats approved paint after erection.

All external doors shall be hung on three hinges screwed into wooden frames or welded to steel frames. The doors shall be furnished with barrel bolts, and mortice locks.

Window frames shall be secured to walls with 2 mm galvanized hoop iron lugs 38 mm wide, one end bent and screwed to frame and two screws to each and built 450 mm into wall with other end turned up into masonry joints. Windows not exceeding 914 mm in height of clear opening shall have two lugs at each jamb, but windows exceeding 914 mm in height of clear opening shall have three lugs at each jamb unless otherwise specified.

3.3.4.4 Ceilings

Ceiling, where shown on drawings, shall be erected on brandering at 450 x 1 000 mm spacing, or in accordance with the manufacturer's recommendation and approval.

3.3.4.5 Roofing

c) Galvanized iron

IBR pattern galvanized deep-fluted sheets shall be carefully laid and fixed in accordance with the manufacturer's instructions with side laps of one corrugation and 300 mm end laps, with ends of sheets bent up or down as required. Sheets shall be carefully drilled for, and secured to wood purlins with, galvanized drive screws, or secured to steel purlins with galvanized hook bolts, each with one galvanized steel and flat bitumen washers. Laps at ends or edges shall be primed with one coat approved self-etching primer and sealed with bitumen strips, size 30 mm wide x 3 mm thick, and carefully drilled for, and secured with, self-tapping screws or 6 mm galvanized bolts with bitumen washers.

e) FC Fascias and barge boards

Fibre cement fascia and barge boards shall be carefully drilled and screwed to roof timbers with, 40 x 12 gauge brass cup headed screws and washers, and shall be painted with two coats acrylic paint.

3.3.5 IRONMONGER AND SMITH

3.3.5.1 Ironmongery

All ironmongery shall be cleaned, oiled and eased until it operates perfectly, after it has been fixed in the work.

3.3.5.2 Windows and door frames

Before building-in, any damage to the shop primer shall be made good by painting with zinc chromate primer.

Windows and doorframes shall wherever possible be built into walls during construction and the lugs well secured. They shall be securely strutted to prevent distortion while the masonry is being built.

After completion and before plastering, the space between the frames and masonry shall be carefully and thoroughly filled with 3:1 cement mortar and the external joints raked out to a depth of at least 10 mm and caulked with a mastic cement forced into the joints.

Steel windows and doorframes, after glazing, shall receive two coats of oil paint to selected colours, after any damage to the zinc chromate primer has been made good.

3.3.6 PLASTERER, PAVIOR AND TILER

3.3.6.1 Plasterwork

All masonry joints shall be raked out to afford a proper key for plaster and all surfaces shall be properly cleaned down and well wetted before any plaster is applied.

When plastering is required on concrete surfaces, these shall be hacked and thoroughly brushed with strong wire brushes to afford a proper key for the plaster. Soffits, beams, etc. shall be rendered in cement plaster as thinly as possible to provide a uniform surface on which cement plaster of a similar composition shall be skimmed.

Internal plaster shall be steel trowelled unless otherwise specified. Plasterwork shall be kept damp until properly set and all finished surfaces shall be protected from injury.

No plaster on walls shall be less than 12 mm or more than 18 mm in thickness unless otherwise specified.

All salient angles and arrises shall be slightly rounded and all internal angles shall be finished perfectly true, square and smooth.

3.3.6.2 Air bricks

Openings formed for air bricks shall be rendered with plaster.

3.3.6.3 Glazed wall tiling

Glazed wall tiling shall be fixed in accordance with SANS 10107. The wall tiling shall be fixed to a plumb-true 3:1 cement mortar screed, not less than 12 mm thick, which shall be scratched and left to dry.

The tiles shall be thoroughly soaked in water, the edges dipped in a grout of White Portland cement and pressed into a solid bed of 2:1 cement mortar, previously applied to the screed. The joints shall be continuous vertically and horizontally and as thin as possible, any white cement being wiped away and the whole cleaned off on completion.

The tiling shall be complete with all internal angles and rounded edge fittings, and shall be of the best quality executed by competent workmen.

3.3.6.4 Glazed floor tiling

Glazed floor tiling shall be fixed in accordance with SANS 10107, on straight regular lines, and the finished floor shall have a neat and workmanlike appearance as specified in 8.2.3 hereof.

3.3.7 PLUMBER

3.3.7.1 Plumbing, drainage and sanitary work

All workmanship and methods used for the installation of plumbing, drains and sanitary work shall comply with Chapter 12 of the Standard Building Regulations except that local Building Regulations having the force of law shall take precedence where conflict exists.

The work will be subject to approval by the Local Authority's Inspectors, if any, and by the Engineer. The Contractor's attention is drawn to the need to employ registered drainlayers and plumbers who are fully conversant with local regulations and codes of practice for this portion of the Works, to ensure that the Local Authority's Inspectors accept the work when finished.

3.3.7.2 Rainwater goods

Rainwater goods shall be free from defects. Gutters and rainwater downpipes shall be accurately fixed, closely fitted together and jointed with an approved jointing compound and bolted.

4 GLAZIER AND PAINTER

4.1 Glazing

Glass shall be cut to fit the rebates with due allowance for expansion, and shall be carefully bedded in putty, pegged or clipped in position, puttied evenly to a uniform level and neatly finished, all in accordance with SANS 680.

4.2 Painting

Before any paintwork is put in hand, surfaces shall be made good after all other trades and the Contractor shall inspect and satisfy himself that all surfaces of plaster, wood, metal, etc., which are to receive finishes of paint, stain, distemper, oil, etc., or paintwork of any description, are in a proper condition to achieve a high quality paint finish on them. All surfaces shall be filled with suitable stopping where necessary, rubbed down, perfectly clean, free from dust, dirt, grease, etc., before any painting etc., is undertaken. No painting or distempering shall be undertaken on plastered wall or ceiling surfaces until in the opinion of the Engineer they have thoroughly dried out and are in a fit state to receive the finish. All rooms and corridors etc., shall be swept clean before the painting is commenced, and no sweeping or dusting shall be done whilst painting or distempering is in progress.

Each coat of paint shall be a distinctive colour. Sample colours are to be prepared in all cases for the final coat. Every coat of paint, etc., shall be a good thick covering coat, and, if not, the Contractor will be required to apply extra coats at his own expense.

Walls behind baths and sinks to a height of 1,8 m or as shown on the drawing shall be painted with one coat alkaline resistant primer and one coat gloss oil paint.

New wrot woodwork specified to be painted (including the backs of wood frames etc.) shall be primed with white and red lead priming paint. Knots shall be knotted with shellac knotting before priming. Where special brands of patent paints are to be used, the manufacturer's priming, suitable for the particular brand employed, shall be used in accordance with the manufacturer's instructions.

New wood work shall be properly sandpapered and rubbed down to a smooth even surface before painting or staining and before each successive coat is applied. Stopping is to be tinted as required to match oiled or stained woodwork.

Existing woodwork previously painted shall be properly rubbed down and sandpapered to approval, or the existing paint removed if required. Running knots shall be cleaned off and coated with shellac knotting.

Where new galvanized iron surfaces are specified to be 'oxidised' before being painted, they shall be prepared with a 10% solution of copper sulphate in water, and the galvanized surfaces shall be washed with the solution. The black deposit formed almost immediately shall be thoroughly washed off whilst still wet with clean cold water and the surface allowed to dry. Other approved patent oxidising solutions if approved may be used to render new galvanized surfaces fit for painting, provided these are applied strictly in accordance with the manufacturer's instructions.

Hardwoods shall be given two coats of an approved timber seal or raw refined linseed oil well rubbed in. Fibre cement shall be painted with an undercoat and two coats of acrylic paint.

Exposed timber, unless painted or oiled, shall be given two coats of carbolineum preservative or equivalent.

Steel and iron surfaces, including those bedded in concrete, shall be painted as specified in the Specification dealing with Structural Steelwork.

Cast iron work shall be delivered to site without painted or coated surfaces. After erection, the cast iron shall be washed, using a detergent and nylon brushes to remove all rust and foreign matter. All traces of detergent shall then be washed off. As soon as the surface is dry it shall be painted two coats of 60% red lead primer, and then two coats of approved bituminous paint. No cast iron which is to be painted shall be previously dipped in tar or bitumen solution. Under no circumstances may wire brushes be used for removing rust or other contaminants.

The whole of the paintwork shall be touched up and made good on completion, and all paint spots and stains removed from floors, glass, etc. and all left perfect. All glass shall be thoroughly cleaned, all floors washed and the work left in a clean and properly finished condition.

4.2.1 ELECTRICIAN

4.2.1.1 General

The Contractor shall provide electrical wiring, internal and external lighting and fittings as shown on the drawings, shall undertake the relevant electrical work in accordance with SANS 10142-1, the Code of Practice for Wiring of Premises, and, on completion, shall submit to the Engineer a certificate obtained from the relevant authority stating that the electrical work complies with its requirements and regulations.

4.2.2 MISCELLANEOUS TRADES, FIXTURES AND APPLIANCES

See Specification Data.

5 MEASUREMENT AND PAYMENT

5.1 Basic principles

5.1.1 General

Unless the building is measured by the sum in terms of item 8.2.12, the relevant items 8.2.1 to 8.2.11 shall apply.

5.1.2 Glazing

The cost of glazing will be held to have been included in the tendered rate for the items such as windows, doors, etc., that require glazing.

5.2 Billed items

5.2.1 Drainlayer

The measurement and payment clauses of the Specifications dealing with sewers, stormwater, manholes and catchpits, and bedding, as applicable, shall apply.

5.2.2 Excavator

In addition to the measurement and payment clauses of the Specifications dealing with general excavation and trench excavation, the following shall apply.

5.2.2.1 Hardcore

Unit:………… square metre or cubic metre (m^2) or (m^3)

Hardcore filling will be measured by area or volume as billed.

The unit rate shall cover the cost of the provision, placing and compacting of the hardcore filling including filling of voids as necessary.

5.2.3 Concretor

5.2.3.1 Prestressed lintels

(Opening to be spanned to be stated)
Unit:……….. metre (m)

Prestressed lintels will be measured linear.

The unit rate shall cover the cost of the supply of all materials and labour in manufacturing and installing the lintels.

