C3.3: PROJECT SPECIFICATIONS

AMENDMENTS TO THE STANDARD AND PARTICULAR SPECIFICATIONS

In certain clauses in the standard, standardized and particular specifications, allowance is made for a choice to be specified in the project specifications between alternative materials or methods of construction, and for additional requirements to be specified to suit a particular contract. Details of such alternative or additional requirements applicable to this contract are contained in this part of the project specifications. It also contains the necessary additional specifications required for this particular contract.

The number of each clause and each payment item in this part of the project specifications consists of the prefix PS followed by a number corresponding to the relevant clause or payment item in the standard specification.

The number of a new clause or payment item, which does not form part of a clause or a payment item in the standard specifications and which is included here, is also prefixed by PS, but followed by a new number which follows on the last clause or item number used in the relevant section of the standard specifications.

PART A: GENERAL

A1 SERVICES

Provision is made in the bill of quantities for payment for searching and exposing of known or unknown services.

PS2 PROGRAMME OF WORK

(a) General requirements

The bar-chart programme to be provided by the contractor shall show the various activities in such detail as may be required by the Employer's Agent. Progress in terms of the programme shall be updated monthly by the contractor in accordance with the progress made by the contractor.

In compiling the programme of work, the contractor shall indicate and make due allowance for the following:

a. Civil works as per the tender drawings, Bill of Quantities and Scope of Works;
b. Mechanical & Electrical (M&E) Works.

PS3 WORKMANSHIP AND QUALITY CONTROL

The Employer's Agent shall, however, undertake acceptance control tests for the judgement of workmanship and quality, without accepting any obligations vested with the contractor in terms of the contract with specific reference to quality of materials and workmanship. Such acceptance control test done by the Employer's Agent shall not relieve the contractor of his obligations to maintaining his own quality control system.

The Employer's Agent shall, for the purpose of acceptance control on products and workmanship, assess test results and measurements.

Where small quantities of work are involved, a lot shall mean a full day's production for a specific item of work subject to acceptance control testing.

PS4 PAYMENT

(b) Rates to be inclusive

VAT shall be excluded from the rates and provided for as a lump sum in the Summary of Bill of Quantities.

(e) Materials on the site

In addition, the Employer's Agent may at his sole discretion also allow payments under "Materials on Site" in respect of any construction materials if stored off-site providing that:

(a) The site selected for this purpose is approved by the Employer's Agent;
(b) Such land is physically separated from any production plant or operation;
(c) Only materials for use under this contract is stockpiled on such land;
(d) The contractor has provided proof of an agreement with the owner of such land that the owner has no claim whatsoever on any materials stockpiled on such land;
(e) Materials obtained by the contractor for or on behalf of emerging subcontractors (SMME's) shall remain the responsibility of the contractor after payment has been made in respect of materials on site;
(f) A cession form for the material has been provided to the approval of the Employer.

(f) Payments Certificates

With reference to Sub-Clause 6 of the General Conditions of Contract, the Employer's Agent's certificate will be issued only after receipt by him of a draft certificate/ valuation prepared by the Contractor in the form prescribed by the Employer's Agent.

The cost of duplicating and delivering copies of the Employer's Agent's Certificate to the Contractor, the Employer's Agent and the Employer shall be borne by the Contractor. A total of three copies of the certificate (A-4 size) will be required by the Employer's Agent and the Employer.

PS4 EXTENSION OF TIME RESULTING FROM ABNORMAL RAINFALL

Extension of time will not be considered for normal rainfall but only for abnormal rainfall or saturated conditions and will be calculated in accordance with the following method:

a) The Contractor shall, in his programme, allow for the anticipated number of working days on which work could be delayed - as given in the Schedule below.

b) Extension of time will be calculated for each calendar month or part thereof over the full period for the completion of the Work, plus any approved extension thereof, as follows:

i) A delay caused by abnormal rainfall will only be accepted for extension of time if, in the opinion of the Employer's Agent, it delays an item or items which lie on the critical path determined by the Contractor's programme. Only delays on working days will be considered;

ii) Abnormal rainfall will be days, as approved, on which rain delayed operations, less the anticipated number of days given in the Schedule below;

iii) The net extension of time determined for each month, which may be negative, shall accumulate algebraically to determine the net number days for extension of time due to abnormal rainfall, but a negative total at the end of the construction period will not be considered;

iv) Where a portion of a month is involved, a pro rata number of days shall be calculated.

SCHEDULE:

Anticipated number of working days on which work could be delayed because of rainfall and saturated conditions.

Month	**Days**	**Month**	**Days**
January	6		
February	9		
March	3		
April	2		
May	2		
June	1		
July	0		
August	0		
September	0		
October	1		
November	2		
December	5		
Total	**31**		

PART B PROJECT SPECIFICATION

PSA GENERAL (SABS 1200 A)

PSA 1 STANDARDISATION MARK (CLAUSE 3.1)

Add the following to the Clause:

All material delivered to the site shall bear the Official Standardization Mark.

PSA 2 CONTRACTOR'S CAMP (CLAUSE 4.2)

PSA 2.1 Restrictions on employee accommodation (Sub-clause 4.2)

No housing is available for the Contractor's employees. The Contractor shall make his own arrangements to house his employees.

The Employer shall place an area at the disposal of the Contractor to enable him to erect his site offices, workshops and stores. Any temporary housing and facilities shall comply with the requirements of the local authority. The Contractor shall provide his own fencing and site security.

PSA 3 DEALING WITH WATER (SUBCLAUSE 5.5)

In addition to the items as set out in Subclause 5.5 the contractor shall also provide pumping equipment, pipes and other equipment as may be necessary.

PSA 4 MEASUREMENT AND PAYMENT

PSA 4.1 Fixed charge and Value Related Items (Sub-clause 8.2.1)

Replace the sub-clause with the following:

Payment shall be a lump sum to provide for the Contractor's expenses in connection with:

(a) setting up and maintaining his organisation, camps and plant on the site;
(b) effecting the insurances and indemnities required in terms of the General Conditions of Contract
(c) meeting all other general obligations and liabilities which are not specifically measured for payment in these contract documents.

The lump sum total of items (a), (b) and (c) as measured and Fixed Charge Items and time Related Items shall not exceed 15% of the nett total Tender Amount. If the Tenderer should tender a higher amount for this item it shall be reduced to the amount allowed above and all other tendered prices increased in the proportion required to retain the same Nett Total Tender Amount.

The tendered lump sum shall not be subject to any variation if the actual value of work done under the Contract exceeds, or falls short of, the Tender Amount, or as a result of an extension of time for completion in terms of Clause 5.12 of the General Conditions of Contract.

Any payment made under this item shall not be taken into account when determining whether the value of a certificate complies with the "minimum amount of monthly certificate" laid down in the Appendix.

Before any payment is made under this item the Contractor shall satisfy the Engineer that he has provided on site an establishment and plant of good quality and in value exceeding that of the first installment. The Contractor may be asked to furnish documented proof that he owns the offices and plant on site, the value of which should exceed the amount claimed in the first certificate. In the event that the Contractor cannot satisfy the Engineer as to the value or ownership, the Engineer shall have the right to withhold part of any payments to be made under this item, until the Works have been completed.

Payment of the lump sum shall be made in three separate installments as follows:

(a) The first installment, 50% of the lump sum, will be paid in the first payment certificate after the Contractor has met all his obligations under this sub-clause and has made a substantial start on construction in accordance with the approved programme.

(b) The second installment, 35% of the lump sum, will be paid when the value of the work done reaches one half of the Nett Total Tender Amount.

(c) The third and final installment, 15% of the lump sum, will be paid when the works have been completed and the Contractor has fulfilled all requirements of this sub-clause. No payment for the scheduled Fixed Charge Items for this contract will not be made until the requirements regarding and the erection of name boards have been met.

PSA 4.2 <u>Time-Related Items</u> (Sub clause 8.2.2)

Replace this sub clause with the following:

Subject to the provisions of 8.2.3 and 8.2.4, payment of item 8.4.1 (time-related item) will take place in equal monthly amounts, calculated on the tendered amount for the item, divided by the contract period in months, with the understanding that the total of the monthly payments which was paid for this specific item does not exceed the proportion that the progress of the works to date bears in relation to the works as a whole.

Should the Engineer grant an extension of time, the Contractor is entitled to an increase in the amount tendered for time related items, and this increase must be kept in the same proportion to the original tender amount as the extension of time is to the original time of the completion of the works.

Payment for such increased amounts will be considered as full compensation for all time related, provisional and general costs which arise as a result of the extension of time.

PSA 4.3 Facilities for Engineer (Sub clause 8.3.2.1)

Change the item descriptions of the following items as follow:

PSA 4.3.1 Item:

a) Engineer's office Unit: sum

The specifications for the items listed below should be provided in accordance with the "Facilities provided by the Contractor" in C3.1 Scope of Works:

The tendered sum shall provide for the following:

Provide the following units:
- 2 x Airconditioned Offices (minimum 10 m²)
- 1 x Airconditioned Boardroom (minimum 20 m²)
- 1 x Kitchen (7 m²)
- 2 x WC units (male and female)
- 6 x carports with crushed stone floor

Note that the areas surrounding the units in the Engineer's camp must be covers with gravel as specified in Section C3.1 Scope of Works

The Boardroom shall each be furnished with the following:
- Air conditioner
- 1 x conference table to seat 20 people
- 20 x new chairs
- White board mounted to wall (Minimum 1.2 x 2m)
- 1 x 10 kg Fire Extinguisher

The office shall be furnished with:
- Air conditioner
- 2 x office desks and 2 x chairs
- 1 x drawing table
- 2 x steel cabinets
- 1 x A1 drawing rack
- 1 A4/A3 Colour laser printer/Scanner/Copier
- 1 x 10 kg Fire extinguisher

The kitchen shall be furnished with:
- 2 Min 300 l fridge/freezer combination fridge
- Microwave of min 36 l and 1 000 W
- Cordless kettle
- 2 x 1.8 m steel folding table
- A set of 12 x each of knifes, forks, spoons and teaspoons
- A set of 12 x each of white ceramic crockery including dinner plates, side plates, bowls, coffee mugs, tea cups and saucers
- A set of 24 x beer glasses
- 1 x large wooden cutting board
- 1 x kitchen knife set in knife block which includes at least a large carving knife, bread knife, medium knife, pairing knife and kitchen scissors

- 1 x meat casserole with lid
- 1 x 10 kg Fire extinguisher

The contractor must supply the following equipment:

- New Dumpy Level and Staff
- New Dynamic Cone Penetrometer (DCP)
- Measuring wheel with electronic display
- Rain gauge
- 2 x 1m spirit level
- 2 x First Aid Kit

The contractor will provide the following additional services

- Uncapped WIFI coverage for the offices and boardroom (min 6 MBs speed)

PSA 4.3.2 Item:

c) Name board Unit: sum

The tendered sum shall provide for two contract nameboards as specified by the detail drawings.

PSA 4.4 <u>Exposing of existing services</u>

Add the following new pay item:

PSA 4.4.1 Item:

Excavation by hand in all materials to expose existing services Unit: cubic meter (m^3)

The tendered sum must include full compensation for all hand excavation as per the dimension approved by the Engineer for the locating, exposing and moving of existing services. Excavation outside of approved dimensions will not be paid. The rate must also include for backfill and compaction to 90% of mod AASHTO density and, if applicable, the removal of excess material not used for backfill, the securing of excavations, for handling surface and subsurface water, for protection of existing services and for any other activity necessary to complete the work. Free haul of 1,0 km will be applicable on the transport of excess material.

No distinction will be made between classes of material or types of services.

<u>Note:</u> The Contractor must provide sufficient supervision over labourers when services are exposed."

PSA 4.5 <u>Occupational Health and Safety</u>

Add the following new pay items:

Provision for the cost related to the Occupational Health and Safety Act, 85 of 1993, and the relevant Regulations:

a) Preparation of a Health & Safety Plan. Unit: Sum

b) Compilation of a Risk Assessment prior to Construction. Unit: Sum

c) Health & Safety induction Training of employees. Unit: Sum

d) Compilation and keeping up to date the Health & Safety file which shall include all documentation required in terms of the act. Unit: Sum

e) Implementation of the Health and Safety Plan over the entire construction period. Unit: Sum

The tendered sum shall include full compensation for providing the above services as required from the Occupational Health & Safety Act. The rate shall include all related costs incurred by the Act, remuneration of personnel, trainers, etc. and equipment required for the execution of the required services as depicted by the Act. The tendered amount for items a, b, c, d and e shall only be paid on the successful completion of the task as approved by the client. The tendered amount for item shall be paid on a monthly basis.

PSA 4.6 SUMS STATED PROVISIONALLY BY THE ENGINEER

Add the following new pay items:

PSA 4.6.1 Item:

Project Liaison Officer Unit: Prov Sum

The total cost is for the duration of the project.

PSA 4.6.2 Item:

Project Liaison Committee Unit: Prov Sum

The total cost is for the duration of the project.

PSA 4.6.3 Item:

Additional laboratory testing Unit: Prov Sum

PSA 4.6.4 Item:

As-Built Survey Unit: Prov Sum

The rate shall cover the cost for a surveyor to conduct an AS BUILT survey of the works as required by the Clients Agent

PSA 4.6.5 Item:

Provision of Accredited Training
(a) Generic skills Unit: Prov Sum
(b) Entrepreneurial skills Unit: Prov Sum
(c) Engineering skills Unit: Prov Sum

PSA 4.6.6 Item:

Remuneration of a trainee student x 2 Unit: Prov Sum

PSC SITE CLEARING (SABS 1200 C)

PSC 1 GENERAL

The areas where work is to be carried out must be kept clean for the duration of the contract. All rubbish must be removed without delay and the site must be left clean and tidy on completion of the service.

PSC 2 DUMPING SITE

No dumping is allowed on site other than at the designated and approved fill areas. Dumping will only be allowed for filling sinkholes and dolines and may not be detrimental to the natural storm water drainage of the area. Only soil, rock, clean masonry and concrete rubble may be dumped in the designated dump areas.

PSC 3 REMOVAL OF TREES

No trees may be removed without written permission from the Engineer.

PSC 4 MEASUREMENT AND PAYMENT

PSC 4.1 Item:

Clear & Grub (Clause 8.2.1) Unit: ha or m or km

Add the underlined text to the second sentence of the item description to read as follow:

"The rate shall cover the cost of clearing the surface, removing boulders of size up to 0,15 m³, grubbing of trees and tree stumps (except large trees (**with girth over 1m**) and stumps as specified in 8.2.2 below), cutting of trunks and branches exceeding 0,5m **up to 1,0m** in girth into transportable lengths....."

Add the following to the pay item description:

"The rate shall include for transport and disposal of material and debris to unspecified site and disposal thereof."

"The area (in ha) shall comprise the entire site to be cleared and grubbed within the limits to be indicated by the engineer on site in writing.

The area of clear and grub measured in linear meter (or km) shall be the sections outside the initial cleared area (measured in hectares), specifically applicable to pipeline routes outside the original cleared site area. The width and length shall be indicated by the engineer on site in writing."

PSD SABS 1200 D: EARTHWORKS

PSD 1 MATERIALS (CLAUSE 3)

PSD 1.1 Classification (Clause 3.1)

Notwithstanding the provisions of Sub-clause 3.1 of SANS 1200 D, the unit rate for excavation shall cover excavation in all materials other than hard rock.

PSD 2 CONSTRUCTION (CLAUSE 5)

PSD 2.1 Excavations (Subgrade Preparation) (Sub-clause 5.2.2)

The Contractor shall allow 6 weeks in his programme for when bulk excavation has been completed for the Engineer to review the founding conditions and to instruct the Contractor to commence with soil improvement and implement these soil improvements, if required, before commencing with construction activities.

Bulk and restricted excavations shall be taken down to the underside of the concrete blinding layers for the various structures. After the earthworks operations have been carried out, the surface shall be watered so that the top 300mm is at optimum moisture content, and this layer shall then be compacted to 100% Mod AASHTO density. The subgrade shall then be carefully levelled and prepared to receive the concrete blinding. Surplus excavated materials shall be removed and spoiled as indicated by the Engineer. Payment for preparation of subgrade and compaction shall be included in the rate for excavations.

PSD 2.2 Excavation for working space (Sub-clause 5.2.2.1 b) and c))

Add the following to the clause:

Other than for the sides of strip or pad footings or where specifically authorized by the Engineer, no concrete shall be placed against the sides of excavations.

For external concrete faces below ground level, (other than concrete placed against the sides of excavations as above) the Contractor shall over-excavate to provide sufficient working space for the erection of formwork.

Tenderers shall allow in their rates for excavation for any over-excavation required for working space.

Excavation volumes for structures will be calculated as the nett volume of the structure below ground level after general site excavations have been completed. No additional payment shall be made for working space.

All water retaining structures shall be shuttered externally on vertical and on other faces inclined within 45º from the vertical.

PSD 2.3 Inspection (Sub-clause 5.2.2.1 d))

Add the following to the clause:

Excavation to final level soil improvement, ready to achieve a binding layer or concrete footing, shall be completed less than 24 hours before such layer or footing is cast.