5.2.4 Mason

5.2.4.1 Masonry

Unit: square metre (m^2)

Masonry will be measured as the net area after all door, window and similar major openings have been deducted.

The unit rate shall cover the cost of the supply of all materials, cutting and waste, building in of timber, masonry lintels, wall ties, etc., plumbing openings and angles, forming all openings and reveals, struck jointing and all other labours, not separately billed. The cost of building in of windows, door frames etc. will be held to have been included in the unit rates tendered for those items.

5.2.4.2 Sills

Unit: ……… metre (m)

External and internal sills will each be measured separately and linear.

The unit rate shall cover the cost of the supply of all materials and for all labours, cutting, waste, jointing, reinforcement, damp proofing of sills where shown on drawings, and cleaning on completion.

5.2.4.3 Damp proofing

(for walls width to be stated)
Unit:…….. metre or square metre (m) or (m2)
Damp proof course for walls will be measured linear as the net length of wall proofed. Damp proofing under floors will be measured as the net area of floor damp proofed.

The unit rates shall cover the cost of the supply and laying of all material, cutting, waste, laps and bitumen sealing where required.

5.2.4.4 Air bricks

Unit: ……… set

Air bricks will be measured by sets comprising inside and outside, complete with copper gauze and reveals.

The unit rate shall cover the cost of the supply and fixing of the complete set.

5.2.4.5 Masonry reinforcing

(width of wall to be stated)
Unit: ……… metre (m)

Where billed, masonry reinforcing will be measured linear.

The unit rate shall cover the cost of the supply, cutting, waste, installation and tools.

5.2.5 Carpenter and joiner

5.2.5.1 Timbers

Unit:…….. metre or number (m) or (No.) or Sum

Timbers will be measured net linear. Roof trusses may be measured by number or as a sum.

The unit rate shall cover the cost of cutting, scarfing, laps, waste and for nails and spikes.

The unit rate for roof trusses, where these are billed by number or sum, shall cover the cost of the supply, manufacture and erection of the trusses including for all necessary "beam filling" between the top of the wall and underside of the roofing.

5.2.5.2 Joinery

Unit: ……. number (No.)

Unless otherwise billed, joinery items will be measured by number and type.

The unit rate shall cover the cost of the supply of all materials, manufacture of the items and for all fixing and painting or oiling as specified.

5.2.5.3 Doors

Unit: ……… number (No.)

Doors will be measured by the number of complete units of each size and type.

The unit rate shall cover the cost of the supply, fixing and sealing of the door and frame (timber or steel, as specified) complete with GI strips, lugs and damp proofing where shown on drawings or as required, furniture, glazing and painting, or oiling. (See also items 8.2.4.1 and 8.2.9).

5.2.5.4 Ceilings

a) Ceilings (type to be stated)
Unit: …………………………………………………………………………….square metre (m2)

b) Cornice
Unit:……….. metre (m)

Ceilings will be measured by area and the cornice will be measured linear.

The unit rates for ceilings and cornices shall cover the cost of the supply of all materials and labour including brandering, fixing, cutting, waste, nails and all fixings and for trimming and forming one trapdoor 600 x 600 mm in each building.

5.2.5.5 Roofing

(type to be stated)
Unit: square metre (m2)

Roofing will be measured as the net area covered measured on the slope, if any.

The unit rate shall cover the cost of all laps, cutting, waste and fixing, and flashingand sealing materials to complete the roof to a weatherproof condition.

5.2.5.6 Fascias and barge boards

(type to be stated)
Unit:metre (m)

Fascia and barge boards will be measured linear.

The unit rate shall cover the cost of the supply of all materials and for all cutting, waste, brackets, fixing, painting, and for all screws, bolts and the like.

5.2.5.7 Skirtings

(type to be stated)
Unit: ……… metre (m)

Skirtings will be measured linear.

The unit rate shall cover the cost of the supply of all materials and for all cutting, waste, brackets, fixing, painting, and for all screws, bolts and the like.

5.2.6 Ironmonger

5.2.6.1 Ironmongery

Ironmongery will NOT be measured or paid as separate items unless the Bill of Quantities includes specific prime cost or other items therefor.

5.2.6.2 Steel windows

Unit: ……… number (No.)

Steel windows will be measured by number of each size and type.

The unit rate shall cover the cost of the supply and fixing complete including all ironmongery, glazing and painting. (See item 8.2.6.9)

5.2.7 Plasterer, Pavior and Tiler

5.2.7.1 Plaster

Unit: ……… square metre (m2)
Plaster work will be measured as the net area plastered, including reveals, lintels and similar areas, and no deduction will be made for door frames or window frames, airbricks and the like. Internal and external plaster will be measured separately. Separate items will be provided for plastering on masonry, on concrete and on manholes.
The unit rate shall cover the cost of the supply of all materials, labour and equipment to carry out the specified work.

5.2.7.2 Tiling

Unit: ……… square metre (m2)

Tiling will be measured by area of completed tile surface.

The unit rate shall cover the cost of the supply of all materials complete with internal angles, rounded edge fittings and specials, and forming screeds.

5.2.8 Plumber

5.2.8.1 Rainwater goods

Unit: …………… metre and number (m)

Gutters and down pipes will be measured linear and will be taken to include drop ends, swan necks, shoes, etc in the unit rate

The unit rates shall cover the cost of the supply of all materials and for all fixing, jointing, cutting and waste, screws, brackets, holder bats and other fixings.

5.2.8.2 Drainage

Unit: ……… sum or prime cost sum

Plumbing and drainage are billed as "sum" or as Prime Cost items.

The amounts tendered for these items shall cover the cost of the supply of all materials and labour for the complete installation of the relevant facilities in accordance with Subclauses 4.1.8.1, 4.1.8.2 and 4.3.8.1 of Specification QB from the service connections on the mains, excluding only the individual units of sanitary ware which are billed separately. (See item 8.2.8.3).

5.2.8.3 Sanitation

Unit: ……… number (No.) or provisional sum

Sanitary ware items will be measured by number or as Provisional sums as billed.

The unit rate for billed items shall cover the cost of the supply and installation, including all fixings.

Provisional sums will be held to include for the cost of purchase and delivery of the relevant items in terms of the Clause in the General Conditions of Contract dealing with Provisional Sums (as amended by the Contract Data, if applicable). Any additional amount added to the Bill by the Contractor will be held to include for all costs of selection, installation, and commissioning and defects liability in terms of the GCC.

5.2.9 Glazier and painter

5.2.9.1 Painting

Unit: ……… square metre (m2)

Painting etc. will be measured and paid on walls and ceilings only. Measurement will be by the net areas painted, reveals, lintels and similar areas being measured.

The unit rates for doors, windows, steelwork, plumbing, fascias and the like will be held to include for painting etc. of the relevant items.

The unit rates for painting etc. shall cover the cost of all labour and material required to prepare the surfaces, paint the specified number of coats and clean up on completion.

5.2.10 Electrician

Unit: ……… number, sum or prime cost

Electrical items will be measured by number, or will be billed as sum or as "Prime Cost" items.

The unit rates or sum shall cover the cost of all labour and material to complete the installation as specified.

5.2.11 Miscellaneous trades, fixtures and appliances

As set out in these Pricing Instructions.

Note: The above will be subjected to the normal retention in terms of the General Conditions of Contract.

GS.1 STANDARD SPECIFICATION FOR DB's AND MOTOR CONTROL CENTRES

(FOR HEAVY INDUSTRIAL AND COMMERCIAL USE)

All major motor control centres and equipment shall be designed in accordance with SANS 1473/60439. The equipment shall conform to SANS 60947 Parts 1-7, unless otherwise stated and shall be suitable for operation on supply voltages of 230/400 Volts and 500/550 Volts, 50Hz, AC. Reference must be made to the detailed technical specification, the relevant line diagram if provided, as well as the following specific requirements.

In addition the design must conform to the following standards:

- **Act No. 85 of 1993 Occupational Health and Safety Act.**
- **SANS 10142 Code of Practice for the Wiring of Premises**
- **Relevant SANS specifications and Codes of Practice**
- **Relevant BSI Specifications and Codes of Practice in the absence of published SANS documents.**
  Relevant IEC Specifications and Codes of Practice in the absence of published SANS and BSI documents.

GS.1.1 CONSTRUCTION OF MOTOR CONTROL CENTRE ASSEMBLIES

All motor control centres shall generally be of the free standing, floor mounted, individual starter with local isolator for each motor type, with front and back access, suitable for bottom cable entries from cable trenches below the assembly. The schematic drawings or project specification show the specific requirements applicable to each assembly.

The assembly will be constructed of powder coated 3CR-12 having a minimum thickness of 2mm except for gland plates which shall be a minimum of 3mm. If thinner material is offered, offered, the construction technique must be approved by the Employer's representative prior to fabrication.

Where specified the assembly enclosure may be required to be manufactured from stainless steel.

The degree of protection shall not be less than IP 43, in accordance with SANS 1222 and capable of withstanding the temperature, humidity and conditions normally associated with heavy industrial applications. The assembly shall be fully vermin proofed.

A hot dipped galvanized steel base frame shall be provided and removable lifting eyes with blanking off plugs shall be provided for heavy assemblies. All panels shall be suitably braced to ensure rigidity.

The MCC's are to be fully assembled in the manufacturer's factory for final acceptance tests. Where broken down for transportation to site, the MCC's will be provided with all items required for re-assembly. Provision must be made for future extension at either side of the MCC. All holes provided for such extension to be suitably plugged or covered.

The overall outside dimensions of the assembly shall be suitable for easy handling of the switchgear. The height of the assembly shall generally not exceed 2100mm above floor level.

All doors shall be fitted with stainless steel or heavy duty rustproof hinges of Barker & Nelson or Zeus manufacture and shall be secured in the closed position by means of locking devices of approved quality. Doors in excess of 450mm height shall be secured at both the top and bottom. Lockable catches are required on all doors. All doors are to be fitted with earth straps.

Covers, other than the hinges type, shall be provided with chromium plated handles to facilitate removal. Removable covers shall be secured in position by means of patent screw locking devices approved by the Employer's Representative. All the equipment shall be mounted behind the doors and neat machine punched openings shall be provided for the purpose of operating handles etc. Employer's Representative's drawings or specifications will detail the instruments required which will be flush mounted. The positions of instruments shall be such that the glass cannot be broken by other equipment when the doors are in the fully open position.

Cut outs which are provided for future equipment and instruments shall be neatly blanked off by means of removable dummy frames. Back plates shall be provided in all spare cubicles for the specified future starters.

The manufacturer's detailed working drawings of the assembly must be approved by the Employer's Representative before any fabrication commences. Any other construction or type of assembly proposed as an alternative to that specified, must have the approval of the Employer's Representative in writing. The drawings will detail all dimensions of busbars, connections, electrical components, make, type and rating. Position and layout of busbars, earth bars and gland plates must be shown in front and side elevation drawings.

GS.1.2 PAINT SPECIFICATION

In general, the following standard colours shall be used, but the final colours are to be confirmed with the Employee's Representative.

Non-essential section	Electric orange (Colour B26 – SANS 1091)
Essential sections	Signal red (Colour A11 – SANS 1091)
Uninterrupted power (UPS)	Electric orange (Colour B26 – SANS 1091)
Instrumentation and control	Electric orange (Colour B26 – SANS 1091)

GS.1.3 BUSBARS

All busbars shall be manufactured from solid high conductivity copper and shall comply with the requirements laid down in SANS 1195. The completed busbar system shall be a standard modular system and shall have been tested to SANS approval and a certificate shall be made available confirming the full busbar technical description, current rating and fault rating together with full details of the test results.

The busbar assembly shall be rated in accordance with the specified ultimate projected faulted level, which will be not less that the short–circuit stresses limited by the protective device(s) on the supply side of the busbars, as well as the specified continuous full load current, with a current density not exceeding 1.60 Amps per mm^2.

The busbars shall be continuously rated for the specified current with a maximum temperature of 40°C relative to a peak ambient temperature of 40°C giving a maximum peak busbar temperature of 80°C.

Busbars shall be mounted in the top section of the assembly and shall be rigidly supported by means of approved insulated busbar clamps to prevent damage resulting from the specified short circuit conditions.

The busbars shall run along the entire length of the assembly up to 76mm from either end. The phase busbars shall be identified in the phase colours red, white and blue.

The busbars shall be arranged horizontally with the longer side of the cross-section in the vertical plane and one behind the other in the horizontal plane. The minimum clearance between live conductors and live conductors and earth shall be 40mm.

GS.1.4 BUSBAR DROPPERS

All busbar droppers must be suitably supported and braced to suit the specified and/or project short circuit conditions. They should be fully insulated and screened against accidental contact.

The droppers to the supply side of a single functional unit, as well as the components included in this unit, may be rated on the basis of the reduced short-circuit stresses occurring on the load side of the short-circuit protective device in this unit provided that these conductors are arranged such that under normal operating conditions an internal short-circuit between phases and/or between phases and earth is only a remote possibility, for example by being provided with adequate insulation or shrouding.

Particular attention shall be paid to the provision of adequate facilities for making off the main power supply cables. Attention must be paid to the vermin proofing of single core cabling.

Bunched cable connections will not be accepted between busbars and outgoing power circuit breakers, fuses or isolators.

GS.1.5 **EARTH BUSBAR**

A solid copper earth bar shall be provided inside each assembly at the back and along the entire length, at a height of approximately 500mm above floor level, or 200mm above the gland plates. A bar is to be provided at the top of the assembly where top entries exist and this shall be solidity connected to the bottom earth bar.

The earth bar will be supported on robust spacers and will have a minimum clearance of 40mm to the sheet steel panel.

The earth bar shall have a cross-section of not less than 40mm x 6mm and shall be drilled with the requisite number of holes for the individual connection of all cable ECC and other earth conductors.

High tensile phosphor bronze or cadmium plated nuts, bolts and lock washers shall be provided through the earth bar at each earth position and at least 5 additional holes will be provided for future connections, each being fitted with nuts and bolts as above.

The earthing positions shall be evenly spaced along the length of the earth bar and the bar must be clearly identified as the earth.

GS.1.6 **BUSBAR CONNECTIONS**

All connections and extensions to busbars shall be effected by means of high tensile phosphor bronze nuts, bolts and washers or cadmium plated, high tensile steel bolts and nuts which shall also be provided for future extensions. The minimum diameter of any holes will be 10mm.

In exceptional cases a relaxation of SANS 1973 may be permitted to allow the drilling of holes, in which case the cross-sectional area as measured is to be reduced by the area of the holes.

GS.1.7 **EQUIPMENT**

Unless otherwise stated on the drawings or as specified, the latest version of the following minimum specifications shall be assumed for equipment to be installed in the switchboards.

Busbars	SANS 1195
Circuit breakers	SANS 60947 Part 2 and SANS 156
Switches, disconnectors and fuse Combination units	SANS 60947 Part 3
Contactors and motor starters	SANS 60947 Part 4
Control circuit devices and switching Elements	SANS 60947 Part 5
Multi-function switching devices	SANS 60947 Part 6
Ancillary Equipment	SANS 60947 Part 7
HRC fuses and fuse switches	SANS 60269

SANS 60947 relates specifically to equipment for use at voltages up to 500 Volts

Where a voltage in excess of 500 Volts is specified, the manufacturer must confirm that the equipment is suitable and has been tested to that higher voltage.

The equipment to be mounted in the panels will be detailed in the drawings or as specified and schedules provided.

All contactors and/or starters shall be protected with suitable back-up HRC fuses or current limiting circuit breakers to protect the equipment against abnormally high currents or short circuits developing in the system.

The manufacturer will be required to ensure the correct co-ordination between fuses, contactors and overload relays to comply fully with SANS 60947 Part 4 in order to achieve "Type 2" co-ordination. Current limiting circuit breakers will only be permitted if the manufacturer submits full details of tests results confirming to Type 2 co-ordination.

Unless otherwise stated, contactors and/or starters shall be rated for 10 million operations for making and breaking no-load current to category AC3 as laid down in SANS 60947. Note that SANS 60947 requires equipment and wiring to be suitable for 7.2 x FLC for DOL starters.

Access to the various starters shall be possible without isolation of the entire MCC, but the doors corresponding to each compartment shall be inter-locked with a local isolator in order that any compartment must be isolated before access to the equipment can be obtained. A mechanical device shall be incorporated in each isolation in the off position to provide a locking out facility during maintenance periods.

Timers and relays controlling a starter shall be mounted in the compartment with the starter. All timers and relays must be clearly labelled with the identity given on the schematic diagrams.

GS.1.8 DERATING OF EQUIPMENT

Full cognizance must be taken of manufacturers derating tables of equipment located in enclosures and the rating of that equipment must be increased accordingly. In all such cases labels must be provided on the front of the associated cubicle stating the maximum permitted circuit loading.

Where high ambient temperature and/or continual high loadings are anticipated, the assembly must incorporate adequate ventilation systems to eliminate the possible build-up of excessive temperatures or humidity. Where specified, renewable filter elements must be incorporated.

GS.1.9 CABLE TERMINATIONS

Due to the continuing miniaturization of equipment, difficulties can be experienced in terminating power cables onto equipment terminals, particularly where more than one cable has to be terminated. The manufacturer shall ensure that suitably designed and rigidly braced copper stubs are extended from such terminals to facilitate the termination of all cables.

GS.1.10 INSTRUMENTATION

All instruments shall be of a matching flush pattern, preferably with a 96mm x 96mm square dial.

All main incoming panels shall be provided with three combined maximum demand/instantaneous ammeters, a voltmeter and selector switch as well as any additional instrumentation detailed on the single line diagrams or as specified.

GS.1.11 AMMETERS

Combined maximum demand type instruments will comprise a moving iron ammeter showing the instantaneous current value, combined with an ambient corrected, manually reset, thermal maximum indicating ammeter which will indicate the mean current reached during any 15 minute period.

The starter cubicles for all motors rated at 11kW and above and all motor driven pumps irrespective of size shall be provided with an ammeter, which shall incorporate an adjustable red pointer and an extended starting characteristic. Allowance must be made for the full load current of all motors to be checked and for all red pointers to be set accordingly.

GS.1.12 CURRENT TRANSFORMERS

Where applicable, the current transformers shall generally be of the ring type complying with the requirements of SANS 60044-1, as amended. The current transformers shall have a Class 3 or 5 accuracy.

GS.1.13 VOLTMETER

Voltmeters shall be of the moving iron, suppressed zero type, having a full scale deflection of not less than 480 Volts, unless otherwise specified.

GS.1.14 VOLTMETER SELECTOR SWITCH

All voltmeter selector switches shall be wired to connect the voltmeter between all phases and each phase and neutral and shall disconnect it in the OFF position. The switch shall have a position located switching mechanism.

GS.1.15 INSTRUMENTATION FUSES

All instrument fuses shall be mounted in the panel onto or next to the busbars. 6mm² wiring shall be used between the busbars and the fuses and shall be kept as short as possible.

HRC cartridge fuse links to SANS 60269 shall be used and shall incorporate visual indication devices to facilitate the location of blown fuses on visual inspection. They shall be designed to clip into the fuse carrier contacts without the use of fixing screws.

Wiring from fuses bases to instruments may be bunched but must be suitably supported in Bowthorpe Hellerman trunking or lacing.

GS.1.16 PROTECTIVE DEVICES AND PROTECTION SETTING

The switchgear shall be provided with the specified protection and auxiliary relays, which must be of a modular pattern, readily accessible, replaceable and extensible.

The thermal overload releases and instantaneous magnetic short circuit trips are to be adjustable over the trip ranges as specified by the Employer's Representative.

The contractor must allow to grade, set and test the protection devices for the main switch, bus section switches and each motor circuit.

GS.1.17 PUSH BUTTONS AND INDICATING LIGHTS

Unless otherwise indicated, the following is the minimum requirement for illuminated push button and indicating lights:

START and STOP push buttons

RUN, STOP, THERMISTORS and HEATER lights

Indicator lamps may only be of the neon or LED types. Where LED's are used as indicators on main supply voltages, a suitable current limiting capacitor and reverse voltage protection diode must be used. For low AC or DC voltage (±24V) a current limiting resistor will suffice.

GS.1.18 CONTROL VOLTAGE SUPPLY /BACK UP SUPPLY

The control voltage shall be provided by a single phase, double wound transformer supplied from the Red and White phases of the main busbars, with the secondary voltage as specified on the schematic diagrams or as specified.