The Contractor shall arrange for the inspection by the Engineer or his Representative of all surfaces immediately before casting concrete.

PSD 2.4 Over-excavation to sides of excavation (Sub-clause 5.2.2.1 e))

Add the following to the clause:

Where the sides of excavations are over-excavated to establish safe slopes, provide access to excavations, or for other purposes not specifically required by the Engineer, such over-excavation shall be backfilled with material as required by the Engineer and compacted to a minimum density of 95% Mod AASHTO.

No separate payment will be made for this work.

PSD 2.5 Over-excavation (Sub-clause 5.2.2.1 e))

Add the following to the clause:

If the material in the bottom of an excavation is loosened, or if there is any over-excavation, any loose or disturbed soil shall be removed, and the over-excavation shall be replaced by mass concrete mix 15 MPa.

No separate payment will be made for replace over-excavation with concrete. No separate payment will be made for over excavation as defined in PSD 2.4 and PSD 2.5.

PSD 2.6 Trimming of surface of bulk earthworks (add the following sub-clause 5.2.2.1 f))

Where blinding, mass or structural concrete is to be cast or where precast elements are to be placed on surfaces established by bulk earthworks, the Contractor shall:

a) Arrange his bulk excavation operation so that over-excavation is avoided, taking into account the requirements in PSD 2.4.
b) Over-fill embankments while placing fills as necessary to allow for trimming and arrange his compaction operations to ensure that the specified density is achieved throughout the finally trimmed embankment; and
c) Shortly before casting concrete or placing precast elements, carefully remove the final layer and trim such surfaces to the design levels and profiles within Grade II degree of accuracy.

PSD 2.7 Disposal of surplus material (Sub-clause 5.2.2.3)

Add the following to the clause:

All surplus material from bulk excavation for concrete units and for pipework shall be dumped, leveled and spread on site at the areas as indicated by the Engineer. No dumping shall be undertaken prior to obtaining detailed instructions from the engineer.

PSD 2.8 Freehaul (Sub-clause 5.2.5.1)

Replace the sub-clause with the following:

All haul within the site of works or within a distance of 1.0 km outside the extremities of the boundaries of the contract as indicated on the drawings shall be regarded as freehaul.

PSD 3 MEASUREMENT AND PAYMENT (CLAUSE 8)

PSD 3.1 <u>Restricted excavation</u> (add the following to sub-clause 8.3.3)

Add the following to this item:

The volume of restricted excavation will be calculated from the net plan dimensions and the difference between the original ground profiles (or terraces), and the blinding layer (or no-fines) levels shown on the drawings. On the sides, the volume will only be calculated to the outside dimensions of the concrete structures. No additional payment will be made for the provision of working space, although it will be provided.

PDS 3.2 <u>Additional Lateral Support / Shoring</u> (Sub-clause 8.3.7)

The contractor must at all times ensure that excavations are safe to work in. Should the excavations exceed 2 meters and appear unstable shoring must be installed. Allowance in the Bill of Quantities has been made for shoring. No claims for extension of time, additional costs or damages for doing shoring will be entertained.

The unit in the Bill of Quantities is m2.d. the Contractor shall submit his shoring design proposal to the Engineer for approval. The unit rate shall cover the product of the surface area of the shoring and the number of days it is required.

PSDB SABS1200DB: EARTHWORKS - PIPE TRENCHES

PSDB 1 CONSTRUCTION

PSDB 1.1 Freehaul Distance

All haul within the site of works or within a distance of 1.0 km outside the extremities of the boundaries of the contract as indicated on the drawings shall be regarded as freehaul.

PSDB 2 MEASUREMENT AND PAYMENT

PSDB 2.1 Dewatering (Sub clause 8.1.1)

Add the following to this item:

The scheduled rates for excavation shall include dewatering of trenches.

PSDB 2.2 Excavations (Sub clause 8.3.2b)

Replace the clause with the following:

Extra-over item:

Only two types of excavations are defined and paid for under this contract. These items are soft excavation and hard rock excavation. No intermediate excavations will be paid for. Hard rock excavations qualifies when blasting or mechanical breaking are applied to break the rock.

PSDB 2.3 Shoring (Sub-clause 8.3.4(a))

The contractor must at all times ensure that excavations are safe to work in. Should the excavations exceed 2 meters and appear unstable shoring must be installed. Allowance in the Bill of Quantities has been made for shoring. No claims for extension of time, additional costs or damages for laying pipes in shored trenches will be entertained.

PSG SABS 1200 G: CONCRETE (STRUCTURAL)

PSG 1 SCOPE OF WORKS

This specification covers the construction of all structural concrete elements.

PSG 2 MATERIALS (CLAUSE 3)

PSG 2.1 Concrete

PSG 2.1.1 Cement (Sub-clause 3.2.1)

Add the following to the sub-clause:

The type of cement to be used for concrete structures shall be approved by the Engineer.

PSG 2.1.2 Storage of cement (Sub-clause 3.2.3)

Add the following to the sub-clause:

Cement shall not be kept in storage for longer than eight weeks without the Engineer's permission.

Cement which has been damaged in any way or which has been stored on site for a period exceeding three months shall be condemned and removed from site.

PSG 2.1.3 Aggregates (Sub-clause 3.4)

Add the following to the sub-clause:

Concrete with reactive aggregates:

The Contractor shall supply a test certificate for the aggregate confirming that it is not reactive.

With each delivery of materials under this clause the Contractor shall supply acceptable written evidence that this clause is being complied with.

PSG 2.1.5 Use of plumbs (Sub-clause 3.4.2)

Add the following to the sub-clause:

The use of plumbs shall not be permitted.

PSG 2.1.6 Admixtures (Sub-clause 3.5)

Replace this sub-clause with the following

Admixtures may only be used with the prior approval of the Engineer. No air-retaining properties will be tolerated.

PSG 2.2 Joint materials (add the following new sub-clause 3.9)

All primers, fillers, sealers, admixtures and breakers shall be suitable for use on potable water.

PSG 2.2.1 Primer

An approved primer, fully compatible with and/or manufactured for the specified jointing and sealing materials shall be applied to the joint surfaces.

PSG 2.2.2 Filler

Fillers shall be closed-cell expanded polyethylene.

Fillers shall be pre-cut to suit the application with a tear-out strip for forming the specified recess for the bondbreaker and sealant.

PSG 2.2.3 Sealer and breaker

The elastomeric sealant shall be a two-pack polyurethane type (gun grade for vertical joints) generally conforming with the physical properties specified in SABS 110 and used with primers as specified above.

The bondbreaker placed immediately prior to application of the sealant shall be a self-adhesive vinyl type (or similar approved material) with a width the same as the joint recess into which it is to be applied.

PSG 3 CONSTRUCTION (CLAUSE 5)

PSG 3.1 Classification of finishes (Sub-clause 5.2.1)

Add the following to the sub-clause:

Concrete surfaces which will be in contact with the natural ground or which will otherwise be covered on completion of the works, shall have a rough finish as specified in sub clause 5.2.1 (a).

Horizontal surfaces and surfaces with a slope not exceeding one vertical to two horizontal shall be finished to a wood float finish. For this finish the surface must be given a finish as specified in sub-clause 5.5.10.1 and after the concrete has hardened sufficiently, it shall be floated to a uniform surface free of trowel marks.

The finished concrete surfaces shall be accurate to degree 1 as defined in sub-clause 6.2.

The visible vertical or near vertical surfaces of valve chambers, and culvert head walls or parapets shall be finished to a smooth surface, repaired and rubbed to remove projections.

The bagging of concrete surfaces to repair defects will not be permitted.

All concrete edges shall be provided with 25 mm x 25 mm chamfers.

PSG 3.2 Cover (Sub-clause 5.1.3 and 5.5.1.5)

Add the following to the sub-clauses:

The exposure conditions for all structures in the works shall be deemed to be "severe". The minimum cover to reinforcement shall be 50 mm for water retaining concrete and 50 mm for all other concrete, unless otherwise specified on the Engineers drawings and bending schedules.

PSG 3.2.1 Spacers for reinforcement (sub-clause 5.1.3)

Add the following to the sub-clause:

Spacers of approved design include purpose made precast mortar blocks. No plastic spacer blocks will be allowed.

Where mortar blocks are used, they shall be properly shaped so as not to slip out of position and shall be made of the same mix as the mortar of the concrete in which they are to be placed.

The mortar shall be well compacted by approved means into the moulds to result in blocks with a density of at least 2 300 kg/m; and which are free from honeycombing. They shall be cured in water for at least seven days. Mortar blocks which have not been manufactured and cured strictly in accordance with these requirements or which are in any other way considered unsatisfactory by the Engineer, will be rejected and shall be removed from the Site.

PSG 3.3 Holes, Chases and Fixing Blocks (Concrete Boxouts) (Sub-clause 5.3)

Where pipes are to be cast into concrete, the Contractor shall provide a box-out in the wall and grout the unit in at a later stage. When constructing such a 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 box-outs for pipes/specials have been provided in the walls, the Contractor shall be responsible for the grouting in of such pipes/specials regardless of whether or not these have been supplied by himself.

An approved non-shrink grout shall be used for the grouting in of pipes and specials after they have been positioned. The details and method statement are to be submitted to the Engineer for approval prior to the commencement of any grouting. The approval by the Engineer shall not relieve the Contractor from his obligation to provide a watertight joint between the concrete and grout used.

PSG 3.4 Strength concrete (Sub-clause 5.5.1.7)

Add the following sub-clause:

The grade of strength concrete for each portion of the works will be indicated on the drawings and/or specified in the Schedule of Quantities. The grade of concrete will be designated as "Class S/A", where "S" is the characteristic strength in Mpa and "A" is the maximum nominal size of coarse aggregate in mm.

With the exception of mixes weaker than 15 Mpa, all concrete for the Works shall be considered to be strength concrete in terms of Sub-clause 5.5.1.7.

No concrete shall be cast until the mix designs have been approved by the Engineer. The Engineer may call for revised mix designs at any stage during the contract.

Contractor to supply and test 6 No. cube test results for approval prior to commencement of the works.

Unless otherwise specified on the drawings or in the Schedule all structural concrete shall have a strength of 35/19 Mpa.

The concrete to be used on this contract shall be as follows:

(a) For all water retaining structures (including reservoir roofs), 35/19 MPa. The slump limits shall be 75 mm. The water/cement ratio shall not be greater than 0,5. A waterproofing agent (Crystalline Admix) shall be added as per supplier's specification to a minimum of 1% by weight of cement.
(b) For all other structures not in contact with water 25/19 MPa concrete.
(c) For anchor blocks, benching and mass concrete, 20/19 MPa concrete.
(d) For no-fines concrete 15/19 Mpa concrete
(e) All sizes of aggregate used shall be 19 mm granite.

These mixes shall be designed for vibration. All data reports prepared by the Institute shall be submitted to the Engineer for information and approval.

DESIGN OF CONCRETE MIX:

The concrete mix design shall be prepared by an approved independent laboratory and submitted to the Engineer for approval. Historical data shall be provided for a similar mix design to the same strength.

The successful Tenderer will be required to submit samples of the fine and coarse aggregate which he proposes using, to an approved laboratory for tests regarding the suitability of such aggregates. The laboratory shall prepare trial mixes of the two stronger grades of concrete required for the contract to establish acceptable design mixes.

PSG 3.5 <u>Formwork and finishes</u> (Sub-clause 5.2)

Add the following to the sub-clause:

FORMWORK TIES

The use of sleeves through the concrete for formwork ties will not be permitted. Ties, when cast in, shall have some form of positive shear key to prevent any rotation when loosening formwork.

The formwork ties and bolt holes shall be placed with regularity and precision.

The finish of exposed concrete surfaces of concrete structures shall be "smooth" as detailed in (b) of sub-clause 5.2.1.

FILLETS AND CHAMFERS

All internal and external angles in concrete works shall have 25 mm x 25 mm fillets and chamfers unless shown otherwise on the drawings.
The units rate tendered for formwork shall cover the cost of forming these chamfers and fillets.

PSG 3.6 Joints (Clause 5.5.7)

Add the following to the sub-clauses:

PSG 3.6.1 General

Notwithstanding Sub-clause 2.4.3 “designated joints” shall only be joints shown on the drawings and in the Schedule. Further joints required by the Contractor because of construction limitations or any other reason, shall be deemed to be “undesignated joints”.

The position and pattern of all joints (designated or undesignated) shall be to the Engineer’s approval.

All joints (designated or undesignated) except expansion and contraction joints shall be treated in accordance with Sub-clause 5.5.7.3.

Joints between tank bottoms, floors or wall bases and the walls and columns standing on them, shall not be made flush with the supporting surface, but shall be made in the wall or the column a distance of 140 mm above the base. The 140 mm high “riser” shall be cast as an integral part of the bottom, floor or base, i.e. the concrete in the riser shall be deposited at the same time as the concrete in the bottom, floor or base adjacent to it.

In cases where there is a fillet at the bottom of the wall or column, the construction joint shall be made 140 mm above the fillet.

The Contractor should note that the details of the undesignated joints shall be identical to the designated joints shown on the drawings where the joint is in a similar situation and performs the same duty.

The Contractor shall further note that the position and the type (where no identical designated joints exist) of undesignated joints shall be subject to the Engineer’s approval.

PSG 3.6.2 Construction joints (Sub-clause 2.4.3 and 5.5.7)

All joints other than expansion, contraction or other movement joints, shall be treated as follows:

As soon as practical, but not before 15 hours after placing, the joint surface shall be prepared to receive fresh concrete.

This preparation, as specified in Sub-clause 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 and sand blasting shall be such as to produce a roughened surface all over.

Concrete surfaces, where concreting is interrupted, shall be protected from the sun as specified in Sub-clause 5.5.8 (d).

Floor slab concrete shall be cast in one continuous pour. Should the Contractor wish to deviate from this requirement for the larger pours, a water bar shall be placed in the centre of the joint. This deviation should first be discussed with the Engineer before construction commences.

A kicker joint shall be formed at all external floor/wall intersections. The kicker shall be formed with the floor pour and shall include a 200mm PVC water bar, of the dumbbell kind. The water bar shall be provided with eyelets so that the water bar can be held in its correct position. A rate item for construction joints is provided in the Bill of Quantities.

PSG 3.6.3 Construction joints (Sub-clause 5.5.7.3)

No vertical construction joints other than those shown on the Drawings may be formed without prior approval. Horizontal construction joints may be formed if the method of construction does not allow for one continuous pour. However, these construction joint will be indicated to and approved by the Engineer. It must be noted that should the Contractor wish to form a construction joint in water retaining concrete, the watertightness of this joint will remain the responsibility of the Contractor. In addition to the precautions to be taken as prescribed under clause 5.5.7.3, the Contractor may ensure watertightness by providing additional means (such as a bandage on the joints or wet to dry epoxy) to the approval of the Engineer. No additional payment will be made to the Contractor for ensuring that construction joints are watertight and the Contractor will have to include such costs in the rate for the concrete.

PSG 3.6.4 Expansion and construction joints

Expansion and contraction joints shall be made in the position and to the details shown on the drawings.

The specified filler strips shall be attached to the complete side of the straight or grooved concrete joint by means of an approved adhesive.

PSG 3.7 Items to be casted in or grouted into concrete (sub-clause 5.4)

Add the following to the sub-clauses:

PSG 3.7.1 Fixing for equipment and pipe specials supplied under this Contract

a) The Contractor will be responsible for the forming of pockets and grouting in of pipe items and/or holding down bolts for equipment supplied under the contract.

b) Upon completion of the positioning and alignment of equipment, the Contractor shall, grout up pipe items, pockets and base plates (subject to (c) below) necessary for the permanent installation of the equipment.

c) Only after the Engineer is satisfied with the alignment and the level of each item of plant shall the Contractor grout up the base plates/pipe specials with an approved non-shrink grout.

PSG 3.7.2 Fixing for equipment supplied under this contract

Holding down bolts or other fixings required for the installation of handstops, crane beams, ladders, handrails and other items supplied under the 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 Engineer.

Where anchor bolts are used which are installed into holes drilled into concrete or masonry, these shall be a type approved by the Engineer.

All anchor bolts shall be stainless steel grade 316.

PSG 3.7.3 Pipes and conduits embedded in concrete

Except with the written approval of the Engineer, no pipes other than those shown on the drawings shall be embedded in concrete and the approval of the Engineer for the position of all services to be embedded shall be obtained before concreting commences.

The clear space between pipes of any kind embedded in reinforcement concrete and the clear space between such pipes and reinforcement shall not at any point be less than:

(a) 40 mm, or

(b) 5 mm plus the maximum size of coarse aggregate, whichever is the greater.

PSG 3.8 Curing and protection (Sub-clause 5.5.8)

Add the following to the sub-clauses:

Level or gently sloping surfaces shall be cured by one of the methods described in Sub-clause 5.5.8 (a) or (b) and vertical surfaces by the methods described in Sub-clause 5.5.8 (e) for a period of five days after casting for an ambient temperature of 5ºC or above and for eight days for an ambient temperature of below 5ºC.