The primary and secondary connections are to be provided by suitably rated and labelled HRC fuses.

Unless otherwise specified, the transformer shall be rated at 0.8 x (total hold-on VA of all contractors plus VA of all lights and relays plus pull-in VA of largest device) with a further additional allowance of 50% for future extensions.

Should the main busbar system incorporate a bus-coupler, 2 control transformers shall be provided. Supplies to the 2 transformers shall be controlled by contactors interlocked to ensure that only one transformer supplies the control circuit at any one time.

Where suitable, a control voltage busbar shall be provided along the length of the MCC.A power supply unit with backup up battery for the PLC is to be installed and wired in a separate cubicle. The 12V DC circuit must be supplied by a 25W DC/DC converter for equipment using 12 Volts (eg. room security sensors). Two (2) backup batteries are to be low maintenance sealed lead acid type of 12 V DC 70AH.

GS.1.19 CABLING, WIRING AND TERMINALS

GS.1.19.1 STARTER WIRING

Particular attention shall be paid to be the method of wiring from busbars to the individual compartments, in order to avoid any cable crossing through a compartment with which it is unrelated.

The wiring between all starter components, isolators, fuses, contactors, overload relays and terminals is to be rated to suit the maximum capacity of the starter and is to be not less than 6mm².

Three phase panels shall be wired in red, yellow and blue PVC insulated conductors for the phases, black for neutral and green earthed circuits.

Single phase panels shall be wired in red and black PVC insulated conductors, for phase and neutral respectively and green for earthed circuits.

Neutral connections shall be black and this colour must not be used for any other wiring.

Multi-stranded or laminated conductors shall be used between all items of equipment in preference to solid conductors. The insulation of these conductors shall not be stripped beyond the leading edge of the terminal in which it has to be accommodated.

Stripping shall be carried out without damage to the conductors, preferably by means of a cable stripper.

Approved crimping lugs and ferrules or approved clamps shall be used for connection into equipment not provided with compression type terminals.

All panel wiring shall be completed and installed at the MCC manufacturing works. The wiring shall be loomed or encased in PVC cable trunking of Hellerman manufacture or equal approved and shall be carried out neatly along vertical and horizontal lines.

GS.1.19.2 CONTROL AND INSTRUMENTATION

Suitably protected control supervisory and auxiliary circuits must be wired with 1 mm² conductors. The wire colour codes must be according to SANS 10142-1:2012. Edition 1.8

220 Vac	-Red
Neutral	-Black
+24 Vdc	-Grey (Marked +24Vdc)
-24 Vdc	-Blue
12 Vdc	-Yellow (Marked +12Vdc)
-12 Vdc	-Blue
Telemetry	-Purple

Each end of the conductor shall be terminated in a pre-insulated, spade or pin type lug, applied by means of the recommended colour coded crimping tool. All control wiring shall be clearly marked by interlocking plastic ferrules, the numbers corresponding to wire numbers on the schematic diagrams.

If control and/or supervisory wiring is required for equipment which is installed on the doors of the panel the wiring shall be bunched together and suitably strapped with spiral binding in the form of a vertical "U" loop between the door and the panel, to ensure that there is no tension on the wiring when the door is rotated along is vertical axis. Approved wiring supports shall be fixed onto the hinged panels, to relieve the weight of the cables off the equipment terminals. Each door shall be suitably earthed.

GS.1.19.3 **POWER CABLE TERMINATIONS**

Sufficient space must be allowed for the connection of all known and future incoming and outgoing cables.

Outgoing cables shall be glanded off on galvanized gland plates at the bottom or top of the vertical cables ways. Where top access is required, it will be specified in the tender document.

Approved shrouded and shielded terminals shall be provided for the outgoing connections to each motor for conductors up to and including $35mm^2$, rated at least 50% in excess of the conductor rating. The terminals shall be fixed in the vertical cables way of the assembly and shall have ample space for making off the outgoing cable terminations.

Conductors of $50mm^2$ and above shall be terminated directly onto the starter equipment, but the cables must be adequately supported to ensure that no strain is imposed on the equipment.

GS.1.20 **GLAND PLATES**

A strong and robust 3mm hot dipped galvanized cable gland shall be provided along the entire length of the assembly at a minimum height of 300mm above floor level. The gland plate shall be constructed in sections and bolted in position to take the load of the cables being glanded to it.

When cables enter/exit from the top of the board, the top cover plate will act as the cable gland plate and shall also be 3mm thick. It shall be bolted to the frame do that it can be removed if necessary. The terminals associated with these cables will be mounted not less than 200mm below the top cover plate.

All gland plates shall be machine punched in the factory to suit each and every cable gland required. Under no circumstances will any drilling or filing be allowed on site.

GS.1.21 **OUTGOING POWER CIRCUITS**

All cables shall be terminated with approved glands to suit the application. Particular attention shall be paid to the termination of ECC cabling to ensure the continuity of all earth conductors.

Every termination of a power cable shall be provided with an approved numbered Bowthorpe Hellerman tag identifying its size and destination, fixed below the cable gland plate in a position which is easily observed from the front to the boards. This procedure must also be incorporated at the motor termination box.

GS1.22 MARSHALLING COMPARTMENTS

When specified, marshalling compartments shall be provided for control circuit wiring.

The marshalling compartment shall be adequately sized to accommodate all the required terminals PLUS provision for a further 50% spare terminals.

Where a motor control centre is to be broken down for transportation to site, each section shall be provided with a marshalling compartment to the above requirement so that the associated wiring is not disturbed.

Where such control circuits are unavoidable and control wiring has to cross a break, it shall be suitably identified and disconnected at one end during transportation.

Terminals for each starter should be grouped together and clearly identified by a permanently affixed label. Terminals shall be mounted on rails and space shall be provided for spare terminals after each group of terminals.

A suitable gland shall be provided for terminating the control cables and adequately sized cable way shall be provided for running the cable ends to the terminals in the marshalling compartment.

A 220 Volt switched socket outlet shall be provided in each marshalling cubicle. Where specified, a switched light shall also be provided.

GS.1.23 PLC HARDWARE

When specified in the tender document, provision shall be made for mounting the PLC hardware in the motor control centre. All PLC components will be supplied by the contractor.

Details of the equipment to be installed and the required arrangement of such equipment will be included in the tender document. In general, the manufacturer shall allow 1 or more compartments or tiers in the MCC for rack assemblies which shall accommodate ONLY the PLC hardware, including the input and output modules. Where special power supplies such as a CVT, UPS or DC supplies are specified, these shall be regarded as part of the hardware and shall be mounted in the same compartment as the other equipment. Ventilation fans and renewable filter elements shall be provided to ensure that temperature limits are not exceeded.

The power circuit drawings and the control schematics relating to each MCC will include all connections to the PLC hardware. All such connections shall be made by the MCC manufacturer via the marshalling compartment.

In addition to the general power earth bar specified elsewhere, an “Instrument Earth 0 Volt Bar” and an “Instrument Screen Earth Bar” shall be provided in each compartment housing PLC Hardware and these shall be used only for instrumentation earthing connections. They shall be electrically isolated from the power earth.

Particular attention shall be paid to the provision of cabling facilities to the modules. Adequate PVC cable trunking shall be installed and separate trunking shall be provided for analogue and digital circuits.

Wiring to and from analogue input and output modules shall be carried out using cables equal to Contronics DEKORON control cable Type 1751, with 0.5mm² conductors.

Each analogue control cable shall be individually earthed to the instrument earth bar by means of its tined copper drain wire AT ONE END ONLY.

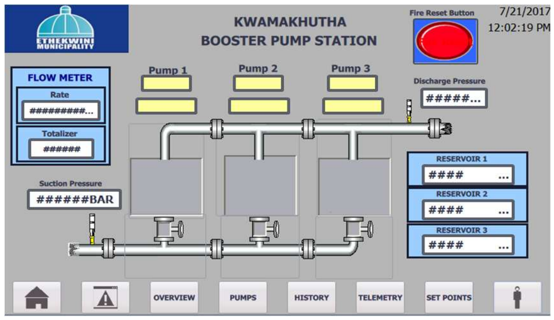
The wiring between each starter panel and the digital input and output modules in the PLC panel shall be as indicated on the circuit diagrams and shall be installed in adequately sized PVC trunking with provision for 50% spare capacity. With the exception of the PLC output to the starter or relay coil, no power circuits may be run in this PVC trunking.

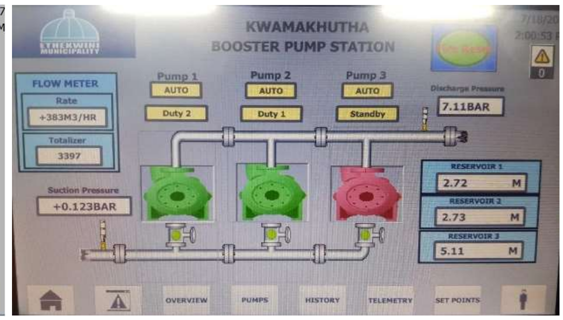
Each end of each core shall be terminated in a spade or pin type pre-insulated lug and marked with its respective wire number by means of interlocking plastic ferrules as detailed in the circuit diagram or termination schedule.
Where connections are to be made between the PLC I/O modules and field cabling, the MCC manufacturer shall wire the I/O module terminal to the marshalling compartment.

GS 1.24 HUMAN MACHINE INTERFACE REQUIREMENTS

The requirements stipulated below relate largely to the HMI graphics and the information that should typically be provided as a minimum. It is expected that the Contractor will use due discernment in design of the HMI. In general, the HMI shall be user-friendly while still providing pertinent information for the facility. Trips/alarms must be easily reset without having to navigate multiple sub-menus. Unless otherwise specified, a 7 inch HMI must be provided.