PSG 3.9 Concrete surfaces (Sub-clause 5.5.10)

Add the following to the sub-clauses:

PSG 3.9.1 Screed finish

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 3.9.2 Wood float finish

Where wood floating is ordered or scheduled, the surface shall first be given a finish as specified in PSG 3.6. 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 screed marks.

PSG 3.9.3 Steel float finish

The surface of tank bottoms, floors and roof slabs, etc. shall be given a steel float finish in accordance with Sub-clause 5.5.10. To Degree 1 accuracy.

PSG 3.9.4 Power floated finish

Where power floating is required the surface shall be treated as specified in PSG 3.11.2 to a degree necessary.

PSG 3.10 Screeds (add the following sub-clause 5.5.16)

GRANOLITHIC SCREED

Granolithic screed shall consist of: Cement - 1 part; Sand - 1.25 part; Coarse aggregate - 2 parts.

The coarse aggregate shall consist of granite or other approved chips which shall pass a 10 mm sieve and be retained on a 5mm sieve.

The cement/water ration of the mix shall be at least 2,0 mass.

PSG 3.11 Repairs and defects (add the following sub-clause 5.5.14)

All defects to the concrete shall be attended to, in full, as soon as possible after the formwork is removed. Further concreting of the element concerned may be prohibited by the engineer until he is satisfied that this remedial work has been satisfactorily attended to.

PSG 3.12 Porous Concrete

Porous concrete shall be laid under foundations and floor slabs, and behind walls, etc., where shown on the drawings and where directed by the Engineer.

Porous concrete shall be placed behind shuttering to form a vertical layer against the external face of foundations, etc. where shown on drawings and where directed by the Engineer.

The thickness of the horizontal, sloping and vertical layers shall not be less than that shown on the drawings.

The exposed faces, both horizontal and vertical, of the porous concrete shall be finished with a cement mortar seal, as specified in Clause PSG2.11.3, where reinforced concrete is to be cast against it.

The schedule rates for porous concrete shall include the cost of the mortar seal and steel float finish.

Porous concrete shall comprise water, cement, coarse aggregate and not more than 5 % by mass of fine sand. Every size of aggregate shall be a single size aggregate, graded in accordance with SABS 1083.

The voids ratio of porous concrete shall not be less than 27,5 %.

No-fines concrete shall be classified by the prefix NF and the size of the aggregate to be used. Class NF19 means a no-fines concrete with a 19 mm nominal size. The volume of aggregate per 50 kg of cement is to be as follows:

Class	Aggregate Size	Aggregate per 50kg cement	Minimum Average Strength of a set of three test cubes after 28 days (MPa)
NF38	38	0.33 m^3	5.5
NF19	19	0.30 m^3	5.5
NF13	13	0.27 m^3	5.5

PSG 3.12.1 Batching and Mixing

The quantity of water to be added shall be just sufficient to form a smooth grout which will adhere to and coat completely each and every particle of aggregate, and which is just wet enough to ensure that at points of contact of aggregate the grout will run together to form a small fillet to bond the aggregate together. The mix shall contain no more than 20 liters of water per 50 kg of cement.

Mixing shall be carried out in an approved batch type mechanical mixer. The whole batch of aggregate together with half of the water shall be placed into the mixer and mixed together for at least half a minute. The cement, followed by the balance of water, shall subsequently be added and the mixing shall continue for at least 1,5 minutes or as much longer as is necessary to ensure that all aggregates are uniformly coated with cement grout.

Testing of porous concrete shall be carried out in accordance with test method 3 of BS 1881 Part 3 : 1970.

PSG 3.12.2 Placing

The Engineer shall be timeously advised to enable him to inspect the excavations or form work before no-fines concrete is placed.

After the placing of the concrete has commenced, it shall be continued uninterrupted and may only be halted at the construction joints approved by the Engineer. Control shall be exercised to ensure that no placed green concrete lies for longer than 30 minutes before being covered with fresh concrete and that the concrete is placed in its final position within 20 minutes after the cement has been loaded into the mixer.

The concrete shall be worked sufficiently to ensure that it completely fills the space to be concreted and that adjacent aggregate particles are in contact with one another. Excessive tamping or ramming shall be avoided and under no circumstances shall the concrete be vibrated.

PSG 3.12.3 Mortar seal over porous concrete

Where concrete is to be cast against previously cast porous concrete, the surface of the porous concrete shall be sealed with a 5 mm thick layer of mortar composed of one part normal Portland cement to two parts of fine aggregate by mass, trowelled on before screed to provide a dense, smooth, uniform plane surface without filling any of the internal voids of the porous concrete. The surface of the seal shall have a steel float finish.

PSG 3.12.4 Protection

All no-fines concrete shall be protected from the elements, particularly from strong wind, flowing water, damage to the surface and loss of moisture. Protection against loss of moisture shall be accomplished by one or more of the following methods :-

(a) Keeping form work in place.

(b) Covering exposed surfaces with sacking or other approved material that is kept continuously wet.

(c) Covering exposed surfaces with plastic sheeting.

PSG 3.12.5 Sealing of surface of no-fines concrete

Where indicated on the drawings or instructed by the Engineer, the surface of the no-fines concrete shall be sealed with a layer of 1:8 cement mortar to prevent loss of moisture from the structural concrete.

This seal shall be placed after the no-fines concrete has hardened and must be leveled off to the same level as the top of the no-fines concrete.

PSG 3.13 Water tightness testing and cleaning (add the following sub-clause 5.5.11)

On completion of concreting and when the concrete has attained its required strength, all structures shall be tested for water tightness. As a result, structures shall not be backfilled until the water test has been successfully completed. No water is available on site and the contractor must make his own arrangements for water for water tight testing of all the structures.

Each structure shall be filled with water and shall be allowed to stand for 48 hours. Thereafter the water level in the structure shall be monitored over a period of 10 days. The effects of evaporation shall be taken into account during this period. The structure will be deemed to have passed the test if it loses no more than 5mm of water after the drop due to evaporation is deducted.

Where there are visible signs of sweating, seepage or leakage, the affected areas shall be brought to standard. Where it is obvious that there is harmful leakage, the test shall be discontinued and the tank emptied without delay. The Contractor shall then, at his own expense, rectify the leak and re-test that tank. After the said tank has successfully passed the water tightness testing the tank shall be emptied again.

In order to conserve water, it shall be sequentially pumped from structure to structure as successful testing is completed. The rate tendered for testing shall include for the cost of testing as described above and the supply and operation of any pumping equipment required.

After the watertight test the water retaining structures shall be disinfected by applying water containing 20mg/liter free chlorine residual for a period of 24 hrs. The water retaining structures will not be accepted and cleaning of the water retaining structures have been passed by Engineer.

PSG 4 TOLERANCES (CLAUSE 6)

PSG 4.1 Permissible deviations (Sub-clause 6.2)

Add the following to the sub-clause:

The degrees of accuracy of construction shall be as follows:

(a) All structures (including water retaining structures) – Degree I accuracy.

(b) All weirs (concrete) and weir plates shall have a tolerance of +1/-1 mm

PSG 5 TESTING (CLAUSE 7)

PSG 5.1 Grouting (add the following new sub-clause 7.4)

The Contractor shall, where so ordered, carry out a site test for each grouting procedure and each grouting gang to be used. The tests shall be carried out on a dummy bedplate similar in configuration to that which is to be grouted, but not exceeding 1 m^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 Engineer.

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-clause 7.2.1 to 7.2.3.

PSG 6 MEASUREMENT AND PAYMENT (CLAUSE 8)

PSG 6.1 Grouting / casting in of pipe specials (add the following sub-clause 8.10)

Add the following pay item:

Item:

Grouting / casting in of pipe pieces in the following diameter Unit: No

The rate shall include all labour, plant and material for the grouting/casting in of pipes of the above items as per PSG 2.6.4. The actual pipe/item to be cast in is measured elsewhere.

PSG 6.2 <u>Step irons</u> (add the following sub-clause 8.16)

Add the following pay items:

Item:

Step irons (Calcamite or similar approved) Unit : No

The rate shall cover all costs to supply and install the step iron. The rate shall include for the drilling into the concrete, supplying and installing chemical anchors as well as the setting out of the step irons in the correct position.

PSHA SABS 1200 HA: STRUCTURAL STEELWORK (Sundry Items)

PSHA 1 MATERIALS (CLAUSE 3)

PSHA 1.1 Structural Steel (Clause 3.1)

Add the following to this clause:

All structural steelwork, including pipe supports and ladders will be to SANS 1421 Grade 300 W. The Contractor must allow in his rates to provide for shop details. Corrosion protection to be hot dipped galvanising to the requirements of EN 10240:1997 and SANS ISO 1461:1999 unless indicated differently.

All handrails and flooring, including supports and fasteners shall be manufactured from hot dipped galvanised mild steel to the requirements of EN 10240:1997 and SANS ISO 1461:1999 unless indicated differently.

PSHA 1.2 Bolts, Nuts and Washers (Clause 3.3)

Add the following:

All bolts, nuts and washers shall be AISI 316 stainless steel.

All sleeve anchors shall be AISI 316 stainless steel.

All fixings shall be AISI 316 stainless steel and this will also apply to any bought out item. An approved molybdenum disulphide anti seize compound shall be applied on all bolts and nuts.

PSHA 2 CONSTRUCTION (Clause 5)

Add the following:

All surfaces shall be abrasive blast cleaned to Swedish standard SIS 05 59 00 of 1967 to SA 2½ finish. The blast profile shall be between 40 and 70 microns.

PSHA 2.1 Holes for Fasteners (Clause 5.2.3)

Add the following to this clause:

Holes for holding-down bolts shall not be flame-cut.

PSHA 2.2 Welding (Sub-clause 5.2.4) (site welding)

Add the following to this clause:

Manual flame-cutting is allowed only where authorised. Edges shall be grinded to be free of unevenness, defects and distortions.

Welding shall comply with SABS 044 Part III, SABS 044 Part iv and SABS 0162.

Welding shall be minimum grade B welding.

The qualification of welders shall be in accordance with the relevant clauses of the above standards, and specifically SABS 044 Part III and shall be Grade 1 welders. Grade 2 welders will be permitted only with the Engineers written approval.

The Contractor shall provide evidence, acceptable to the Engineer, that welding procedures and welders have been tested in accordance with the requirements of AWS D1.1-81.

No welding shall be permitted on site without the express approval of the Engineer, with the exception of those details shown on the drawings as Site Welded.

PSHA 2.3 Handrails (Clause 5.2.6)

Handrails shall be of the two rail type, ball and stanchion, top mounted, type Mentis MT 90 or similar approved.

Add the following:

Handrails and stanchions shall be hot dipped galvanised and painted to the following specification:

(a) Hot dip galvanise in accordance with Table 2 of SANS 763.

(b) Clean with Galvkleen or similar approved to achieve a water break free surface and allow to dry.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	After hot-dip galvanizing, do not passivate.	
2	Coat epoxy primer (two part for HDG surfaces)	75
3	Coat polyurethane enamel (two part)	50
		Total = 125 µm

Where handrails are specified as stainless steel, the handrails shall be AISI 316 stainless steel.

PSHA 2.4 Prefabricated open and chequer plate floors (clause 5.2.8 & 5.2.9)

Open grid steel covers and floor panels shall be pressure locked and welded as “Maclock” type “Eggcrate” or similar approved. All span bars shall have a depth of 40mm and be of such a width and at such a spacing that the maximum deflection of any bar under a 10 kN/m^2 uniformly distributed load shall not exceed 1/360 of the clear span. Under no circumstances will cutting and welding be permitted on site.

Framing to open grid “Maclock” or “Eggcrate” covers or panels shall be assembled and welded to the detail as shown on the drawings.

Chequer-plate flooring shall be of 6mm minimum thickness “treadplate” flooring or similar approved with raise 5-bar pattern and lifting key holes at each end of each plate.

Frames shall be angle and bar welded together and as detailed on the drawings.

PSHA 4.3 <u>Open grid/ chequer plate flooring</u> (clause 8.3.4)

Replace sub-clause 8.3.4 with the following:

Item:

Open grid flooring

Supply and install HDG floor grating, bearer bar=40mm Unit: m^2

Supply and install cast-in HDG 45 x 45 x 5 mm angle support complete with fishtail lugs Unit: m

Add the following to the clause:

The open grid or chequer plate flooring covers or panels will be measured by area, and the unit rates will be held to include for all cutting, welding, galvanising, etc. The cast-in angle support will be measured separately per linear meter. This rate will include for installation, galvanising, fixing complete with cement mortar and/or bolts/fishtail lugs which may be required to secure the frame. The rate shall include for supply and installation.

PSLSABS 1200 L: MEDIUM PRESSURE PIPELINE

PSL 1 SCOPE

All water pipelines in this contract shall be deemed to be medium pressure pipelines.

PSL 2 MATERIALS (CLAUSE 3)

PSL 2.1 General (Sub-clause 3.1)

Add the following to the sub-clause:

Pipes

All pipes shall be of class as indicated on the drawings. The corrosion protection to the flanged steel pipe material shall be either Epoxy Coated or Hot dipped galvanized to SABS specifications

PSL 2.2 Steel Pipes, Fittings and Specials (Sub-clause 3.4)

Add the following to 3.4:

a) Steel pipes with normal bore up to 150mm diameter shall be manufactured to conform to all the requirements of SANS 62 whereas steel piping of larger diameter shall be manufactured to conform to all the requirements of SANS 719.

b) BUTT WELD FITTINGS: Steel butt welding pipe fittings shall be to ANSI B 16.9, BS 1965 or BS 1640 of the same schedule as the piping or heavier. Butt weld fittings in stainless steel shall be to ASA B 36.19 for schedule 5S and 10S and ASA B 16.9 for schedule 40S and 80S. Alternatively, fittings may be to BS 1640

PSL 2.3 Other types of pipes (Sub-clause 3.7)

Add the following to 2.3:

a) PLASTIC PIPING: uPVC piping shall comply with the requirements of SANS 966 mark for pressure pipes and shall be fitted with spigot and socket joints with rubber sealing rings.

b) GRP PIPING: GRP piping shall comply with the requirements of SANS 1748 mark for pressure pipes and shall be fitted with suitable couplings where the GRP piping connects to non-GRP piping or equipment. Joints between GRP pipes shall be GRP couplings (Flowtite double bell coupling or equal approved). Above ground GRP pipes shall be coated with 300 microns of UV resistant polyurethane or equal supplier-recommended coating. GRP pipes cast into concrete shall comply with manufacturer guidelines on floatation. The GRP piping installation of GRP pipes larger than dia. 800 mm shall be done by (or under the supervision of) a specialist field technician endorsed or provided by the GRP pipe manufacturer. The GRP pipe manufacturer shall be ISO 9001:2015 certified.

PSL 2.4 Isolating valves (Sub-clause 3.10)

Add the following to the sub-clause:

Except where otherwise specified, isolating valves shall be of the resilient seal gate type, with a non-rising spindle and shall be arranged for clockwise closing. All valves shall be standard coated and shall receive a final coat of light blue enamel paint after installation. All valves shall be flanged and drilled to the specification.

Materials shall comply to the following specifications:

Materials of Construction (minimum specifications)

Component	*Specification*
Body	Cast Iron to BS 1452 Gr 14
Bonnet	Cast Iron to BS 1452 Gr 14
Spindle seal housing	Cast Iron to BS 1452 Gr 14
Hand wheel	Cast Iron to BS 1452 Gr 14
Cap top	Cast Iron to BS 1452 Gr 14
Gate	Spheroidal Graphite Iron to BS 2789 Gr 17 covered with nit rile rubber
Spindle	EN57 Stainless Steel
Spindle seal “O” rings	Nit rile rubber
Seal housing “O” rings	Nit rile rubber
Seal bush “O” rings	Nit rile rubber
Wiper ring	Nit rile rubber
Seal housing	Nylon
Spindle nut	Bronze to SABS 200 Code 30

A copy of the relevant valve specification of the proposed valves shall be attached to this tender document.

PSL 2.4.1 Marking of valves

The design pressure in Megapascal (MPa) shall be engraved on the side of the valve where it is legible. Valves shall be marked with the item number of the schedules when delivered to site.

PSL 2.4.2 Handwheels and closure

Where handwheels are specified edges shall be machined to a smooth surface. Wording “OPEN” and “CLOSE” will be casted into handwheels. Valves will close clockwise except where it is otherwise specified. Spindles will be of the non-rising type.

PSL 2.4.4 Protection of valves

Valves shall be painted externally with a zinc chromate primer according to SABS 679 Type 1. (Dry film thickness of 50 mnc) After installation damaged primer shall be made good with compatible primer in accordance with valve suppliers specifications.

Subsequently to making good of the primer the valve shall be painted with two layers of alkide based enamel according to SABS 630 Grade 1 (dry film thickness of 250 micro meter per layer) to match the colour of adjoining pipe work.

PSL 2.4.5 Handling, delivery and installation

All valves and related items shall be handled with the necessary care throughout all processes of manufacture, testing, delivery and installation. Valves furnished with lifting eyes shall be handled only by those eyes and other valves shall be handled solely with slings that will cause no damage.

In particular the inlet and escape orifices of air valves and special valves shall be effectively sealed after manufacture until completion of installation and this sealing shall be examined regularly to ensure that it is still effective.

Valves shall be effectively supported, packed or fastened down for transporting and care taken to avoid valves knocking together during transport.

Valves shall be stored in a safe place above ground and shall be protected against the ingress of foreign matter.

PSL 2.5 Fittings (Sub-clause 3.12)

Add the following sub-clause:

Generally all special fittings are to be manufactured in mild steel as applicable. No aluminum fitting shall be permitted. Fittings shall be compatible in respect of working and test pressure to those of the pipelines.

PSL 3 CONSTRUCTION

PSL 3.1 Laying Depths and Cover (Sub-clause 5.1.4)

Add the following to sub-clause 5.1.4.1:

Water mains shall be laid to follow the grades of the existing adjoining roads, except where otherwise instructed by the Engineer. The depth from finished sidewalk level to the top of the pipe barrel shall be as follows, except where otherwise directed:

a) on sidewalks = 900 mm

b) below carriageways = 1 000 mm

c) outside road reserves = 900 mm

PSL 3.2 Jointing Methods (Sub-clause 5.2)

Notwithstanding the provisions of sub-clause 5.2 of SANS 1200L, jointing of pipes and specials of all diameters shall be as follows:-

i. uPVC pipes - by rubber ring spigot and socket.

ii. Steel pipes - by welding except where pipes are connected to flanged fittings or elsewhere as shown on the drawings or as instructed by the Engineer.

iii. GRP pipes – by coupling (Flowtite double bell coupling or equal approved) except where stainless steel and GRP pipes are connected using flanges or elsewhere as shown on the drawings or as instructed by the Engineer. Anchors for above ground

pipe shall be designed as cradles with high friction cradle liners and a pretensioned steel clamp pressing the pipe against the cradle. The pretension of the clamp shall be sufficient to prevent the pipe from moving in the cradle. The clamp shall allow for thermal expansion of the GRP pipe.

iv. Steel pipes shall connect to uPVC and GRP pipes using a steel flange adaptor or couplings. All pipes and fittings shall be suitable for a test pressure of 1200kPa.

PSL 3.3 Anchor / thrust blocks and pedestals (Sub-clause 5.5)

Add the following to the sub-clause:

Dimensions of all anchor / thrust blocks shall be supplied by the Engineer as and when required. The Contractor shall request such information not less than 14 seven calendar days in advance.

PSL 3.4 Crossing existing services (Sub-clause 5.1.4.3)

There will be existing services that will be crossed. Generally these areas can be identified and careful hand excavation will be required to expose these services.

PSL 3.5 Pipe laying personnel (Sub-clause 5.1.1)

The laying of pipes and ancillary fittings shall be performed only by a qualified person who is registered as an artisan in the pipe fitting or drain laying trades, or is qualified by reason of having attended and passed the course on pipe laying of the Civil Engineering Industry Training Board.

PSL 3.6 Steel pipes, specials and fittings scope

This specification covers the manufacture, corrosion protection, delivery, erection, installation, making good of corrosion protection as well as over-coating as may be required, site-testing and commissioning of steel pipes, specials and fittings mostly for the conveyance of water, but also for air, at normal ambient temperatures between 5ºC and +70ºC.

PSL 3.6.1 Manufacture of steel pipes

Steel pipes with normal bore up to 150mm diameter shall be manufactured to conform to all the requirements of SABS 62 whereas steel piping of larger diameter shall be manufactured to conform to all the requirements of SABS 719, all as may be amplified or amended below.

The requirements regarding pipe sizes and grades, wall thicknesses, pipe lengths and pipe and requirements are specified in the Pipe Schedule and / or stated in the Schedule of Quantities.

The following minimum wall thicknesses shall apply:

External Diameter (mm)	Minimum wall thickness (mm)
168 – 406	4,5mm
419 – 508	5,9mm
570 – 864	6,0mm

With regard to Sub-clause 4.2.2.1 in SABS 719 the Contractor shall, before commencing with pipe manufacture, satisfy the Engineer that the welding methods to be used in the pipe manufacture are adequate by:

a. The preparation of a weld sample employing precisely the same welding process, equipment and artisans by which the pipe shall be manufactured.

b. The preparation and destructive testing of the sample in (a) above, as laid down in Clause 7.2 of SABS 719.

The results of the tests on the test pieces shall comply with the requirements of Clause 7.2 of SABS 719 in all aspects.

Such destructive testing shall be carried out for each grade of steel and for each thickness of steel in that grade.

With regard to sub-clause 4.2.2.2 and 4.2.2.3 in SABS 719 the height of the inner weld reinforcement shall not exceed 1mm.

PSL 3.6.2 Manufacture of pipe specials

Only pipe conforming to the requirements of Clause PSL 3.5.1 above, may be used for the manufacture of pipe specials.

For pipes of nominal bore, up to 150mm diameter T-pieces shall be heavy class pipe only, with the same wall thickness for both main and branch pipes. The manufacturing process and quality requirements are as specified in the relevant section of BS 806 (Section 3).

Dimensions and joint types for pipes specials are specified in the Pipe Schedule and / or stated in the Schedule of Quantities.

Welding shall be done by a welder holding a valid competence certificate (Grade 1) in terms of SABS 044 – Part V. Butt-welded joints shall conform to the requirements for welding for pipes, and the Contractor shall prove all butt and fillet welded joints to be crack-free by carrying out dye penetrant tests, following the procedure laid down in BS 4416.

If at all practicable, pipe specials shall be subjected to hydraulic pressure tests as specified. Where this is not feasible, butt-welds must be subjected to radiographic inspection over their full length, with inspection procedure and acceptability limits for defects as specified in API 1104, keeping a record of all weld inspection and repair.

Where working pressures allow the use of malleable cast iron fittings for nominal bore up to 150mm diameter, these shall conform to the requirements of SABS 509.

PSL 3.6.3 Pipe flanges, bolts and jointing

PSL 3.6.3.1 Material and dimensions for flanges

The requirements for the materials and dimensions for flanges are in all respects as specified in SABS 1123.

A raised joint face shall be provided on all flanges of pressure rating higher than 2,5 MPa unless otherwise agreed to by the Engineer or as stated in the Schedule of Quantities, and the backs of cast of forged flanges shall be machined.

The machined surfaces of flanges shall be covered immediately after machining by a temporary rust preventative film of a suitable type as specified in BS 1133 (Section 6).

All flanges shall be drilled to SABS 1123 (Table 1600/3) or otherwise to the class as stated in the Schedule of Quantities or on drawings.

PSL 3.6.3.2 Welding on of flanges

The procedure for the welding-on of flanges, shall comply with the requirements of BS 806 (Section 3).

The proficiency of the welder and the quality requirements for the weld are the same as those specified in Clause PSL 3.6.3 above.

As a rule, the bolt holes in flanges for pipe specials shall not be on the vertical centre line.

When so specified in the Schedule of Quantities, flanged pipes shall be hydraulically tested after the welding-on of the flanges to a test pressure of 1,5 times the pressure rating of the respective flange.

PSL 3.6.4 <u>Bolts</u>

Materials and dimensional requirements of bolts and nuts are specified in SABS 135 or 136. These requirements shall correspondingly be prescribed by the Contractor when ordering.

The threaded length shall be adequate to allow two full threads to protrude beyond the nut after the latter is fully tightened.

Each bolt shall be fitted with a nut and steel washer and bolts, nuts and washers shall be cadmium plated in accordance with and to a thickness specified for Class A in BS 1706.

Unless otherwise indicated in the Pipe Schedule, the number of bolts to be supplied shall be determined on the basis that each flange is to be supplied with half the number of bolts required for that flange.

PSL 3.6.5 <u>Jointing</u>

Gaskets for flanges shall be recommended by the Contractor’s supplier and shall be submitted to the Employer’s Agent for approval.

PSL 3.6.6 Pipe joints and coupling other than flanges

Pipe ends shall be prepared for the type of jointing and coupling as specified in the pipe schedule and / or stated in the Schedule of Quantities with the requirements for and preparations as specified in SABS 62 and 719 as applicable.

Standard couplings and flange adapters shall be of the Viking Johnson type or equivalent and all loose bolts with nuts and washers shall be cadmium plated in accordance with and to a thickness specified for Class A in BS 1706 and shall be lined and coated as specified in Clause PSL 3.6.8 below.

PSL 3.6.7 Lining and coating of steel pipes, specials and fittings

All pipes, specials and fittings, including couplings and flange adapters, shall be fully lined and coated by fusion bonded epoxy on the outside and liquid epoxy on the inside with a minimum of three coats to a minimum total dry film thickness of 400 micrometres on a steel surface that has been prepared by sandblasting to Grade SA 2.5 as specified in SIS 055900, with a delay of not more than four hours between sandblasting and the application of the first paint coat.

Successive paint coats shall be of different colours, and the colour of the final coat shall be approved by the Engineer prior to painting. Over-coating time between the applications of successive coats shall not exceed 24 hours.

The epoxy product and process shall be presented to the engineer prior to the ordering of any pipe fittings applicable.

The coating and lining applied shall be as per the Standard Specification DWS 9900 Section C1 unless specified otherwise in the text above. The Specification is attached under C5 Annexures.

Tape wrapping

All underground steel pipes joints (flanged, flexible coupling, etc.) shall be tape wrapped in accordance with this specification. No additional payment shall be made as the rate for the coupling shall include for the tape wrapping.

External steel pipe coating and wrapping specification:

A Denso Corroklad 750 tape or equivalent should be applied to the external surface of the steel pipeline.

The tape consists essentially of a specially formulated polyethylene film laminated to a pressure sensitive, non-hardening thermoplastic adhesive. The adhesive layer is generally one and a half times thicker than the polyethylene film.

The composite wrapping system provides a durable impact and cut resistant rockshiled for normal and rugged service conditions.

Technical Data
The following information pertains to the Corroklad 750 tape:

- The base layer is made of polyethylene and is 0,3mm thick.
- The adhesive layer consists of rubber modified bitumen and is 0,45mm thick.

- The product thickness is 0,75mm.
- The tape has a minimum tensile strength of 15 MPa.
- The minimum elongation at failure is 300%.
- The adhesive and peel strength of the tape at 25°C is 2,2N/mm and 1,65N/mm respectively.
- The minimum dielectric strength of the tape is 25 KV.
- Cathodic disbondment by ASTM G8 Method B is 425mm².
- The service temperature of the tape is –10°C to 65°C.

Application Procedure
Corroklad tape can be successfully wrapped by hand (maximum tape width 100mm) and by machine. The general application is detailed below.

Surface Preparation
- All dirt, loose ruste/mill scale and grease must be removed from the pipe surface.
- The minimum surface preparation acceptable for tape wrapping with Corroklad is ST2 (Swedish Standard SIS 055900-1967, Mechanical wire brushing).

Priming the Pipe Surface
- The primer to be used is Denso Primer D or equivalent Polymer Bitumen Solution, and is to be applied by means of a medium pressure cop gun.
- The primer may be thinned for application with white spirits or toluene.
- The primer should nominally cover 9m² liter.
- The minimum drying period at 20°C is 20 minutes.
- The flash point occurs above 23°C.
- If the pipes are prepared and primed off site, it may be necessary to apply a second coat of primer on site in order to rejuvenate the first application. This is only required if the pipe is being wrapped on site.
- The primer should be dust free prior to the application of the tape wrap system. Should the primer be contaminated, the surface must be reprimed.
- The primer should be allowed to dry for approximately 30 minutes at 20°C to 25°C prior to the application of the tape system.

Tape Application
- The Corroklad tape or equivalent should be spirally wrapped onto the primed pipe, utilising a 55% overlap.
  55% Overlap will ensure a minimum of two layers of tape at any point.
- Ensure that a constant web tension of 10 to 15kg/100mm is maintained during wrapping.
- At no time is the shrinkage of the total width of tape to exceed 2%.

Pipe Handling
- Non-metallic slings are to be utilised when handling the wrapped pipe sections or pipe, in order to ensure that no mechanical damage occurs to the tape.

PSL 3.6.8 Making good and over-coating of steel pipes, specials and fittings

PSL 3.6.8.1 Steel pipes, specials and fittings

After erection, all damage to the Epoxy coatings or Linings, shall be made good strictly in accordance with The DWS 9900 Specification which is attached under C5 Annexures.

PSL 3.6.8.2 Handling, delivery and installation

All pipes, pipe specials and fittings shall be handled throughout the processes of manufacturing, corrosion protection, delivery and installation with all care necessary to prevent any damage.

After the corrosion protection of the outside of pipes and specials has been carried out, these items must be handled only by means of straps that will in no way damage the protection.

After completion of corrosion protection at the place of manufacture, all pipe ends shall be effectively closed off by at least a sheet of plastic held fast to the pipe and by binding wire.

This seal shall be checked specifically during delivery and after off-loading on site to confirm that it is still fully effective and shall immediately be repaired or replaced if damaged. Should there be the slightest danger of the ingress of foreign matter into the pipework during installation, the ends shall be kept sealed off all the time.

Pipes shall be supported during travelling on shaped and padded cradles while pipe specials shall be adequately supported and separated from each other to prevent any damage.

Steel pipes will only be offloaded with the aid od a spreader boom of 6m length to spread the point load and minimize the deflection in the pipe.

At the delivery points on site, pipes, pipe specials and fittings shall be supported by plastic sandbags of sufficient strength, such that the under sides of the pipes and pipe specials are at least 200mm off the ground. The number and positioning of supports under the pipes, shall be such as to prevent any undue pipe deflection.

Bolts, nuts, washers and jointing, shall be packed in strong metal or wooden containers with effective lids, with each different sizes of bolts grouped separately in hessian bags all clearly labelled as to their contents.

Pipe work shall be securely clamped in its final position by means of galvanised fittings.

PSL 3.7 Flexible couplings at structures

Flexible couplings shall be provided at the point where pipelines enter all structures.

PSL 3.8 Valves (Sub-clause 3.10)

PSL 3.8.1 Scope

This specification covers the requirements for material, manufacture, delivery, installation, over-coating as may be required, site-testing and commissioning for gate valves for use in pipe work, mainly for the delivery of raw and purified water, but also for air supply, at ambient temperatures up to 70°C.

PSL 3.9 Testing of pipelines (Sub-clause 7.3)

PSL 3.9.1 Test pressure (Sub-clause 7.3.1(a))

Replace the Sub-clause 7.3.1 with the following:

All pipes shall be tested at 1.25 the working pressure at the specific point where the pressure test be executed. The Contractor shall identify the points on the pipeline where the hydrostatic pressure test be executed and shall notify the Engineer in advance in order for the Engineer to be able to furnish the Contractor with the required test pressure at the specific test point.

PSL 3.9.2 Method of testing (Sub-clause 7.3.1(b))

Add the following new clauses:

a) The Contractor shall provide an approved test pump, an accurate water meter, sealed pressure gauge, tested and certified by an independent testing organisation, and all other equipment, materials and labour required for the test.

b) The section of pipeline to be tested shall be clean and closed off at the ends by isolating valves, end caps or approved end-closure pieces

c) During the initial filling stage, the pipe section joints and all specials, fittings and valves shall be visually inspected for visible leaks and same rectified before proceeding with the test.

d) The pressure shall be maintained for one hour and if a pressure drop occurs, more water shall be added to reinstate the test pressure and the valve closed again. The quantity of water added shall be measured by recording the readings before and after pumping. This procedure shall be repeated for a period of 24 hours, with water added at hourly intervals where necessary to reinstate pressure and water meter reading recorded. At the end of the 24 hour period, the aggregate quantity of water required to reinstate pressure over 24 hours shall be determined.

e) The Contractor shall give the Engineer 48 hours written notice of his intention to commence pressure testing and the Engineer may attend and supervise all or any part of tests. All records and recording charts shall be handed to the Engineer as soon as tests over any section have been completed.

f) All valves, specials, fittings and exposed joints, shall be inspected visually during the 24 hours pipeline test and all visible signs of leaks, sweating and distress shall be reported and attended to without delay.

g) Immediately after completion of the prescribed 24 hours hydrostatic test, all air valves shall be tested in turn before test pressure in the pipeline is released. Each air valve shall be isolated and the drain plug removed. The air valve shall work freely without restraint. The isolating valve shall be checked for leakage before replacing the plug. Finally, the automatic resealing of the air valves shall be checked by re-opening the isolating valve.

h) After completion of tests on air valves, the section of pipeline under test shall be completely refilled with water, if necessary, and pressured to the static head shown on the drawings or indicated by the Engineer. Each scour valve shall be checked by opening isolating valves where applicable for a duration sufficient to check the complete opening and closing cycles. If necessary, the pipeline shall be refilled after each individual test and re-pressurised to the prescribed static pipeline head in order to test all scours within the section under test.