Home Screen

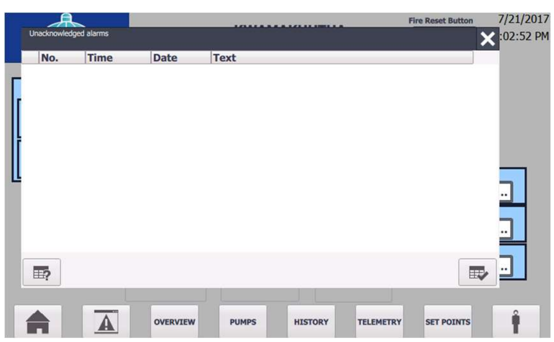


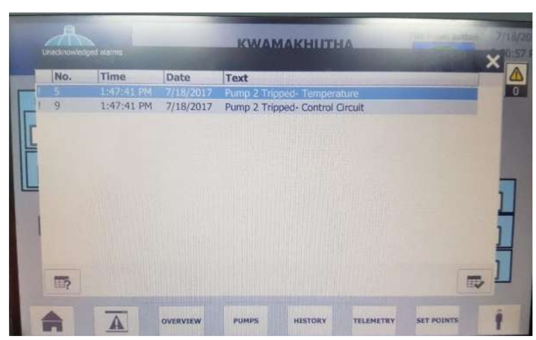


The Home Screen shall be the primary landing page on the HMI and must generally be in accordance with the images above. It must display the main components of the installation and provide a general indication of the statuses of major equipment. It shall indicate the duty/standby state of the equipment and display relevant information pertaining to the control and operation of the facility. These include, calling reservoir levels, suction pressure, discharge pressure, BPT levels, control set-points and flow readings among others, as required.

The equipment graphics shall be active such that if pressed will provide further operating information/commands for the specific piece of equipment. The number of unacknowledged active alarms must also be displayed for information.

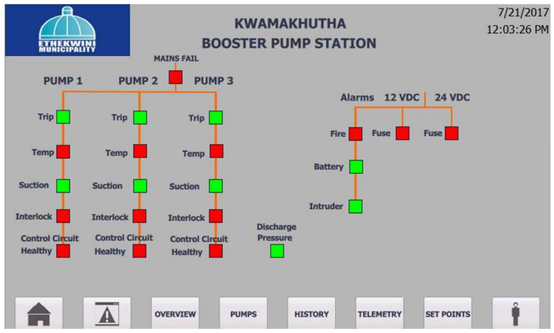
Alarm Screen

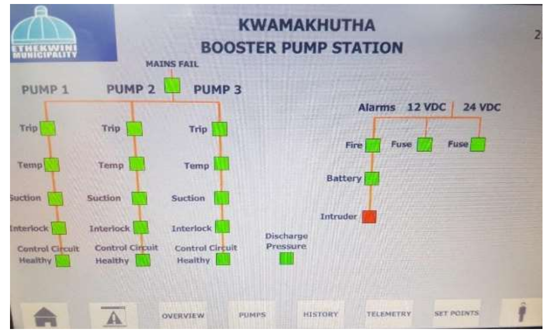




The alarm screen must pop-up to indicate active alarms/trips or faults. It must be equipped with buttons to acknowledge a specific alarm/trip/fault and an information button that provides information on the specific alarm/trip/fault which is selected at the time. Once an alarm is acknowledged it will no longer be listed on the active alarms screen.

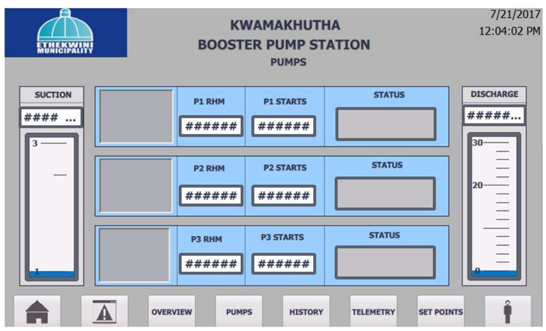
Overview Screen





The overview page is used specifically for fault-finding. It provides information at a glance as to the health of a specific piece of equipment or the facility as a whole. By means of a "Fault-tree" all possible trips/protection that could hold out equipment must be graphically laid out so that a fault is easily identifiable. Red indication denotes a fault and green denotes a healthy state.

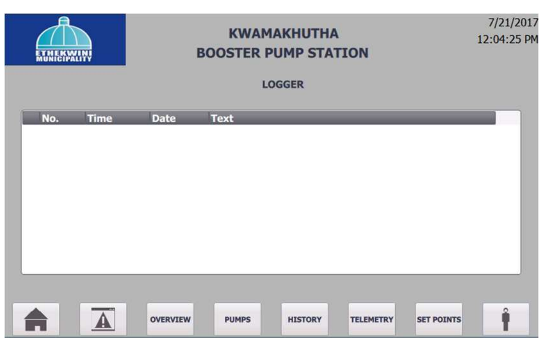
Equipment Screen (Pumps Screen)

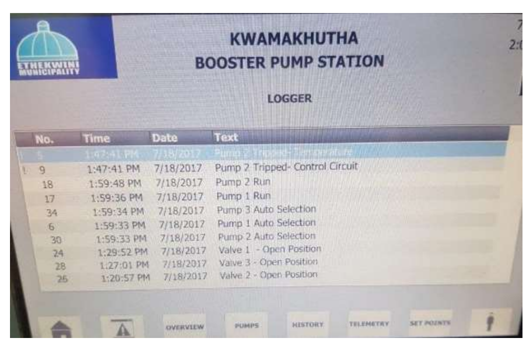


The equipment screen provides specific information on the equipment (pumps/sleeve valves etc.). It must display a run-hour meter and the number of starts. The status window must show if the equipment is healthy or tripped. If tripped, the specific trip condition must be displayed. The equipment graphic must also change colour to show running, stopped and tripped (green, red and orange respectively).

If the equipment graphic is clicked, specific operating/control information about that piece of equipment must be displayed. This includes, but is not limited to (as applicable): run hours, duty/standby status, operating state (running/stopped/tripped), vibration readings, temperature readings, flow-rates, pressures, open percentage, manual/automatic, associated valve statues, etc. A maintenance timer must also be incorporated into this menu, with a reset button to zero the hours if the equipment is returned to service after overhaul. This must operate separately from the run-hour timer.

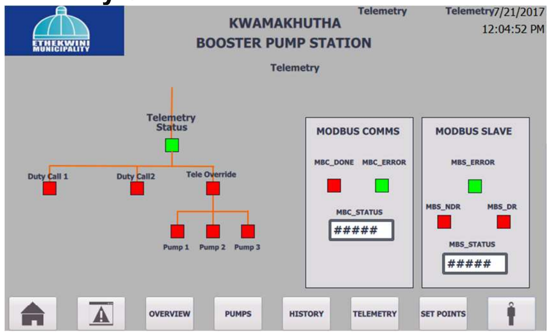
History Screen

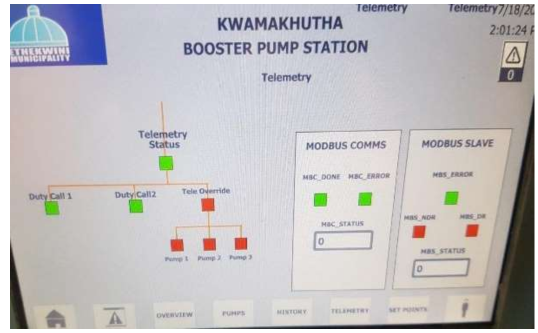




The History page provides a list of the most recent trips, alarms or other events in chronological order.

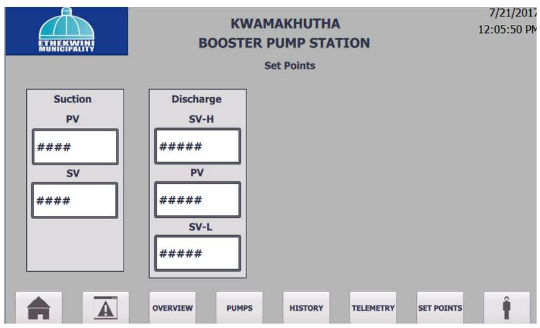
Telemetry Screen

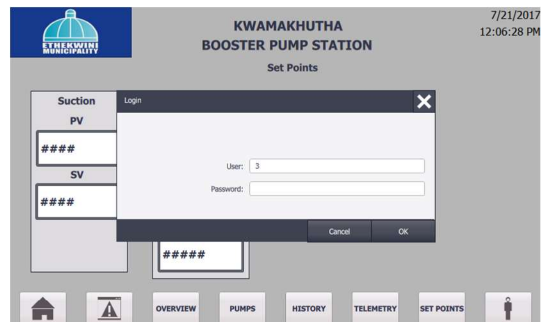




Similar to the Overview screen, the Telemetry screen provides an overview of all the signals received from the Telemetry unit to the PLC. These signals may be used for Control or simply for display purposes. This screen is used as a quick reference as to the health of the Telemetry signals and as an indication if telemetry control is active and what equipment is being controlled.

Set-Points and Log-in Screen





All control and operational set-points (including timers) must be changeable via the Set-Points screen. The set-point screen shall only be accessible to certain users and must be accessible via password protected log-in. A “Log-out” button must be provided <u>and</u> the log-in must automatically release after 15 minutes. The current user status must be displayed on the home screen (eg.: “User 3 logged in” or “No User logged in”).

Trends

Where applicable, trends of analogue signals such as pressure and flow rate shall be accessible on a separate screen. These signals are to be sampled every 30 minutes and provide at least 24 hours of trending.

GS.1.25 **SURGE DIVERTERS AND 4-20 MA LOOPS**

Where specified the MCC is to be equipped with surge diverters of approved manufacture and bearing the SANS mark.

The arrestors or diverters shall be mounted inside the panel on the incoming unit. The supply side connections shall be made in the factory to the three phase busbars, whilst the earth side connections shall be made to the earth bar of the board.

All 4-20 mA loops are to be electrically isolated from the PLC analogue input by means of an isolator unit or splitter unit.

All loops entering the panel from the field must be protected by means of surge protection units. With circuit breaker protection, equal or approved. All surge protection units are to be bonded to earth by means of 4mm² multi strand earth cable.

GS.1.26 SPARE FUSE CARTRIDGES

Where HRC or other cartridge types fuses are specified or used to protect instruments or circuits, the MCC shall be suitably equipped with a compartment for housing one third of all fuse cartridges specified, having a minimum of 1 set (i.e. 3 phase) of fuses of each size specified and all such spare fuses shall be provided inside this compartment on handing over. The compartment shall be clearly labelled: “Spare fuse cartridge”: replace used-up fuses.