PSL 3.9.3 Remedial measures (Sub-clause 7.3.1 (c))

Add the following new clauses:

a) Should the maximum leakage limits as specified be exceeded, the Contractor shall determine the position and cause of the leaks and shall take remedial measures at his own expense and to the satisfaction of the Engineer to stop such leaks and ensure the specified degree of water tightness.

b) If during the contract period of maintenance, the number of leaks and other defects is considered by the Engineer to be more than could reasonably be expected from a well laid pipeline operating under normal conditions, he may order the Contractor to re-test parts or the whole of the pipeline at the Contractor's own expense and no claims for escalation in costs or for whatever other reasons the Contractor might consider to submit claims shall be considered, except where such re-tests are the result from damages caused to the pipeline by the Employer."

PSL 3.10 Concrete work (Sub-clause 5.13)

Add sub-clause 5.13 as follows:

PSL 3.10.1 Encased pipe work

a) Where pipes and / or specials are permanently encased in concrete, e.g. in thrust blocks, walls of concrete valve chambers, stream crossings, etc., the coating over the portion to be so encased shall be to the same standard as the rest of the pipeline, except where indicated to the contrary in the Schedule of Quantities or on the drawings.

b) Whenever it is necessary to encase pipes in concrete, the flexible joints shall not be encased and the concrete shall terminate 300 mm from the flexible joint.

c) All specials encased in concrete shall be painted with one coat of bitumen primer and two coats of bit mastic paint to a dry film thickness of 180 micrometers.

PSL 3.10.2 Brickwork (Sub-clause 5.14)

Add sub-clause 5.14 as follows:

a) Brickwork is to be built to the dimensions, thicknesses and heights as shown on the drawings.

b) All exposed brickwork shall be plastered and shall have joints raked out to a depth of 12 mm to ensure good plaster fond.

c) Mortar shall consist of one part cement to four parts approved sand by volume and shall be used within one hour of mixing.

d) Brickwork shall be built in stretcher bond and all common bricks shall be well wetted before being laid.

PSL 4 MEASUREMENT AND PAYMENT

PSL 4.1 Steel specials and fittings (sub-clause 8.2.1)

Add the following clause to the payment item:

The rate shall also cover the cost of the coating and lining as specified in this contract as well as repairing or making good, damaged coatings and linings on site.

PSL 4.2 Steel specials and fittings (sub-clause 8.2.2)

Add the following payment item:

Item:

Fabrication, supply, transport and install and test the following pipe fittings. All items to be approved by Engineer prior to ordering. Unit: number (no)

The unit of measurement for payment for the manufacture, corrosion protection and final over-coating as may be required, delivery, installation of pipes, site-testing and commissioning of pipes, pipe specials and fittings conforming with this Specification shall be measured by number for each type, class and size as stated in the Schedule of Quantities.

The rates tendered and paid for valves and fittings must include the cost of the provision of an approved coating and the cost of any additional couplings other than those listed in the Schedule of Quantities to connect to the water mains.

All adapters and distance pieces required for the extension to the specified level and length as shown on the drawings for air and scour valves must be included in the rates for the units. All underground pipe fittings shall be wrapped in an approved isolating material as specified in PSL 3.5.7

The cost of providing couplings, cutting pieces, etc. shall be allowed for in the rate tendered for pipe work.

PSL 4.3 Reinstate Road Surface

Add the following payment item:

Item:

Reinstate road surface as per detail drawings:

a) Cut and remove existing gravel layer in windrow and stockpile Unit: m^3

b) Reinstate existing gravel layers to original state (98% MAMDD) Unit: m^3

The above item covers the complete repair of the road surface where the pipeline trench exaction is required over an existing gravel or surfaced road. The rate shall cover all materials, plant, watering, stabilizing, labour and tests to repair the road surface and related layer works back to its original state.

PSLB SABS 1200 LB: BEDDING (PIPES)

PSLB 1 MATERIALS

PSLB 1.1 Selected granular material (Sub clause 3.1)

Add the following to this sub-clause:

Granular materials shall be selected from trench excavations. If the contractor elects not to apply selection of material from excavations, he shall provide suitable material from any other approved source at his own expense.

Bedding material shall be either of the following type:

a) Type A : Finally graded, composed of material with the following properties:

i) Percentage by mass passing:

4,75 mm screen - 100 %
0,425 mm screen - 80 to 100 %
0,002 mm screen - 0 to 45 %

ii) Liquid limit (LL) as determined in accordance with SABS Method 852 shall not be more than 15, when performed on all the material passing the 0,425 mm sieve.

iii) Plasticity index (PI) as determined in accordance with SABS Method 852 shall not be more than 15, when performed on all the material passing the 0,425 mm sieve.

iv) Linear shrinkage (LS) as determined in accordance with SABS Method 853 shall not exceed 5 %, when performed on all the material passing the 0,425 mm sieve.

b) Type B : Medium graded, composed of material with the following properties:

i) Percentage by mass passing:

4,75 mm screen - 80 to 100 %
0,425 mm screen - 60 to 80 %
0,002 mm screen - 0 to 40 %

ii) Liquid limit (LL) as determined in accordance with SABS Method 852 shall not be more than 35 %, when performed on all the material passing the 0,425 mm sieve.

iii) Plasticity index (PI) as determined in accordance with SABS Method 852 shall not be more than 18, when performed on all the material passing the 0,425 mm sieve.

iv) Linear shrinkage (LS) as determined in accordance with SABS Method 853 shall not exceed 7 %, when performed on all the material passing the 0,425 mm sieve.

c) Type C : Granular, composed of material with the following properties:

i) Percentage by mass passing:

9,5 mm screen - 100 %
4,75 mm screen - 70 to 100 %
0,425 mm screen - 30 to 60 %
0,002 mm screen - 0 to 45 %

ii) Liquid limit (LL) as determined in accordance with SABS Method 852 shall not be more than 40 %, when performed on all the material passing the 0,425 mm sieve.

iii) Plasticity index (PI) as determined in accordance with SABS Method 852 shall not be more than 20, when performed on all the material passing the 0,425 mm sieve.

iv) Linear shrinkage (LS) as determined in accordance with SABS Method 853 shall not exceed 10 %, when performed on all the material passing the 0,425 mm sieve.

Items a), b) and c) are conveniently summarised in the following table:

Material	PERCENTAGE BY MASS PASSING SCREENS				ATTERBERG LIMITS SHALL NOT EXCEED		
	9,5 mm	4,75 mm	0,425 mm	0,002 mm	Liquid Limit (LL) %	Plasticity Index (PI)	Linear Shrinkage (LS) %
Finely graded / A	100	100	80 -	0 - 45	30	15	5
Medium graded / B	100	80 - 100	100	0 - 40	35	18	7,5
Granular / C	100	100	60 - 80	0 - 35	40	20	10
		70 - 100	30 - 60				

PSLB 1.2 <u>Bedding</u> (Sub-clause 3.3)

Add the following to this sub-clause:

All steel pipes in the works shall be classed as “rigid” with flanged joints and shall be bedded on Class C bedding as described in sub-clause 5.2 of SABS 1200 LB, unless otherwise specified or instructed by the Engineer.

PSLB 1.3 <u>Backfilling of pipe trenches</u> (Sub-clause3.5)

Add sub-clause 3.5 as follows:

No backfilling of pipe trenches on top of the selected fill layer may commence without the written consent of the Engineer or his Representative.

PSLB 2 CONSTRUCTION

PSLB 2.1 <u>Waterlogged trench bottoms</u> (Sub-clause 5.5)

Add sub-clause 5.5 as follows:

a) Where trench bottoms are too soft and waterlogged to permit placement and compaction of bedding material in the normal manner, such trench bottoms shall be excavated to a depth of at least 300 mm below the underside of pipes and specials for the full width and length of the trench affected.

b) The full width and length of the trench bottom and at least 500 mm height of both sides of trench walls shall be covered by an unwoven approved geotextile, similar to Kaymat U24.

The full width and length of the trench shall thereupon be covered by a 300 mm thick layer of coarse gravel, coarse sand or 19 mm nominal size crushed stone, fully compacted within the confines of the geotextile to take the mass of the pipe filled with water and all loads on the pipe without settlement.

The free drainage layer shall be covered over the full width of the trench by a single layer of geotextile with the cloth on trench walls folded over and overlapping to completely seal off the free drainage layer against ingress of sand or fine soil particle.

Pipes shall be laid directly on the bed prepared as above and pipe bedding and selected backfill completed as specified.

PART B: MECHANICAL WORKS

PS1: MECHANICAL SPECIFICATIONS

APPLICABLE STANDARDISED SPECIFICATIONS FOR MECHANICAL WORKS

STANDARD SPECIFICATION FOR MECHANICAL WORKS
(INCLUDING GENERAL WORKS)

The following Standard Specifications shall generally apply to all equipment proposed on this Contract. However, there are specific requirements in certain sections of these Documents which pertain to particular items of Mechanical Equipment. These Particular Specifications shall supersede the Standard Specifications.

SERIES M1 GENERAL

M1001	General Mechanical Engineering	Applicable
M1002	Corrosion Protection	Applicable

SERIES M2 OPERATION AND MAINTENANCE AND SAFETY

M2001	Operation and Maintenance	Applicable
M2002	Maintenance Requirements (Section C5)	Applicable

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

M3001	Mountings	Applicable
M3002	Grid Floors, Guard rails and Ladders	Applicable

SERIES M4 FASTENERS

M4001	Nuts, Bolts and Fastening Sets	Applicable

SERIES M5 MEDIUM PRESSURE PIPES

M5001	Generals for Medium Pressure Pipes	Applicable

SERIES M6 PUMPS

M6001	Centrifugal Type Pumps	Applicable
M6002	Axial Flow Pumps	Not Applicable
M6004	Positive Displacement Type Pumps	Applicable
M6006	Self-Priming Type Pumps RAS	Not Applicable
M60014	Air Lift Pump	Not Applicable
M60015	Submersible Type Pumps	Applicable

SERIES M7 VALVES

M7001	General Valves	Applicable
M7002	Telescopic Valves	Applicable
M7003	Actuators	Not Applicable

SERIES M10 MECHANICAL FLUID CONTROL EQUIPMENT

M10001	Fluid Control Gates and Tank Valves	Applicable

SERIES M14 DISINFECTION AND CHEMICAL DOSING

M14001	Gas Chlorination	Applicable

SERIES M16 SETTLING TANKS

M16002	Clarifiers	Applicable

SERIES M20 LIFTING EQUIPMENT

M20001	Overhead Travelling Cranes	Applicable
M20002	Crawl Beams and Chain Blocks	Applicable
M20003	Davits and Winches	Applicable

SERIES M1 GENERAL

SECTION: M10001: GENERAL MECHANICAL ENGINEERING

TABLE OF CONTENTS

SERIES M1 GENERAL

SECTION: M10001 GENERAL MECHANICAL ENGINEERING

SCOPE

This specification sets out the general requirements applicable to mechanical installations and shall apply where it is relevant to the Contract unless it is superseded by the project specification.

DESIGN SPECIFICATION

General

This Specification lays down the performance, quality and overall system requirements of the Works. Deviation from the Specification will only be considered if the Engineer considers such deviation an improvement.

Safety

Safety shall be an all important and overriding consideration and proper attention shall be paid to this aspect at the design stage. Equipment which is potentially dangerous shall be designed in accordance with a relevant South African or international Standard.

Hazards must be avoided or guarded. Nip points shall be guarded; sharp corners shall be rounded off; operating handles, supports and protrusions shall be kept clear of access ways.

Moving parts shall be properly guarded to the satisfaction of the Engineer.

An emergency stop button shall be installed in a convenient position next to each machine. The installation shall be designed to provide immediate access without the danger of accidental operation.

Where, in the opinion of the Engineer, an installation is not safe, the Contractor shall remedy such defect at his own cost to the satisfaction of the Engineer.

Design factors

A high-quality standard is demanded and reliability, long life, trouble free operation, efficiency, ease of maintenance and operation, and neatness are essential.

All plant and equipment shall be of robust construction and the design shall, as applicable, be based on:

the full range of duties which can be reasonably anticipated;
the power and torque transmitted by the driver system under full load and stalled conditions;
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;
conservative service and safety factors based on approved standards or laid down in the printed specifications of reputable and approved manufacturers;
a safety margin of at least 20% in addition to any service or safety factors which apply;
twenty four hour per day operation;
a minimum life of 100 000 hours before repair or major part replacement; and
Prevention of serious damage from normal operational problems such as blockages, blinding, jamming, seizure, mal-function and, as far as is practical, mal-operation; if these occurrences cannot be avoided by good design.

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

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,

mal-operation, overload and, as far as practical, misuse. All reasonable and economically justifiable protections to prevent or limit damage to plant and equipment, particularly in high risk situations, must be incorporated. Protections shall:

be directed at the source of the problem, limit forces to safe levels and act quickly enough to prevent; stop or prevent from starting all equipment at risk;
activate an alarm with a labelled indicator on the control panel whenever a protection operates;
not permit unauthorised tampering; and
Operate reliably after long inactive periods exposed to corrosive and dirty conditions.

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:

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.

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.

On abrasive applications abrasion resistant materials and slow speed operation shall be utilised.

Susceptibility to fatigue failure shall be minimised by proper design and manufacturing procedures. In particular, changes in section shall be radiused and care must be taken to avoid the use of welded components in areas of fluctuating stress.

The locking of nuts and pins in position shall be done to the approval of the Engineer.

Wearing parts shall be designed for interchangeability and ease of removal and replacement.

Arrangement and mounting

The arrangement and general design shall take the following requirements into consideration:

Lifting eyes, lugs, hooks, etc., shall be provided on heavy or large items to facilitate handling.

Castings or fabrications shall have machined pads for seating and be mounted on either soleplates or baseplates as appropriate.

Where accurate alignment is required, positioning pins and/or jacking screws shall be provided.

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

With plant and equipment to be mounted on or against concrete or brick structures, provision shall be made for adjustment in the mechanical design. Any special accuracy requirements must be specified on the Contractor's Drawings.

Lifting equipment

All lifting equipment shall comply with the following requirements unless otherwise stated:

All aspects of lifting equipment, including design, fabrication and installation work shall be full in accordance with the relevant aspects of the Occupational Health and Safety Act and Regulations.

Lifting equipment shall be designed and constructed in accordance with a generally accepted technical standard.

The safe working load (SWL) shall be marked clearly on all items.

The complete installation shall be inspected and shall be tested over its complete lifting range using a load which is at least 125 % of the safe working load.

High-tensile or alloy steel chains shall have a factor of safety of at least four.

Chains shall have a factor of safety of at least five.

Steel-wire ropes shall have a factor of safety of at least six.

Man made fibre ropes or woven webbing shall have a factor of safety of at least six.

Natural fibre ropes shall have a factor of safety of at least ten.

MATERIALS OF CONSTRUCTION

Installation

General

The Works shall comply with the following:

When erected and installed, the plant and equipment shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.

The requirements of Sub-clause "Arrangement and Mounting" must be noted.

The Contractor shall provide all foundation bolts, supports, hangers, brackets, etc. required for the support and fixing of equipment.

The Contractor is not responsible for grouting puddle pipes which pass through liquid retaining walls or slabs but shall be responsible for all other grouting necessary for all plant and equipment.

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.

Corrosion protection requirements shall be carefully attended to and the relevant paragraphs of Sub-clause "Paint Application" (see Clause "Corrosion Protection: Paint Coatings) must be noted. All mating faces must be coated before and sealed after assembly.

Fastener threads must be coated with a nickel-based, anti-seize compound before assembly.

Crevices which are formed between two surfaces shall be filled, prior to final fastening, with a suitable formable packing. This applies particularly to stainless steel.

Alignment of shafts

Shafts for drives, such as motors, with an output above 150 kW shall be aligned to the driven shaft as follows:

Final alignment shall be done after installation and before commissioning, shall be checked in the presence of the Engineer and shall be to his approval. Alignment shall be sufficiently accurate to ensure that no initial pre-load is placed on the shaft coupling.

Each motor shall be aligned to its pump using laser aligning equipment.

The use of pourable epoxy resin chocks 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.

Materials

Materials – 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.

Steel

All structural steel shall comply with the requirements of SANS 1431 grade 300W and shall be legibly marked with the maker's name or trade mark and identification marks.

Plastics

Thermoplastics and fibre reinforced polymers shall be UV resistant, have adequate tensile strength and high impact strength and generally suit the application.

Castings

Castings shall comply with the relevant South African or British Standard for the material used, including the following:

Grey Cast Iron Castings	-	SANS 1034	BS.1452
S.G. Iron Castings	-	SANS 936/7	BS.2789
Steel Castings (General Purpose)	-	SANS 1465	BS.3100
Aluminium Castings	-	SANS 989/992	BS.1490
Copper and Copper Alloy Castings	-	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 and sand and slag inclusions 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.

Fabrication of carbon steels

Standards

Steelwork shall be constructed, fabricated and erected in accordance with SANS 1200H where applicable.

Finish

Weld spatter and other protrusions shall be removed. Sharp edges shall be rounded to a radius of at least 2 mm.

Requirements for corrosion protection

In addition to finishing requirements, the requirements of corrosion protection application shall be taken into consideration. All surfaces must be accessible for surface preparation and coating. Inaccessible pockets, open hollow sections or the like shall not be permitted except where hot-dip galvanizing (without painting) is

called for. Surfaces which cannot be properly prepared after fabrication must be abrasive blasted and coated with a two-pack epoxy pre-weld primer before fabrication.

Inspections

The Contractor shall arrange for the Engineer to inspect fabrications, including fabricated pipework, in the fabrication workshop and prior to corrosion protection.

Fabrication of stainless steels

The requirements regarding the fabrication of carbon steels apply to the fabrication of stainless steels as well. In addition, the following requirements apply to the fabrication of stainless steels.

Surfaces which become contaminated with steel or otherwise stained or otherwise marked so as to be of uneven colour, shall be cleaned by pickling or electro-cleaning rather than by grinding.

The Contractor shall arrange for the Engineer to inspect fabrications, including fabricated pipework, in the fabrication workshop.

Welding

General Welding Requirements

Standards: Standards complying with good modern practice, and acceptable to the Engineer, shall be adopted. These include the following:

BS 5135 - 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 competent artisans approved in accordance with BS 4872.

Welding to be continuous: All welding shall be continuous on all sides of any joint unless otherwise approved in writing by the Engineer. No crevices will be permitted and where stitch welding has been approved by the Engineer, the crevices so left shall be sealed with an approved filling compound after priming but before further painting.

Weld appearance: Welding shall be free of blowholes and all welding flux shall be removed. All weld spatter and other sharp imperfections shall be removed prior to abrasive blasting. Prior to painting, weld beads with a surface irregularity exceeding 3 mm or with sharp crests having a radius under 2 mm shall be ground. Weld grinding must not be performed on 304L or 316L stainless steel, however, unless unavoidable.

Site welding: Site welding shall be kept to a minimum and shall only be undertaken with the approval of the Engineer.

Type of stainless steel: Austenitic stainless steels to be welded shall be of the low carbon grade (i.e.: 304L, 316L, etc.).

Welding rods: The welding rods used shall be the most suitable for the metal and purpose. Type 309 stainless steel welding rods shall be used for welding 3CR12 unless otherwise approved in writing.

Welders: Only welders experienced with welding stainless materials shall be used.

General: All possible steps shall be taken to ensure maximum corrosion resistance, 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.

Guards

Guards shall comply in all respects with the Occupational Health and Safety Regulations 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 316 stainless steel (uncoated) but may also be hot-dip galvanized, zinc-sprayed or aluminium-sprayed carbon steel, coated to specification in all these cases. Fasteners shall be M10 or larger and shall be of 316 stainless steel.

Machine vibration levels

The mechanical vibration of machines measured at all important points such as bearings shall be lower than that specified as "good" for that class of machine in BS 7854 (ISO 10816).

Noise control

Noise levels

The noise level of the complete installation shall not exceed the following:

a maximum noise level at the Site boundaries not exceeding an equivalent continuous sound level of 55 dB(A) when all equipment installed is being operated; and

A maximum noise level at a distance of 1 m of each sound producing mechanical equipment of 80 dB(A).

Where the Contractor is unable to restrict the noise level of the machines to the maximum specified, by the appropriate selection of suitable equipment; e.g. by selecting slow speed or silent type machines, quiet type cooling fans, suitable silencers, etc. then an alternative solution, such as an acoustic hood or similar shall be offered.

Bearings

Bearing systems shall be designed to provide safe shut down without damage under normal stoppages as well as electrical supply failure.

Lubrication

Grease lubrication

Grease lubrication is preferred and all greasing points must be easily accessible.

Equipment with multiple greasing points shall be provided with grease lines which are piped, separately, to a single easily accessible position.

In cases in which motorised lubrication is provided to more than one destination, a distributor shall be provided. The distributor shall be a positive displacement device which ensures equal, successive lubrication to all destinations.

Pipework for grease distribution shall be of stainless steel or non-ferrous metal.
Oil lubrication

Oil level indicators shall be fitted for visual checking. Drain cocks, including 316 SS fittings where necessary to permit convenient draining, and plugged at the end, shall be provided for oil reservoirs exceeding 1,5 litre capacity. Drains shall be from the lowest point and syphon type drains are unacceptable.

Lubrication systems shall be designed to exclude dirt and moisture. Air vents on the oil reservoir shall contain an air filter.

MEASUREMENT AND PAYMENT

The provision of all general mechanical design, construction and material requirements as specified within this standard specification shall be included for in the overall price of equipment offered.

SERIES M1 GENERAL

SECTION M1002: GENERAL CORROSION PROTECTION

TABLE OF CONTENTS

SERIES M1 GENERAL

SECTION M1002: STANDARD SPECIFICATION FOR GENERAL CORROSION PROTECTION

CORROSION PROTECTION: APPLICATION AND CONTROL

Painting contractor

Surface preparation and coating application shall be carried out by experienced industrial painting contractors who are fully equipped and staffed to do such work in their own covered premises strictly in accordance with the paint manufacturer's recommendations. Before proceeding with the corrosion protection coatings, the Contractor shall submit the name of the painting sub-contractor for approval by the Engineer.

Site work

Surface preparation and coating application shall not be done on Site except for minor repairs, for application of the final aesthetic coat, where specifically called for or where permitted by the Engineer in writing.

Systems to be used

Systems: The corrosion protection systems to be used on the plant and equipment will usually be specified for the equipment, but if not, the Contractor shall recommend a suitable system for approval by the Engineer. If doubt exists as to the system or colour to be used, the Engineer's requirements must be ascertained.

Alternative systems: Alternative systems superior to those specified may be used if approved in writing by the Engineer.

All items to be painted: Except where otherwise specified, all metal surfaces shall be painted. This includes hot-dip galvanized items and metal-sprayed coatings. In the latter case the paint shall be in the form of a sealer. Details of approved painting systems to be used are given below.

Coating appearance: After installation on Site the finished paintwork must be neat, smooth, of uniform colour and to the approval of the Engineer.

316 Stainless steel: It is not usually necessary to paint 316 stainless steel. If corrosion of 316 stainless steel does occur, and depending on the appearance or extent of the problem, the Engineer may call for pickling, electrocleaning, painting or replacement of the item at no additional cost. Painting may however be required if contaminated or stained surfaces cannot be properly cleaned or where stitch welding has been approved.

Quality control of coating application

Inspection: The Contractor shall arrange for the coating application on fabricated steelwork to be inspected throughout by the Engineer. The Engineer may approve inspections by an independent competent person (hereinafter called the Inspector) appointed by and at the cost of the Contractor. Inspection report: A written report of the inspections, prepared by the Inspector and signed by both the Inspector and the Contractor, shall be submitted for appraisal by the Engineer before delivery of the equipment to Site.

Inspector qualifications: Inspectors appointed by the Contractor shall hold an appropriate qualification from either the CISA, the SAIW or the SAQCC.

Identification of items: Every item to be coated shall be identified by a welded or hard-stamped code. Records shall be maintained for each item.

CORROSION PROTECTION: SURFACE PREPARATION

Imperfections

Welding shall be free of blowholes and all welding flux removed. All weld spatter, sharp edges and other imperfections shall be removed prior to abrasive blasting. Prior to painting, weld beads with a surface irregularity exceeding 3 mm or with sharp crests having a radius under 2 mm shall be ground. (Weld grinding must not, however, be performed on stainless steel). Areas to be painted shall be free of crevices. If the Engineer has permitted stitch welding, crevices shall be filled with a compatible sealing compound after the priming coat has been applied.

Abrasive blasting

Before coating all surfaces shall be properly degreased and abrasive blast cleaned to an SA3 finish with a 40-65 µm surface profile to Swedish Standard SIS 055900 of 1967. The abrasive shall comply with paragraph 4.3.3 of SANS 064 and shall be free from all traces of oil, grease, foreign matter and corrosive contaminants such as chlorides, etc. The prepared surface shall be given the first coat of the painting system within 4 hours after cleaning.

In instances where stainless steel and 3CR12 are to be painted, the surface shall be suitably abrasive blasted prior to primer application.

Between coats

Between coats or with previously painted surfaces in good condition, all traces of oils, greases, soluble salts and corrosive air borne contaminants shall be thoroughly washed from the surface to be painted using a detergent type cleaning agent, rinsed and dried. The previous coat shall then immediately be lightly sanded or otherwise prepared as recommended by the paint manufacturer, wiped clean, dried and painted. Solvents are not acceptable as a surface cleaning agent.

Hot-dip galvanized surfaces

Hot-dip galvanized surfaces to be painted shall be free from white rust and shall be cleaned with an approved water based galvanizing cleaner using non-metallic abrasive pads until a "water break free" surface is obtained. The surface shall then be thoroughly rinsed with clean potable water to remove all residues and dried immediately prior to painting. Where necessary to obtain adhesion a sweep blast of the surface shall be done after cleaning.

CORROSION PROTECTION: METAL COATINGS

General

Fabrication of items to be protected by metal coatings shall be in accordance with SANS ISO 14713.

Hot-dip galvanizing

Standard: Hot-dip galvanizing shall be done in accordance with SANS 121 (ISO 1461:1999) Hot-dip Galvanized Coatings on Fabricated Iron and Steel Articles.

Thickness: Coatings shall be to the thicknesses detailed in the Standard.

Passivation: Hot-dip galvanized material which is to remain unpainted shall be passivated as specified in SANS 121. Items to be painted after hot-dip galvanizing shall be air dried and not passivated.

White rust: Hot-dip galvanized material shall be substantially free from white rust when it is erected on site. Stacking and storing shall at all times be done in a manner to prevent white rust forming.

Repair: Damage to hot-dip galvanizing caused by welding, grinding, etc. is not acceptable. The repair to hot-dip galvanizing damaged by handling or transport shall be done by cleaning the area and applying 3 coats of a zinc rich primer giving a dry film thickness of at least 100 µm and containing at least 94 % zinc in the dried film. If the opinion of the Engineer is that damage is excessive, such items will be rejected by the Engineer and shall be replaced by the Contractor at his own expense.

Welding: Welding after hot-dip galvanizing is not acceptable.

Test certificate: The Contractor shall supply a galvanizer's guarantee or test certificate prior to installation.

Sprayed metal coatings

Standard: Sprayed metal coatings shall be done in accordance with SANS 1391: Standard Specification for Thermally Sprayed Metal Coatings as amended below. The statements below apply to Part 1 of SANS 1391.

Symbols: The type symbol described in Table 1 of the Standard shall be used to specify material and thickness requirements; i.e. AL for aluminium, Zn for zinc, followed by the minimum average thickness in microns.

Thickness: The minimum coating thickness for both Aluminium and Zinc shall be 150 µm.

Thickness testing procedure: The procedure laid down in Clauses 4.2.1.3 a (1) or b (1) of SANS 1391: Part 1 for the determination of the coating thickness shall not be regarded as sufficient. The thickness shall be checked on every surface plane at points not more than 300 mm apart for small articles and 500 mm for large articles, e.g. angles shall be checked along all 4 surfaces, channels along all 6 surfaces, pipes in 4 planes etc. The minus tolerance on thickness in isolated areas shall also not exceed -10% and such low areas shall not be larger than 50 mm in diameter.

Period between preparation and coating : For the purpose of Clause 3.3 of SANS 1391: Part 1, the time between preparation and coating shall be shortened from 4 hours to 2 hours at any application area closer than 10 km from the coast.

Sealing: Unless otherwise specified, all metal coatings shall be sealed immediately after metal-spraying using a suitable pre-treatment wash primer followed by coats of low viscosity sealant until absorption is complete. This shall be followed by a suitable top coat system to give a smooth final finish. The various coatings used shall be as specified or, if not specified, shall be selected by the Contractor to suit the duty and submitted to the Engineer for approval. The final coat shall normally be applied on site after installation. Colours shall be as specified or as agreed with the Engineer. Depending on the particular application, the following systems are acceptable:

System 1

Application of micaceous oxide pigmented polyamide cured epoxy to achieve a dry film thickness of 60-80 µm; (Sigmarite Sealer, or equivalent);
One coat of solvent borne modified acrylic coating to achieve a dry film thickness of 70 µm; (Sigma Topacryl coating, or equivalent); and

One coat of solvent borne modified acrylic finish to a dry film thickness of 30-45 µm; (Sigma Topacryl finish, or equivalent).

System 2

Application of one coat of two component epoxy primer to a dry film thickness of 40 µm; (Intergard 269, Chemrite Carboline Rustbond Penetrating Sealer, or equivalent);
Application of one intermediate coat chemical resistant vinyl copolymer to a minimum dry film thickness of 70 µm; and
Application of one coat of vinyl copolymer chemical resistant enamel to a minimum dry film thickness of 40 µm.

System 3

Application of one coat of two component epoxy primer to a dry film thickness of 40 µm; (Chemrite Carboline Rustbond Penetrating Sealer, Intergard 269, or equivalent); and
Application of two coats of polyurethane enamel (twin pack) to a minimum combined dry film thickness of 70 µm.

CORROSION PROTECTION: PAINT COATINGS

Paint selection

Paint quality: Paint shall be of best quality, of approved manufacture and brand and comply with the requirements of the relevant SANS or BS specifications.

Compatibility: To avoid incompatibility between paint coats due to variations in formulation, the different coats in any one paint system shall be provided by the same manufacturer.

Confirmation of suitability: Contractors shall obtain confirmation from their paint suppliers that, when using their paints, the systems specified are technically correct and suitable for the application and the material being coated.

Paint application

Surface preparation: All surfaces shall be properly prepared as specified in Clause "Corrosion Protection: Surface Preparation".

Painting: Paints shall be applied strictly in accordance with the manufacturer's instructions by tradesmen skilled in this class of work. Thinning of paint shall only be allowed for spray application and the manufacturer's recommended thinners shall be used.

Coating of hidden areas: Areas which will be inaccessible after erection and surfaces resting on floors shall receive the full paint system prior to erection. Mating or contact surfaces shall be prepared and primed and be brought together while the paint is still wet.

Items encased in concrete: Metal to be encased in concrete shall be painted externally up to 30 mm inside the concrete section, leaving the remainder bare so as to facilitate bonding with the concrete.

Crevices: Crevices will not be permitted. Where unavoidable crevices are accepted by the Engineer, such crevices shall be filled with a compatible filler after application of the priming coat.

Protection of machined surfaces: Where painting of machined surfaces is not possible or advisable, these surfaces shall be coated with an approved proprietary anti-corrosion compound giving 12 months protection under operating conditions. Shaft ends and machined mating or mounting surfaces or pads shall be so coated and shall not be painted.

Coating thickness: The dry film thickness shall be measured using a non-destructive thickness gauge such as the "Mikrotest" or equivalent and shall comply with the Specification.

Repair: Painted areas damaged during transportation, erection or any means whatever shall be repaired as follows - Rusted spots shall be removed and cleaned by means of a wire brush or emery paper to a bright metal finish and the surrounding paint which is still intact shall be feathered for a distance of 50 mm beyond the damaged area. Spot priming and repair shall consist of all the coats previously applied and shall overlap the undamaged area.

Protection on site : Proper and adequate use of cover sheets and other means shall be made to protect the existing paintwork from damage and from metal dust and sparks when welding, grinding, and wire brushing on site. Similarly effective steps shall be taken to prevent spillage or splashing or other damage to floors, walls and equipment when painting on site and any damage or mess caused shall be corrected at the Contractor's cost.

Final coat: The final external coat/s shall always be applied on site after installation except for System A/1, where all coats shall be applied by a specialist applicator at his premises. A professional, smooth finish with a uniform colour is required.