GS.1.27 LABELS

The requirements of SANS 10142-1 must be complied with.

All boards or panels shall be fully labelled using sandwich type labels, fixed to the board or panel by means of either screws or rivets, or by gluing into metal label holders which are bolted to the board.

Labels should be black lettering on a white background, not less than 6mm in height and mounted centrally below each respective starter unit, in an approved position. A centrally mounted label shall be provided to indicate the manufacturer’s details, the design busbar rating and asymmetrical fault level.

A label indicating where the board is “Fed From” shall also be fixed to each MCC.

All relays and wiring terminal blocks inside the MCC shall be labelled to clearly identify the control gear and wiring to equipment.

The cable markings shall indicate the number of cores – core cross sectional area – original of the cable – cable number, of the cable. E.g.

4-35-M-01
2-2.5-M-02

Pump 1 cables

3-10-P1-01
7-1-P1-02

Pump 2 cables

3-10-P2-01
7-1-P2-02

Pump 3 cables

3-10-P3-01
7-1-P3-02

GS.1.28 WORK TESTS

The MCC shall be fully assembled and wired before being dispatched from the works. The Contractor and the switchboard manufacturer will carry out a full functional test to prove the correct operation of the entire MCC, including interlocking, remote control and the simulation of all protection devices. All other circuits external to the switchboard will be simulated and will be tested accordingly.

All MCC’s with a fault level of 10kA or more shall be type tested by an accredited person and a signed certificate issued with the MCC, The costs of all these tests shall be borne by the contractor, The tests shall be witnessed by the Employer’s Representative.

Unless otherwise specified, the correct function of the PLC hardware will not be the responsibility of the MCC manufacturer, but the contractor will be expected to have an artisan standing by during tests in order to observe the MCC operations and carry out any remedial work required.

The tests shall be witnessed by the Employer's Representative and shall be recorded in triplicate on approved test forms.

GS 1.29 SOFT STARTER

Conformity of standards

EC
The soft starter shall be constructed and tested in accordance with the international IEC standards EN 60947-1 and EN 60947-4-2 and respect the following EC directives:

- "Low voltage Equipment" No. 2006/95/EC
- "Electromagnetic compatibility Directive" (EMC) No.2004/108/EC

UL
The soft starter shall be constructed and tested in accordance with UL 508.

Product features
The soft starter shall comply with the following technical requirements:

General specification

- Three phase control with operation voltage: 208 - 600VAC or 208 - 690VAC, 50/60 Hz
- Wide rated control supply voltage: 100 - 250VAC 50/60 Hz
- Built-in bypass to reduce energy consumption at full speed and increase the life time of soft starter.
- Possibility for both in-line and inside-delta connection of the motor
- The soft starter shall have built-in Modbus RTU for communication. Support for other protocols shall be an option.
- The soft starter shall be equipped with one analog output
- The soft starter shall have a minimum of 3 signal Relays Output for Run, Bypass (Top of Ramp) and Event signal.

User interface

- The soft starter shall support multiple languages in both the manual and HMI, including: English, Swedish, German, French, Italian, Spanish, Portuguese, Dutch, Polish, Russian, Finish, Turkish, Czech, Chinese and Arabic.
- The soft starter shall have a detachable keypad with graphical LCD display. The keypad shall have start and stop buttons, information button for access to a built-in manual and an USB-port for connection to a PC.

Environmental conditions

- The soft starter shall have coated PCBAs to withstand harsh environments
- The soft starter shall support operational temperature of -25 to +60℃ with de-rating of maximum 0.8% per ℃ above 40℃
- The soft starter shall be able to operate on up to 4000 meters above sea level with de-rating of maximum 0.67% per meter above 1000 meters

Motor starting, stopping and operation

- The soft starter shall have pre-start functions:
  - Stand still brake, to keep the load still before start
  - Motor heating, to keep the motor well-tempered before start
- The soft starter shall have the following start ramps available:
  - Voltage start ramp
  - Torque start ramp
  - Full voltage start
- The soft starter shall have possibility for slow speed forward and backward operation for positioning of a motor load.
- The soft starter shall have Torque Control and pump cleaning feature, to eliminate water hammering and prolong lifetime of the pump system.
- The soft starter shall include a kick start feature to be able to start heavy loads.
- The soft starter shall have the following three types of current Limit:

- Current Limit
- Dual Current Limit
- Current Ramp

- The soft starter shall have a limp mode feature to allow the soft starter to operate even with shorted thyristors in one phase.
- The soft starter shall have possibility for sequence start of up to 3 different motors.

Built-in motor protections
The soft starter shall integrate motor and load protections, which shall under no circumstances be disabled when the integrated bypass is used. The soft starter shall also be able to present a warning before tripping for each protection.
The soft starter shall have the following motor protections available

- Electronic Overload Protection, class 10A, 10, 20, 30
- Locked Rotor Protection
- Motor Underload Protection
- Current Imbalance Protection
- Voltage Imbalance Protection
- Overvoltage and Under Voltage Protection
- Phase Reversal Protection
- Earth-fault Protection

It shall also have input for PTC and PT100.

Built-in diagnostics
The soft starter shall have the following diagnostics features:

- THD(U)-Total Harmonic Distortion
- Counted number of start sequences
- Motor runtime measurement
- Thyristor runtime measurement
- Auto phase sequence detection
- Electricity metering
- Voltage sags detection
- Time to trip estimation
- Time to cool estimation

Fault detection
The soft starter shall provide following fault detection, to protect both the starting equipment, the load and the soft starter itself

- Phase loss
- High current
- Low control supply voltage
- Fault connection
- Bad network quality
- Thyristor overload

GS1.30 VARIABLE SPEED DRIVES

1. General

This part of the specification describes the general requirements for the Variable Speed Drives, the VSDs. The nominal values, the standard documents and the drive's minimum performance are defined in this part. The VSD does not include motor in this specification. The specification uses the term Motor unit which means a combination of the VSD and the motor.

If the project-specific part of the specification (Appendix A) is in contradiction with the other parts of the document, the project-specific document shall apply.

2. Requirements for the Manufacturer

2.1 Certifications

The Frequency Converter Manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system.

The Manufacturer shall have the Environment Certification ISO 14001.

2.2 Experience

The Manufacturer shall have adequate experience in frequency converter manufacturing and have adequate business volume in order to provide credibility in his commitments and a capability of long term support. The Manufacturer shall prove his experience by quoting references of units in the specified power and voltage range.

2.3 Local support

The Supplier shall have a permanent representative office with a trained and skilled support staff, in the country where the goods are delivered, in order to prove his commitment for local support and to provide a channel for communication. The local representatives shall be easily accessible and shall be able to arrive at the site within 24 to 48 hours' notice.

The engineers employed by the Supplier's regional office shall be certified by the Manufacturer and provide start-up service including physical inspection of the drive, connected wiring and final adjustments, to ensure that the VSD meets the required performance.

The Supplier shall be able to give basic drives training to the Customer's engineers, preferably on the site but anyway, in the country where the customer's site is. The training shall, as a minimum, include system concepts and basic troubleshooting. The Supplier shall also be capable of solving most VSD problems quickly. He shall also have a 24-hour support from the Drives Factory, to avoid any delays during service or repair work on the site.

The Manufacturer shall be able to offer commissioning of the drive to be done by the local office.

The most common spare parts like fuses, IGBTs as well as main control- and IO-boards shall be available in 48 hours from the notification through a regional service center of the Supplier. The more rarely used spare parts should be available in maximum 5 days on site!

3. Basic requirements for the VSDs

3.1 General requirements

The VSD shall be of the most modern design, yet user friendly and be simple to install, commission and maintain. The VSD shall be able to start and control the speed of a standard squirrel cage induction AC motor. The VSDs shall be CE marked. The VSDs have to be built to comply with the IEC standards. In the Australian market the VSDs shall have a C-tick.

The materials used in the VSD shall be recyclable, non-toxic and flame retardant.

The VSD shall be a digitally controlled drive, using, at least, the Pulse Width Modulation (PWM) with flux vector control, a Direct Torque Control (DTC), or equivalent. It shall have IGBT's in the inverter section of the throughout the power range, and it shall have the following minimum specifications.

Operating conditions:

Rated Input Voltage	:	380V - 415V, three-phase, ± 10% or
	:	380V – 500V, three-phase, ± 10% or
	:	525V – 690V, three-phase, - 10%, + 5%
Rated Input Frequency	:	48 - 63Hz
Fundamental Power Factor	:	0.97 or better at nominal load

Efficiency	:	≥ 98 % at nominal load
Output Voltage	:	0 - U_N, three-phase
Output Frequency Range	:	0 to 300 Hz, adjustable
Output Frequency Resolution	:	0.01 Hz
Accel/Decel Time	:	0 – 1800 s, adjustable
Overloadability (by load type)	:	
Constant Torque	:	150% of nominal current for 1min in every 5 mins.
Variable Torque (pump & fan)	:	No overloadability required
Ambient Temperature	:	40 °C, for higher temperatures see below
Installation Altitude	:	1000 m, for higher altitudes see below
Max. Relative Humidity	:	95 %, non-condensing. In presence of corrosive gases, the max. relative humidity is 60 %
Max. Corrosion Level of the Cooling Air	:	
Chemical Gases	:	IEC 721-3-3, class 3C2
Solid Particles	:	IEC 721-3-3, class 3S2
Max. Vibration Level (IEC 68-2-6)	:	
2 to 9 Hz	:	0.3 mm
9 to 200 Hz	:	1 m/s^2
Main Protections	:	Overcurrent, short circuit, input/output phase loss, motor overload and underload, over/under- voltage, overspeed, overtemperature, motor stall, other internal fault.

The VSD shall be able to give a 100 % output current continuously in the above specified conditions. In order to ensure that the drive can provide the required output current in the specified ambient conditions, the Manufacturer shall inform the required derating, if the ambient temperature given in the project-specific specification is higher than 40 °C or if the installation altitude is more than 1000 m above the sea level. The derating factor shall be specified so that neither the lifetime of the VSD nor the unit's performance, overloadability included, nor the reliability of the VSD shall suffer.

Storage conditions (in the protective package):

Ambient Temperature	:	- 40 to +70°C
Corrosion Level of the Cooling Air	:	
Chemical Gases	:	IEC 721-3-3, class 1C2
Solid Particles	:	IEC 721-3-3, class 1S3
Max. Vibration Level (IEC 68-2-6)	:	
2 to 9 Hz	:	1.5 mm
9 to 200 Hz	:	5 m/s^2
Shock (IEC 68-2-29)	:	max. 100 m/ s^2, 11 ms
Free fall	:	250 mm for weight under 100 kg 100 mm for weight over 100 kg

3.2 VSD Accuracy

The VSD shall have a minimum speed control accuracy of ± 10% of the nominal slip of the motor, without a pulse encoder feedback. In practise, this means e.g. for a four-pole, 50 Hz motor with a 45 rpm slip speed, an accuracy of ±0.3 % of the motor nominal speed. The VSD shall be capable of a dynamic accuracy of at least 0.4 %sec. without additional options. If this accuracy is not achieved without a speed feedback, the Manufacturer shall specify the accuracy that can be reached and if required, a pulse encoder with adequate control devices shall be included in the motor unit at the VSD Supplier's expense. The dynamic accuracy means the drive's capability to response fast in a dynamic situation, for example, if the load changes. It is measured by the change of speed and time, i.e. how long it takes to recover to the reference speed.

3.3 Starting torque and torque step rise time

Constant torque applications: The Starting Torque of the Motor unit without a pulse encoder feedback shall be at least 150 % of the rated Motor unit torque.

Variable torque applications: The Starting Torque of the Motor unit without a pulse encoder feedback shall be at least 100 % of the rated Motor unit torque

In case of need of fast torque rise time, the torque step rise time from 10 % to 90 % of the full nominal torque should be less than 5 ms, when the motor is fully magnetised. If the motor mechanical time constants are longer than that, the torque step rise time should be according to mechanical time constant.

3.4 Quality assurance and warranty

Every VSD has to be tested functionally. The inverter part of the VSD or each inverter module at least has to be tested by running it with a motor at full nominal load. A test report of the tests made has to be included with the VSD.

The warranty period of the VSD has to be a minimum of 24 months from the date of delivery or 12 months from the date of commissioning, whichever comes first.

4. Enclosure and mounting

The VSDs up to 75 kW in 400 V and 690 V or 90 kW in 500 V, can be installed separately in drive modules. There should be a possibility for flange mounting, to provide for cases, when the drive is installed in a cabinet and to enable installation of the heatsink outside the cabinet.

The VSD shall be equipped with fuses and a main circuit switch must be available either as standard or, at least, as an option. The switch shall be equipped with a door interlocked handle, padlockable in the open position. Input fuses shall be of semiconductor type, and their characteristics co-ordinated with the drive’s electronic protection circuits so that they do not blow from normal output faults such as an overcurrent fault. The Control Panel of the VSD shall be accessible for programming and controls with the main door closed. The whole assembly shall be implemented with a strict consideration of the EMC Compatibility and Regulations as described further in this specification.

<u>Panel Design Specs:</u>

Standards	:	IEC 439-1, EN 60439 & VDE660 Part 500.
Protection Class	:	IP21 or better
Cabinet access	:	From front
Cable entry and exit	:	Bottom entry as standard. Both bottom and top entry have to be possible.

5. User interface

5.1 General

The user interface shall be similar throughout the power range to avoid confusion amongst the users and need for training in several different units.

5.2 Inputs and outputs

The following standard Inputs and Outputs at least shall be provided, to be used in interface with the control system:

Analog Inputs	:	1 x Programmable differential voltage input 0(2) - 10V 2 x Programmable differential current input 0(4) - 20mA
Analog Outputs	:	2 x Programmable current outputs 0(4) - 20mA
Digital Inputs	:	6 x Programmable Digital Inputs, optoisolated, common or separate ground
Relay Outputs	:	3 x Programmable Digital outputs with a changeover dry contact

All the control terminals shall be clearly marked.

The following functions at least shall be available via the IOs:

Input	**Output**
Analog	Analog
Speed reference	Motor speed
Torque reference	Motor torque
PID-control feedback (actual value)	Motor current
Correction signal to reference	Output frequency
	Output voltage
	Output of the process PID controller
	Control deviation of the PID controller
	Actual value of the PID controller
	Process speed
Digital	Relay
Start	Fault
Stop	Running
Forward/reverse	Ready
Pre-programmed constant speeds	Rotation direction
Speed up / down (motor potentiometer)	Fault/warning
Start and stop from 2nd source	Warning
Selection of acceleration / deceleration ramp	Stall fault or warning
Selection of user macro	VSD temperature fault or warning
Run enable	Motor temperature fault or warning
Selection of control place	Speed or torque limit reached
Fault reset	Motor magnetised
	Controlled via serial communications

5.3 Serial communications

The VSD shall as standard have a provision for communication with PC software tools. In addition, the following serial communication protocols at least shall be available as option: Modbus, Modbus+, Interbus-S, Profibus DP, LONWORKS and DeviceNet. It shall be possible to add the serial communication later.

5.4 VSD keypad

The VSD shall have a detachable keypad with alphanumeric operating display for programming and controlling purposes. The displayed messages shall be in user friendly, descriptive text. Coded messages are not acceptable. Parameter setting shall be possible by using the keypad.

Parameter setting shall be easily accessible and user friendly with actual text messages. Password protection shall be provided to avoid unauthorised tampering with the set parameters. It shall be possible to read and write the set parameters with the help of the control pad, enabling thus copying of parameters between the VSDs of a similar application, to save time during the commissioning and to avoid mistakes. The VSD shall have a local lockout to prevent accidental transfer from remote to local.

Direct keypad entry shall be provided to observe the following actual parameters. Any three of the following parameters or actual values shall be selected to be always displayed.

- Input Voltage
- Input Frequency
- Output Voltage
- Output Frequency
- DC Bus Voltage
- Output Power
- Output Torque

- Output Current
- Motor Speed
- Process Speed

The following parameters shall always be displayed during normal operation.

- Speed Reference
- Run / Stop / Fault
- Remote / Local

The VSD shall have self-diagnostic properties to display faults and warnings as they occur and be able to store at least 15 previous faults into the fault memory. The fault memory shall be accessible by PC maintenance tools.

The following drive control functions at least shall be available from the keypad:

- Run
- Stop
- Local / Remote selection.
- Forward/Reverse (if function enabled)
- Accelerate (manual/mode)
- Decelerate (manual/mode)
- Parameter setting
- Scrolling & Viewing through Actual values

5.5 Application programming

The VSD shall be designed for both simple and the most complicated applications, yet it shall be user friendly. The VSD shall have built-in application macros, to allow selection of the range of pre-programmed control configurations and further, the VSD shall enable storing of two customer modified macros at least, to suit the specific application. It shall be possible to reset the parameter settings back to the original macro settings through the keypad. The parameter readouts shall be in text format and not coded.

5.6 PC Tools

The VSD Supplier shall have a Windows based PC software available for monitoring and controlling the VSDs, and the software shall be offered as an option. The software shall be supplied with the necessary hardware and a provision for connecting a PC with the VSD. It shall be possible to set and modify parameters, control the drive, read actual values and make trend analysis using the software.

6. Software features

6.1 Power loss ride-through

The drive shall have a power loss ride-through capability. This means that the drive controls should stay alive during a power loss by means of the energy stored in the load. The ride through time shall be the longer the higher the kinetic energy of the load is. The motor shall be magnetised as long as there is kinetic energy in the system.

6.2 Flying start

The drive shall have a built-in Flying Start feature. This feature will allow a Motor unit which is still rotating, to be restarted without first stopping it. The VSD shall restart the motor from the rotating speed and then reaccelerate to the speed indicated by the speed reference signal. The Flying Start feature shall be available in both directions, to be able to start the drive in the required direction regardless of the rotation direction of the motor.

6.3 Flux optimisation

The VSD shall have a built-in automatic Flux Optimisation function. The Flux Optimisation function minimises the sum of the magnetising current and the load current so that the drive can still follow the given reference. This feature reduces energy consumption and motor noise when driving at less than the nominal load.

6.4 Flux braking

There shall be a possibility for Flux Braking, where VSD increases the motor magnetisation to dissipate the extra energy in case of need for small braking power. It shall be possible to use the braking to decelerate the motor from one speed to another – not only for stopping the motor.

6.5 Critical speed jump-over

The VSD shall have programmable skip speeds to jump over critical resonance speeds. If the speed reference is in the critical speed area, it is ignored and the latest speed reference is maintained. Three programmable critical speeds at least shall be available.

6.6 Current/speed limiting

In case the acceleration or deceleration ramps are too fast for the drive capacity, the drive shall be able to automatically reduce the ramp to prevent tripping. Also, in case of transient overloads the drive shall automatically reduce speed to prevent an overcurrent trip, if the drive capacity is not sufficient to handle the load.

6.7 PID-controller

The drive shall have a built-in PID-controller for control of the customer process.

6.8 Restart

In the event of a fault trip due to overvoltage, overcurrent or loss of analogue signal, the VSD shall be programmable to attempt an automatic restart. For safety reasons, the maximum number of attempts shall be five (selectable) within a short time. If the fault does not clear after the attempts, the drive shall lock out.

7. Environmental effects

7.1 Harmonic Distortion

The VSD shall have built-in AC or DC chokes to minimise the Total Harmonic Distortion (THD). The THD of the unit for current has to be less than 50% in a supply network with a short circuit ratio (Rsc) of 300 (i.e. the ratio of the supply network's short circuit current to the unit's nominal current). If the supply voltage is 440 V or higher, the THD value has to be less than 55%. However, the VSD Manufacturer shall submit to the contractor the VSD Harmonic spectrum for the project-specific supply network. The spectrun shall be used in the design of appropriate harmonic filters, if required by the Customer. The single harmonics shall be presented up to 25^{th} harmonic and the THD has to be calculated taking into consideration harmonics up to 40^{th} harmonic.

7.2 EMC Regulations and Compatibility / C-Tick

The supplied VSDs shall carry the CE mark (or C-Tick in Australia) indicating that they comply with the essential requirements of the relevant EU directives (or C-Tick requirements in Australia). The VSDs shall meet the requirements set in EN 61800-3 for Industrial Low-Voltage Networks. If the project-specific specification states that the requirements for Public Low-Voltage Networks stated in EN 61800-3 must be met, the Supplier shall be able to provide such units at least up to 75kW in earthed networks. If separate EMC filters are required, they shall be of built-in type.