Final colour code – general

The final colour code shall be as follows:

PIPEWORK				
CONTENTS OF PIPE	BASIC COLOUR	COLOUR OF INDICATOR		
		1 BAND	2 BANDS	3 BANDS
AIR				
Compressed, Power	Arctic Blue (F28)		-	-
Aeration	Arctic Blue (F28)	Canary Yellow (C61)	-	-
Instrument	Arctic Blue (F28)	Salmon Pink (A40)	-	-
Vacuum	Arctic Blue (F28)	Primrose (C67)	-	-
Lime Transfer	Arctic Blue (F28)	Crimson (A03)	-	-
Blower	Arctic Blue (F28)	Verdigris Green (E22)	-	-
CHEMICALS				
Aluminium Sulphate	Jacaranda (F18)	Verdigris Green (E22)	-	-
Sodium Aluminate	Jacaranda (F18)	Crimson (A03)	-	-
Ferric Sulphate	Jacaranda (F18)	Canary Yellow (C61)	-	-
Lime (dry powder)	Jacaranda (F18)	Salmon Pink (A40)	-	-
Activated Carbon	Jacaranda (F18)	Light Stone (C37)	-	-
Polyelectrolyte	Jacaranda (F18)	Cloud White (G80)	-	-
GASSES - (other than air); liquefied or gaseous				
Butane, Propane	Light Stone (C37)	-	-	-
Ammonia	Light Stone (C37)	Ultramarine (F09)	-	-
Blast furnace	Light Stone (C37)	Crimson (A03)	-	-
Carbon Dioxide	Light Stone (C37)	Light Brunswick Green (H07)	-	-
Coke Oven	Light Stone (C37)	Light Grey (G29)	-	-

PIPEWORK				
CONTENTS OF PIPE	BASIC COLOUR	COLOUR OF INDICATOR		
		1 BAND	2 BANDS	3 BANDS
Producer	Light Stone (C37)	Verdigris Green (E22)	-	-
Chlorine, Hypoclorite	Light Stone (C37)	Canary Yellow (C61)	-	-

WATER				
Cold Drinkable	Brilliant Green (H10)	Cornflower (F29)	-	-
Hot Drinkable	Brilliant Green (H10)	Crimson (A03)	Cornflower (F29)	-
Boiler Feed (Distilled)	Brilliant Green (H10)	Crimson (A03)	Cloud White (G80)	Crimson (A03)
Boiler Feed (De-mineralised)	Brilliant Green (H10)	Cloud White (G80)	-	-
Industrial, Raw	Brilliant Green (H10)	Golden Yellow (B49)	-	-
Reclaimed	Brilliant Green (H10)	Jacaranda (F18)	-	-
Backwash	Brilliant Green (H10)	Light Stone (C37)	-	-
De-sludge	Brilliant Green (H10)	Canary Yellow (C61)	-	-
Stove Circulating	Brilliant Green (H10)	Salmon Pink (A40)	-	-
Hydraulic Power	Brilliant Green (H10)	Terra Cotta (A10)	-	-
Final Treated Effluent	Aquamarine (E67)	-	-	-
Interchange, Stage	Drakensberg Green (H36)	-	-	-
Raw Sewage	Olive Green (H05)	-	-	-
Sea Water	Light Brunswick Green (H07)	-	-	-
Primary Sludge	Dark Brown (B03)	-	-	-
Waste Activated Sludge	Light Brown (B15)	-	-	-
Digested Sludge	Light Brown (B15)	Light Olive Green (H21)	-	-
Pasteurised Sludge	Light Brown (B15)	Cloud White (G80)	-	-
OIL				
Diesel Fuel	Golden Brown (B13)	Cloud White (G80)	-	-
Hydraulic Power	Golden Brown (B13)	Salmon Pink (A40)	-	-
Lubricating	Golden Brown (B13)	Verdigris Green (E22)	-	-
Transformer	Golden Brown (B13)	Crimson (A03)	-	-
Paraffin	Golden Brown (B13)	Arctic Blue (F28)	-	-

PLANT AND EQUIPMENT	
EQUIPMENT	COLOUR CODE
FIRE FIGHTING	
Equipment and Pipework	Signal Red (A11)
ELECTRICAL	
Distribution Boards, Switch-Gear, Terminal Boxes and Conduits	Light Orange (B26)
Emergency Stop	Signal Red (A11)
MACHINE GUARDS	
Inside	Light Orange (B26)
Outside	Colour of Machine
Protruding Shafts, Exposed Gear Wheels and Rotating Parts	Light Orange (B26)

PIPEWORK				
CONTENTS OF PIPE	BASIC COLOUR	COLOUR OF INDICATOR		
		1 BAND	2 BANDS	3 BANDS
OVERHEAD TRAVELLING CRANE				
Final colour		Golden Yellow (B49)		
HANDRAILS				
Horizontal Rails and Chains		Golden Yellow (B49)		
Stanchions		Black		
Protrusion, Sides of Ramps		Black and Yellow Diagonal Stripes		
GENERAL				
Scour Pipes		Deep Buff (B24)		
Valves		Basic colour of pipeline		
WORKSHOP FLOOR DEMARCATION				
Demarcation Lines		Golden Yellow (B49)		
Working Areas		Pastel Grey (G54)		
No Parking, No Storage		Golden Yellow (B49)		
Aisles and Walkways		Brilliant Green (H10)		
Storage Area		Terracotta (A10)		
Urethane based paint is to be used for concrete surfaces Traffic paint is to be used for tarred surfaces				

EXCEPTION:

Items made of 316 or 316L stainless steel may be left unpainted provided the surface is of uniform self-colour without blemishes, rust, marks or stains. If blemished the surfaces must either be painted or cleaned by pickling and/or electro-cleaning (not grinding or other mechanical means).

Painting systems

Definition of terms

The abbreviation "d.f.t." used in this Specification shall mean dry film thickness given in microns and, except where otherwise specified, is the minimum (not average) thickness permissible.

SYSTEM A/1

Three coats of a low solvent, high solids, polyamine/amide cured, epoxy (twin pack) to a minimum thickness of 350 µm.

Notes:

The coating shall undergo holiday detection over the full surface in accordance with SANS 1217. This test shall be done by an inspector holding an appropriate qualification from either the CISA, the SAIW or the SAQCC.

When applied to hot-dip galvanized surfaces, a suitable epoxy primer shall be used after careful surface preparation before applying this system.

This system shall be applied by a specialist applicator prior to delivery to site with particular attention to the required interval between coats.

The first and third coats shall be a different colour to the second coat.

Applied to:

Items subject to immersion and/or wet abrasion; e.g. screw pumps, clarifier rotating arms, scum boxes and weirs, pipework, chutes, tanks, etc.

SYSTEM A/2

System A/1, plus		d.f.t = 350 µm
1	Coat wash primer to SANS 723	d.f.t = 40 µm
		Total d.f.t = 390 µm

SYSTEM A/3

2 Coats of a micaceous iron oxide pigmented polyamine/amide cured epoxy sealer/coating (twin pack) with d.f.t = 60 µm per coat.	Total d.f.t = 120 µm

Notes:

Use Sigmarite Sealer, or equivalent.
Applied to Hot dry applications up to 200 ºC.

SYSTEM A/4

3 Coats of a micaceous iron oxide pigmented polyamine/amide cured epoxy sealer/coating (twin pack) with a d.f.t = 80 µm per coat.	Total d.f.t = 240 µm

Notes:

Use Sigmarite Sealer, or equivalent.

Applied to Immersed applications in potable water up to 100 ºC.

SYSTEM A/5

2 or 3 coats polyamine/amide cured coaltar epoxy.	Total d.f.t. = 400 µm

Notes:
Where paints are available in different colours, each coat shall be a different colour.

SYSTEM B/1

1 Coat aluminium filled epoxy (twin pack)	d.f.t. = 125 µm
1 Coat polyurethane enamel (twin pack)	d.f.t. = 40 µm
	Total d.f.t. = 165 µm

Application a maintenance coat over weathered coatings on steel.

Notes:

Surface preparation shall include, as a minimum, removal of all loose mill scale, non-adherent rust and loose paint prior to wire brushing and de-greasing and shall be in accordance with an appropriate internationally accepted standard such as the Steel Structures Painting Council of the USA or that of the Swedish Standards Institute's St standards.

SYSTEM B/2

1 Coat HB epoxy primer	d.f.t. = 100 µm
2 Coats polyurethane enamel (twin pack)	d.f.t. = 60 µm
	Total d.f.t. = 160 µm

Applied to motors, gearboxes, cast iron components, steel fabrications, etc.

SYSTEM C/1

1 Coat inorganic zinc silicate	d.f.t. = 75 µm
1 Coat high build modified acrylic coating	d.f.t. = 75 µm
1 Coat modified acrylic finish to approved colour	d.f.t. = 30 µm
	Total d.f.t. = 180 µm

Notes:

The primer must be factory applied. The intermediate and final coats may be applied on Site.

Particular care shall be taken to obtain the recommended anchor pattern during abrasive blasting and to achieve the required primer thickness on all surfaces in one coat.

The primer shall be tested for full cure before applying the subsequent coats.

This system shall not be used for items subject to immersion.

Intermediate coat shall be Sigma Topacryl, or equivalent.

Top coat shall be Sigma Topacryl Finish, or equivalent.

Applied to heavy fabricated steel items requiring a primer which travels well and/or can be left for an extended period before overcoating.

SYSTEM C/2

1 Coat inorganic zinc silicate	d.f.t. = 75 µm
1 Coat epoxy tie coat	d.f.t. = 75 µm
1 Coat polyurethane enamel (twin pack)	d.f.t. = 40 µm
	Total d.f.t. = 190 µm

Notes:

The complete system must be factory applied and touch ups will be required on Site.

The primer shall be tested for full cure before applying the subsequent coats.

This system shall not be used for items subject to immersion.

Applied to:

Heavy fabricated steel items requiring a hard, high gloss colour finish - e.g. bridges, tanks, non-immersed piping, structural steel, etc.
SYSTEM C/3

1 Coat inorganic zinc silicate	d.f.t = 75 μm
1 Coat modified silicone heat resisting coating suitable for 200 ºC	d.f.t = 75 μm
	Total d.f.t = 150 μm

Notes:

Particular care shall be taken to obtain the recommended anchor pattern during abrasive blasting and to achieve the required primer thickness on all surfaces in one coat.

The primer must be factory applied.

The primer shall be tested for full cure before applying the subsequent coat.

A tie coat suitable for 200 ºC shall be included between the primer and top coat if so recommended by the paint manufacturer.

The top coat must cure at ambient temperatures.

Applied to:

Steel and cast iron items on dry heat applications with temperatures up to 200 ºC continuous.

SYSTEM C/4

3 coats modified silicon	Total d.f.t = 120 μm

Notes:

Steel and cast iron items on dry heat applications with temperatures up to 540 ºC continuous.

SYSTEM D

1 coat epoxy primer (twin pack, for HDG surfaces)	d.f.t = 75 μm
1coat polyurethane enamel (twin pack)	d.f.t = 50 μm
	Total d.f.t. = 125 μm

Applied to:

Hot-dip galvanized steel pipes, handrails and stanchions, guards, steelwork, etc.

SYSTEM E/1

1 coat wash primer to SANS 723	d.f.t = 10 μm
1 coat zinc chromate primer to SANS 679 Type 1	d.f.t = 40 μm
1 coat universal undercoat to SANS 681	d.f.t = 35 μm
2 coats silicone urethane gloss enamel top coat to colour code.	d.f.t = 70 μm
	Total d.f.t = 155 μm

Notes:

If the specified dry film thickness of the zinc chromate primer of 40 µm is not achieved with one coat, an additional coat shall be applied.

The paints used shall be suitable for internal and external use.

An alternative priming and undercoat system of superior corrosion resistance may be used.

SYSTEM E/2

1 Coat phenolic based primer	d.f.t = 20 µm
1 Coat universal undercoat to SANS 681	d.f.t = 35 µm
2 Coats machinery enamel	d.f.t = 50 µm
	Total d.f.t = 105 µm

Notes:

The paints shall be suitable for internal and external use.

The paints selected shall not be damaged by oil spillage or grease and shall be reasonably chemical resistant.

SYSTEM E/3

1 coat zinc chromate self-etching wash primer to SANS 723 max	d.f.t = 10 µm
1 coat zinc chromate primer to SANS 679 Type 1	d.f.t = 40 µm
1 coat universal undercoat to SANS 681	d.f.t = 35 µm
2 coats single pack urethane gloss enamel	d.f.t = 60 µm
	Total d.f.t = 145 µm

Notes:

All paints shall be suitable for internal and external use.

If the specified dry film thickness of the zinc chromate primer of 40 µm is not achieved with one coat, an additional coat shall be applied.

SYSTEM E/4

1 Coat water borne vinyl based primer; Dulux Corrocote 3 or equiv.	d.f.t = 40 µm
2 Coats Acrylic Semi Gloss top coats; Ameron 234 or equivalent	d.f.t = 100 µm
	Total d.f.t = 140 µm

Applied to:

General use on hot-dip galvanized surfaces.
SYSTEM E/5

1 Coat twin pack epoxy zinc chromate primer	d.f.t = 30 µm
2 Coats acrylic semi gloss coats; Amercoat 234 or equal approved	d.f.t = 100 µm
	Total d.f.t= 130 µm

SYSTEM E/6

1 Coat epoxy strontium chromate primer	d.f.t = 25 μm
2 Coats Dulux Silthane Gloss enamel	d.f.t = 60 μm
	Total d.f.t = 85 μm

Note:

The paints used for this system must be suitable for a continuous operating temperature of 120ºC or higher.

SYSTEM F

1 Coat vinyl copolymer polyester	Total d.f.t = 100 μm

Applied to steel floor grating.

SYSTEM - FUSION BONDED EPOXY

This is a water resistant, non-toxic and non-tainting, fusion bonded epoxy pipe coating in accordance with SANS 1217. The material used shall be of Type 2; i.e. a thermosetting powder-coating material. The finished coating shall have a thickness of 300 μm and no reading shall be less than 200 μm.

Note:

The Contractor shall execute holiday detection over the full surface in accordance with SANS 1217.

The items to be coated shall be prepared in accordance with Clause 4.1.1 of the SANS 1217 and, in particular, shall have edges ground to a radius of curvature of at least 3 mm.

The surfaces to be coated shall be prepared in accordance with Clause 4.1.2 of SANS 1217 and, in particular, shall be blasted to a preparation grade of Sa 3.

Pre-heating is needed to achieve the required coating thickness.

Applied to immersed objects, cast iron valve bodies, pipe work, etc.

SYSTEM – HOT-APPLIED THERMOPLASTIC

This is a synthetic thermoplastic polyamide, Rilsan or equivalent, which shall be applied by dipping the hot object into a fluidised bed of the polymer. The coating shall be executed in accordance with the supplier's recommendations. The finished coating shall have a thickness of 300 μm and no reading shall be less than 200 μm.

SERIES M2 OPERATION, MAINTENANCE AND SAFETY

SECTION M2001 OPERATION AND MAINTENANCE MANUALS

TABLE OF CONTENTS

SERIES M2 OPERATION, MAINTENANCE AND SAFETY

SECTION M2001 OPERATION AND MAINTENANCE MANUALS

SCOPE

This specification covers the supply of Operation and Maintenance manuals as called for in the schedule of pricing. The specification sets out the general requirements applicable to the Operation and Maintenance manuals and shall apply where it is relevant to the Contract unless it is superseded by the project specification.

GENERAL

The contractor must submit one full set of provisional Operation and Maintenance manuals to the engineer for checking and remarks, at least one month before any commissioning and testing exercises are undertaken. The manuals will be returned to the contractor, who is to incorporate the changes and comments into the final manuals, before re-submittal.

Three sets of the final Operation and Maintenance manuals must be submitted to the engineer once the manuals have received final approval. The engineer will thereafter distribute these final manuals to Client accordingly.

LAYOUT OF THE MANUALS

Appearance

The manuals are to be firmly bound in plastic covered files suitable for A4 sized paper, information leaflets, suppliers' information and manuals. The Operation and Maintenance manuals are to have the following information on their covers and spines:

Operation and maintenance manual for the specific project;
Contractors name, address and contact details; and
Date at which the plant was handed over to the client.

All relevant information that is not of A4 size or which is of A4 size and cannot be bound / filed into the manual is to be folded / filed into an A4 plastic sleeve which in turn is to be bound into the final manual.

Drawings on large format paper are to be neatly folded and placed in plastic sleeves so as to be removed and replaced easily.

All sections of the Operation and Maintenance manuals are to be clearly labelled and neatly partitioned.

The Operation and Maintenance manuals are to be sorted in accordance to the way the plant has been segregated into various working areas and / or stations. Repeated equipment is to be referenced or cross-referenced to the appropriate section of the manual where the relevant information for the equipment is filed.

Contents

The following details / information shall be included in the manuals:

Maintenance Requirements

A summary, in tabular form, is to be provided for the major and minor services of the equipment supplied. Time intervals are to be clearly indicated.
A summary, in tabular form, is to be provided for the standard inspection and adjustment of equipment supplied. Time intervals are to be clearly indicated.

These summaries shall specify the recommended consumables and quantitative adjustments for the equipment including contact details of the relevant suppliers. Suppliers of spares if different are to be provided along with the original equipment manufacturers details. If specialized services or maintenance is to be carried out on the equipment, the contact details of these specialists are to be provided.

Technical

A detailed technical description / specifications shall be provided for all equipment supplied under. This shall as a minimum include:

Tag number;
Details of the design of the equipment including working drawings and the description of the equipment;
Scope of operation including performance curves, where applicable;
Electrical requirements, where applicable;
Materials of construction including corrosion protection specification;
List of spares and where necessary additional tools.
Installation details; and
Condition monitoring specifications and requirements.

OPERATION AND MAINTENANCE

The following procedures, operational philosophies and functions of the equipment shall be provided:

For all equipment, the startup procedures shall be described including pre-start checks. This includes for equipment that automatically starts.
Shut down procedures for all equipment is to be described.
The operational time for each piece of equipment supplied shall be detailed.
The maintenance schedule, regularity of maintenance along with the time intervals between maintenance periods shall be clearly stated.
The checking of lubricant and coolant levels along with adjustment of machines shall be clearly described.
Standard inspections, services and adjustments shall be described clearly along with time intervals of when these procedures are to occur.
Major inspections, services and adjustments shall be described clearly along with time intervals of when these procedures are to occur.