A detailed description and other directions to maintain the EMC Compatibility during the installation of the VSD and associated field cables and connections, shall be given by the Supplier in conformance with the EMC Directives or C-Tick. The Contractor shall follow the directions during installation, in order to achieve attenuation of the RFI.

7.3 Audible Noise

The full load audible noise of the frequency converter shall not exceed 70 dB(A) in 200 kW applications and below. Above 200 kW, the full load audible noise shall not exceed 78 dB(A). If the frequency converter is installed in a cabinet and requires a separate cooling fan, these limits also include the noise of the additional cooling fan. This requirement is made to keep the electrical room quiet so that it is not necessary to use hearing protection. The audible noise of the motor should also be minimised. For that purpose the switching frequency of the frequency converter shall be at least 2 kHz throughout the power range.

7.4 Efficiency

The full load efficiency of the VSD shall be at least 98 % including all the additional equipment which is needed to meet this specification.

GS.1.31 SITE TESTS

After completion of erection, cabling and field wiring, the contractor shall set all overloads, protection devices etc. and shall again carry out a full functional test to prove the correct operation of the entire MCC, including the simulation of all remote devices. A signed compliance certificate by the Contractor's accredited person for the MCC and its installation shall be handed over to the Employer's Representative on Completion.

The tests shall be witnessed by the Employer's Representative and shall be recorded in triplicate on approved test forms.

GS.1.32 INSTALLATION OF MOTOR CONTROL CENTRES

The contractor shall make it his responsibility to furnish the switchboard manufacturer with all the relevant information in respect of the accommodation to be provided, including cable trenches and ducts etc.

Where possible, the largest number of cubicles or panels should be installed intact, to avoid assembly on site, provided space and handling facilities and conditions do not lead to damage of the unit.

The contractor will advise the manufacturer which of the cables enter or leave from the top or bottom of the MCC.

GS.1.33 DRAWINGS, EMPLOYER'S REPRESENTATIVE'S APPROVAL, GUARANTEES

CAD generated drawings of the equipment showing full details of layout and proposed wiring system and equipment offered shall be submitted for approval to the Employer or his Representative prior to manufacture. The drawing must include part numbers and manufacturers of all plant and equipment.

The Employer's Representative shall also be advised when the board are being manufactured and when they will be ready for inspection at the works, Equipment which is despatched to the site without the authorization of the Employer or his Representative may be rejected and all costs incurred in having it returned to the factory, where necessary, and any liability for delays, will be for the contractors account.

The contractor will issue to the Employer's Representative one set of sepias and 3 copies of drawings of the "As Built" equipment which has been installed and connected on site after the draft copy has been approved. Handbooks, spares lists and maintenance instructions etc. will be issued to the Employer's Representative in triplicate at the time of handing over the equipment before the guarantees period commences.

The manuals shall be comprehensive and to include all equipment supplied. A 12 month guarantee shall cover the sheet metal enclosures and all the equipment installed therein against fault workmanship and materials. The guarantee period shall begin from the date the MCC's are completely installed and accepted by the Employer's Representative. Fair wear and tear of equipment will be excluded from the guarantee.

GS.1.34 **COMPLETION**

Prior to the handing over of the boards or panels and the associated electrical installation, they shall be rendered completely free of all dust or rubbish that may have collected during installation and building operations, and finished surfaces shall be made good where necessary, using the identical paint finishes from the same batch, as at the time of manufacture.

The MCC's shall be vermin proofed. Similarly, all cable trenches will be thoroughly cleaned out and all covers fitted before the work will be considered as complete. All labels will be correctly engraved and fixed to panels and cables as specified before the work can be considered complete.

All cable sleeve or other openings shall be closed or patched up and made good: Cable sleeves shall be sealed using an approved expanding foam sealer and neatly trimmed.

GS.1.35 **SUGGESTED SUPPLIERS**

Refer to Annexure A.

GS.1.36 **MANUFACTURERS**

Manufacturers may be considered by the Employer's Representative, but only if they have a proven track record of manufacture to SANS 1473/SANS 60439.

The tenderer shall ensure that copies of these Standard Specifications, Detailed Specifications, layout drawings and single line diagrams if available shall be provided to the manufacturers to ensure that they make full allowance for all requirements in their pricing.

ANNEXURE A

SCHEDULE OF RECOMENDED EQUIPMENT. THE TENDER MAY, HOWEVER, OFFER ALTERNATIVES

Soft starters	ABB
Variable speed drives	ABB
Circuit Breakers	Merlin Gerin, ABB, CBI
Contactors, indication lamps	ABB, Telemecanique,
Relays, fuses, motor protection relay	Omron, ABB,Finder
Control switches, selector switches	Krause and Naimer, ABB, Telemecanique, Moeller
Electronic Motor Controller	ABB UMC22-FBP,Omron SEK
Ammeter, voltmeter, current transformer, operations counter, hour meter.	Hartmann and Braun
Cables, Wire	Aberdare
HRC fuses and holders	G.E.C.
DC Power Supplies	Meanwell Ad-155B
Electrically operated solenoids	Festo, Asco, Burkert
Level Control	Siemens Milltronics Multiranger MR200 DP 6R, Siemens stainless steel echo max transducer brackets FMS310.
Surge Arrestors	Dehnguard 275 and 1 No. DehnGap
Power supplies	Siemens / SITOP series
Relays	Omron, ABB
Terminal relays	Weidmuller, Klippon, Phoenix Contact
Electrical motors	WEG,ABB
Emergency stop stations	Cutler Hammer, ABB
Circuit breakers	ABB, Schneider, M&G
Fuse switches	ABB Stromberg
Terminals	Klippon, Phoenix Contact
Cable glands	Pratley Envirogland
Junction boxes	York enclosures
Power monitor	Schneider , ABB
Open channel measurement flow meter	Siemens Milltronics Multiranger MR-200 DP 6R
Radar level meter	Krohne, VEGA, Siemens
Magnetic flow meter	Safmag, Siemens, Krohne, Endress & Hauser
Other flow meters	Siemens, Fuji, Krohne, Endress & Hauser
Flow switches	EGE
Pressure transmitter	Wika, Siemens
Differential pressure transmitter	Wika, Siemens
Chlorine gas leak detectors	Siemens, Grundfos
Residual chlorine meter	Siemens, Grundfos

Dissolved oxygen meter	Hach LDO type
Turbidity meter	Hach, Endress & Hauser
Temperature measurement	Wika, Siemens
Pressure gauges	Wika ,Siemens
Air flow meters - Thermal resistance type	Endress & Hauser
Proximity switch	efector (Shorrock Automation)
Solenoid operated valves	Bürket
Surge protection	Surgetek : BCT BE24 (signals) DEHNguard 275 (line) DEHNgap B (neutral) Phoenix Type TT-2-PE- 24VDC
	DehnVentil 255 - Mains
Loop splitters	Omniflex type LPI/LPS
UPS	APC
SCADA	Adroit
PLC	Siemens S7 1200
HMI	Siemens Touch screen
Industrial Ethernet network switch	Unmanaged - Hirschmann Managed - Hirschmann
Pneumatic actuators	Festo, Biman
Electrical Valve actuators	Aumanat
Telemetry Unit	ISTAT M2X3
Pipework Coating	Plascoat PPA 571 Aqua
Non-Shrink Grout	Pro-Struct 531-MCI

ANNEXURE B

COMPULSORY DATA PACK FOR MCC

1) Drawings 3 sets
2) Drawings electronic format CD as built
3) Factory Routine Test Certificates (SANS 1473-1)
4) Site Test Certificates
5) Certificate of Compliance
6) Maintenance Manual
7) Technical Specifications
8) All Electronic and Electrical Manuals
9) Partial Type test certificates for MCC over 10Ka.
10) Paint Thickness certificate.
11) All programmable parameters of all electronic/instrumentation equipment, overload settings, soft starters, shall be supplied.
12) An electronic copy of the PLC program installed in the plant
13) A schematic of all cable routes and joints of all cables. This should show the position of all cable markers installed.
14) A life cycle letter from the manufactures of all electrical and electronic equipment. (Soft Starter/VSD). Contact details of all agents/ sole suppliers of all electrical and electronic equipment for after sales service and back up.

ANNEXURE C

SPECIFICATION FOR THE INSTALLATION OF LIGHTING

This is the Standard Specification for the Installation of Lighting at the pump stations. All lighting installations shall comply with the Occupational Health and Safety Act (85 of 1993) and the SABS Wring Codes of practice 01042. All lighting offered shall be of the latest energy efficient lighting and control. All lighting shall be of the Eskom approved energy saving LED type and shall match or exceed the existing lux levels.

The installation shall be done in the manner outlined below in the following areas.

PANEL ROOM, OUTSIDE, DRY AND WET WELL LIGHTS

Type of light Fixture
Five Foot (5ft) double dust and hose proof light fittings/250MV.

Method of Mounting
All light fittings shall be mounted with 8mm x 40mm stainless steel Double Wedged anchor Bolts.
.

Method of Termination:
Each light fitting shall have a 500mm, two core plus earth cabtrye. Tail piece that is to be terminated in a four way round junction. Box (preferred CCG No1); having a rating of no less than IP65.The strip connectors shall be rated at 30amps for ease of connection and disconnection.

Electrical Circuit
The lighting circuit in each location shall have its own circuit breaker and must be labelled.

Light Switch
Each location shall have its own weather proof light switch in its own enclosure and be labelled. This should mounted at the main door entrance of the panel room or as instructed by the Engineer.

Mounting Height
The light fittings shall be mounted at a height that is maintenance friendly. If a ladder is to be used it shall be of a maximum of a 5ft ladder. Lights in sumps must be mounted out of the flood zones.

General Installation of Conduits
The use of PVC conduit is only permitted if it is installed in such a manner that it is not exposed to direct sunlight. Hospital or spacer bar saddles shall be used to fix the conduit onto the wall. Bosal pipe must be used for outside installations.

Outside Lighting
These lights shall be controlled via a timer.

C3.5 CONTRACT AND STANDARD DRAWINGS

No Standard Drawings