MEASUREMENT AND PAYMENT

All costs sustained from the compilation of the Operation and Maintenance manuals shall be deemed to be included in the schedule of pricing, where called for in the supply of these documents.

The tendered sum shall include for the supply of a complete set of Operation and Maintenance manuals per set of equipment supplied. Final payment for these manuals will only be transferred once the engineer has approved and received the final documents along with the relevant plant drawings.

SERIES M2 OPERATION, MAINTENANCE AND SAFETY

SECTION M2002 MAINTENANCE REQUIREMENTS (SECTION C5)

C5. MECHANICAL AND MAINTENANCE (ENGINEERING) SPECIFICATIONS

H. MAINTENANCE REQUIREMENTS

H.1 Requirements

1. A 6-month Operation Service Period, which shall include only the maintenance under an Operation and Maintenance Plan for the centrifuge system, shall be included as part of the Operation Service under this Contract. The Employer shall provide all resources required for operation of the Works, while the Contractor shall be responsible for all routine and preventative maintenance.

2. The Operation Service Period of the contract will commence immediately after the Design-Build Period of the Contract.

3. The maintenance part of the contract shall be in accordance with the Schedule of Prices, and no adjustment of rates shall apply.

4. The pricing of maintenance shall be an all-inclusive monthly amount, based on a schedule of items included in this document. If no schedule of items is included in this document, the Employer's Representative shall supply one. Individual rates for the items will be added up to an all-inclusive monthly amount shown separately for each month.

5. In order to ensure compliance and efficiency, a penalty / bonus system will be applied for various activities. This will be based on a points system and when a designated number of negative points are scored during any month, a penalty will be applied and an amount will be deducted from the monthly payment. Should a designated number of positive points be scored, bonus points will be accumulated. The monetary value of accumulated bonus points will not be paid out during the contract but at the completion of the contract. Under no circiumstances shall the penalty points for a month be subtracted from accumulated bonus points.

6. The Contractor will be required to qualify for a Commissioning Certificate prior to commencement of the Operation Service Period. This is to ensure that the works are received in good working order with no defects prior to commencement of the Operation Service Period.

7. The scope of the maintenance requires the Contractor to:

Provide routine and preventative maintenance strictly in accordance with the relevant operating and maintenance manuals and keep in good working order all the works, plant and equipment supplied installed and commissioned under Design-Build.

Keep full records of routine and preventative maintenance performed on all the equipment individually, in a maintenance database, a hard copy of which must be appended to the manufacturers O & M Manuals.

Keep all records of adjustments made to equipment.

Take full responsibility for the maintenance of the works supplied, installed and commissioned under "Design-Build" to ensure continuous operation and functionality twenty four (24) hours per day seven (7) days a week.

Submit monthly reports and attend all meetings which may be convened by the Engineer and /or Employer on an ad-hoc basis

Maintenance schedules must be submitted to the Engineer and Employer for approval within 14 days of commencement of the Contract.

9. The above list may not be complete.

10. The Employer's Representative will administer the contract on behalf of the Municipality and the Engineer will act as the Employer's Representative for the duration of the Operation Service Period.

A provisional sum has been allowed for in the Schedules of Quantities to cover the costs of this service for a 6 months period. The costs will be deducted monthly from the Contractor's payment certificates, and payment will be made directly to the Engineer.

H2 Penalty System

H2.1. General

The provisions of this Clause deal with the right to reduce payment due to the Contractor as a result of his (the Contractor's) failure to comply with the provisions of the contract documentation, and/or his lack of diligence in the execution of any work, activity, duty or obligation in terms of the contract and/or his failure to or execute any instruction given by the Engineer or the Employer in terms of this contract. The stipulation of this clause shall not in any way be construed as negating or limiting any other remedy that the Employer may have in terms of the contract documentation.

For the purposes of this clause, term "reduced" or "reduction" or "deducted" when used in the context of any payment due to the Contractor means the reduction of payment due to the Contractor in terms of the payment certificate applicable to the period in which the non-compliance incident(s) occurred.

All money amounts stipulated below shall be subject to non-compliance incident(s) during the Three (3) year maintenance period.

H2.2. Non-Compliance

A non-compliance incident is any one or more of the following which arises or occurs as a result of the Contractor's (or any of his site employees) action or lack of action or non-compliance with the provisions of the contract documentation:

H.2.2.1 Endangerment to the safety of the Employer's or user's personnel and vehicles, the Contractor's site employees and the public. (penalty points = 6)
H.2.2.2 Failure to implement any instruction given by the Engineer within the period prescribed by such instruction or the contract documentation (as applicable). (penalty points = 4)
H.2.2.3 Unauthorised removal from the site of any plant and equipment and record originals. (Penalty points = 4)
H.2.2.4 Inaccurate and/or record keeping or failure to submit monthly records. (Penalty points = 3)
H.2.2.5 Failure to advise the Engineer and/or employer of any impending equipment breakdowns identified during routine maintenance work. (Penalty points = 3)

H2.2.6 The non-compliances stated in H2.2.1 to H2.2.5 above will attract the penalty points indicated in brackets.
H.2.2.6 The following table indicates the penalty point allocation which will be applied to any callout made by the Employer or the Engineer. An emergency call out requires urgent attention and the Contractor will be informed whether a call out is an emergency or not.

Reaction Time	Penalty points			
Hours	Normal	Emergency	TOTALS	
2h or less	0	0		
4 hr to 5h 59min	0	3		
6hrs to 7h 59 min	1.5	6		
8hrs to 9h 59min	3	9		
10hrs to 11h 59min	4.5	12		
12hrs to 13h 59min	6	15		
14hrs to 15h 59min	7.5	18		
16hrs to 17h 59min	9	20		
18hrs to 19h 59min	10	23		
20hrs to 20h 59min	11.5	26		
22hrs to 23h 59min	13	30		
Greater than 24hrs	15	40		

NOTE : Each point is worth R500

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3001: MACHINE MOUNTINGS

TABLE OF CONTENTS

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3001: MACHINE MOUNTINGS

SCOPE

This specification covers the requirements for machine mountings which are to be included with all equipment offered and not as separate items.

DESIGN SPECIFICATIONS

Common baseplates

Both direct-coupled and belt-driven machines shall be mounted with their drivers on common cast iron or fabricated steel baseplates of rigid construction.

Corrosion protection

Steel baseplates shall be hot-dip galvanized unless specified otherwise.

Machined mounting pads

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 solid 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.

Fasteners

Anchor fasteners shall be of grade 316 stainless steel with threads coated with a nickel-based, anti-seize compound before assembly.

Alignment

Preliminary alignment 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.

Shimming

Not more than three shims may be used at any point and these must be made of a corrosion resistant material.

Jacking screws

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 and side way alignment and direct-coupled motors above 150 kW shall be provided with jacking screws for vertical alignment as well. Jacking screws shall be of grade 316 stainless steel.

Grouting

Baseplates shall be designed and grouted as 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. The initial grouting shall be overseen by the supplier's technical representative.

Soleplates

In applications where baseplates are not practical, machined soleplates, suitably fixed and grouted to the concrete plinths, shall be provided. No machine may be mounted directly onto a concrete base without the use of either a baseplate or soleplate.

MEASUREMENT AND PAYMENT

All mountings are to be included in the price for the item of equipment offered. Mountings are to be included as ancillary equipment where reference is made to “ancillary equipment”

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3002: GRID FLOORS, GUARD RAILS AND LADDERS

TABLE OF CONTENTS

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3002: GRID FLOORS, GUARD RAILS AND LADDERS

SCOPE

This specification covers the supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of all grid floors, guard rails and ladders.

DESIGN SPECIFICATION

Grid flooring

All grid flooring shall be GRP type or equal approved with bearer bars across the shorter span. The depth of bearer bars shall not be less than 30 mm with a bearer bar pitch of not greater than 40 mm. Panels are to be set level and fixed down in angle frames so as to prevent rocking. All cut-outs in grid flooring for pipes, valve spindles and the like are to be banded and made before any corrosion protection is done. The edges of removable grid access covers must also be banded.

Guard railing

Guard railing shall be provided in accordance with legislated requirements and shall be provided generally in positions where the vertical change in level is 1 000 mm or greater.

Guard railing shall comply with SANS 0104.

All guard railing shall be of GRP and shall comprise hand and knee rails not less than 32 mm diameter and stanchions spaced at not more than 1,8 m except where specifically directed otherwise in writing by the Engineer.

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 stringers, and the vertical height, measured from the top of the hand rail to the nosing of the tread, shall be at least 900 mm.

For applications covered by this Specification, the rails and stanchion shall withstand, without permanent deflection, a proof force of 890 N and 1780 N respectively, applied at any point and in any direction. Contractors shall provide proof that their guard railing has been tested and withstands these loads. The loads specified in SANS 10160 for guard railing and stanchions are to be adhered to.

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.

Railing, if tubular, shall be joined using the slip-jointing method with separate and neatly fitting tubular inserts fitted into the railing bore. If used, pins shall have their ends peened over and smoothed or, if taper pins are used, shall be filed off flush with the rail. The joint shall withstand the loads specified above when situated in any position including centrally between two stanchions. Joints shall preferably be located inside the stanchion balls. All joints shall be sealed.

Railings shall be ended off with positively fixed (pinned) 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 endings will be permitted.

Stanchions shall generally be base-mounted to suit the arrangement requirements and shall be of solid or welded construction. Welding shall be compatible with the material, shall not impair the strength or corrosion resistance of the material, shall be continuous and shall be smoothly finished and then passivated.

Stanchions shall be self-draining to suit the mounting arrangement.

Holes for the rails to go through the stanchions shall have a diametral clearance not exceeding 1 mm but preferably 0,5 mm. On stairways with stanchions vertically mounted, the hole shall be angled to suit and shall accurately fit the angled rail with the abovementioned clearances. The crevices caused by rails passing through the stanchions shall be sealed.

Stanchion feet which are attached to metallic surfaces shall have minimum dimensions of 150 mm X 60 mm. Two fasteners, of minimum size M16, shall be used to attach the foot. Foot material thickness shall be not less than 8 mm. Neatly fitting packing 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. 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 attach the foot to the concrete. Foot material thickness shall be not less than 10 mm. Non-shrink, cementitious grout shall be applied under the foot just prior to final tightening of nuts.

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:

The structural design shall be done in accordance with the requirements of SANS 0104.

No opening in guard railing installed in public places shall allow the passage of a ball of 100 mm diameter.

Permanent ladders and stairs

General

Permanent ladders shall comply, primarily, with the requirements of the OSH Act and, secondarily, with SANS 10400.

Permanent ladders

Ladders shall comply with the following detail design aspects:

Access points to the head of ladders from platforms and walkways shall be protected by self-closing gates or by chains.

No part of the ladders shall project into the passageway.

The clear width between stringers shall be between 450 mm and 550 mm.

A minimum clear space of 230 mm must be allowed behind the rungs.

The diameter of the rungs shall be between 20 mm and 50 mm.

Additional rungs shall be provided in the same horizontal plane as the top rung in order to close the gap between the platform and the ladder. Sufficient rungs shall be provided to ensure a maximum gap of 75 mm. These top rungs shall be at the same level as the floor or platform to which access is being provided.

Stringers shall be formed from flat bar. The vertical distance between the ladder support brackets shall not exceed 1 800 mm.

The stringers shall extend to 1 100 mm above the floor or platform and shall be matched with any guard rail protections at this level. Connections between hot-dip galvanized steel ladders and stainless steel guard railing shall be bolted. Unless laterally supported by the guard rails, these stringers shall be supported by vertical structural sections (not flat bar) whose footings shall comply with this Specification for guard rail stanchion feet.

All rises in a flight shall be uniform and the surface of the top rung shall be level with the top platform or landing. The height chosen for the rise shall be between 225 mm and 255 mm.

Except on chimneys, the height of a ladder should not exceed 6 000 mm. Greater heights shall be provided with intermediate landings between each 6 000 mm ladder section.

If the height between start and end levels is over 4 000 mm, the ladder shall be fitted with a safety cage. The safety cage shall extend at least 1 000 mm above the higher landing. The cage shall be no more than 700 mm away from the plane of the rungs. The cage shall comprise no fewer than seven vertical elements.

Anchor bolts shall be of grade 316 stainless steel and shall be no smaller than M16.

Stringers, rungs and anchor brackets shall be of solid structural sections (e.g. flat bar, round bar, square bar, angles, etc.) and no hollow sections will be accepted for any part of the ladder.

Stairs

Stairs shall comply with BS 5395

MATERIALS OF CONSTRUCTION

Grid flooring

Grid flooring and frames shall be GRP Materials. Painting shall be done to suit the relevant safety codes.

Where grid flooring bears onto painted surfaces, strips of rubber insertion material shall be secured under the grid flooring to protect the paint.

The fixing clip set (saddle clamp and locking plate) and all fasteners shall be of grade 316 stainless steel.

Guard railing

All guard railing shall be of GRP materials

Stanchion feet shall be epoxy-coated.

A nickel-based, anti-seize compound shall be applied to all threads before fastening.

All components shall be supplied in the pickled and passivated condition which may also be polished. All surfaces must be uncontaminated and unmarked to ensure maximum corrosion resistance. A manufacturer's test certificate shall be provided for each batch of stainless steel giving the chemical analysis of the material.

Inserts for internal slip joints may be of non-corrosive material using steel reinforcing provided the steel is completely enclosed.

Where kickplates are required by legislation, these shall extend to 150 mm above the walkway level.

Permanent ladders and stairs

Unless other materials are specified, ladders and stairs shall be of carbon steel and hot-dip galvanized after all fabrication has been completed.

TESTING AND COMMISSIONING

Works testing

Where applicable an inspection of the assembled units will be conducted at the manufacturer's premises to check material integrity, corrosion protection and fabrication soundness. Material certificates are to be issued to the engineer before deliver to site of the equipment.

Tests on completion

Performance testing will be carried out on the equipment after commissioning and adjustment. All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

The tests will be performed on the equipment over a single 8 hour shift. They shall consist of the following:

An inspection will be carried out to ascertain that the equipment has been installed correctly and with due diligence.

Any load testing required.

The equipment will be considered acceptable when:

Equipment has been correctly installed and satisfies the engineer.

The equipment passes any load tests called for.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

MEASUREMENT AND PAYMENT

Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3003: WASTE SKIP

TABLE OF CONTENTS

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3003: WASTE SKIP

SCOPE

This specification covers the supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of a waste skip.

DESIGN SPECIFICATIONS

General

The waste skip is to have a capacity of 3 cubic meters and must have provision in its design to be able handled and transported by a skip loader vehicle.

MATERIALS OF CONSTRUCTION

Waste Skip

The waste skip is to be fabricated from mild steel plate. The floor is to be 4 mm thick and the sides are to be 3 mm thick. Suitable sized lifting lugs are to be provided, two on each side of the waste skip from which a skip loader vehicle would be able to safely and securely lift the unit under full load. The waste skip is to be reinforced on all corners and on its side. Drainage holes are to be provided for the release of any fluids that may accumulate in the item. Two channel iron frames is to be welded to the underside of the unit so that the base of the container underside clears the ground or bogey on which it is mounted.

Corrosion protection

Corrosion protection shall be carried out in accordance with the requirements of the General Corrosion Protection Specification: -

Mild Steel : System – Fusion Bonded Epoxy 250 microns minimum.

Colour : Golden Yellow (B49)

TESTING AND COMMISSIONING

Works testing

The waste skip is to be able to be loaded and off loaded by a skip loader vehicle and be transported safely and securely under full load conditions.
Checks on all equipment will be conducted for correct operation and functioning during the defects liability period at 1 month, 6 months and 12 months after final plant take-over.

SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be accordance with the original equipment manufacturers recommendations

MEASUREMENT AND PAYMENT

Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M4 FASTENERS

SECTION M4001: NUTS, BOLTS, AND FASTENING SETS

TABLE OF CONTENTS

SERIES M4 FASTENERS

SECTION M4001: NUTS, BOLTS, AND FASTENING SETS

SCOPE

This specification covers the requirements for fasteners and fastening sets which are to be included with all equipment offered and not as separate items.

DESIGN SPECIFICATIONS

Fasteners general

Standards

Bolts and nuts shall be hexagon head type complying with SANS 1700 with threads of the coarse pitch series. Allen head screws of any type shall not be used without the Engineer's written consent.

Fasteners M12 and smaller

All fasteners M12 and smaller shall be manufactured of grade 316 stainless steel.

Fasteners larger than M12 - in corrosive areas

All fasteners in corrosive areas shall be manufactured of 316 SS. 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 internal and external areas in the vicinity of the inlet works of a wastewater treatment works. All fasteners embedded in brick, concrete or soil shall also be of 316 SS.

Fasteners larger than M12 - Non-corrosive areas

Fasteners larger than M12 which are in non-corrosive areas shall, except when specified otherwise, be hot-dip galvanized.

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.

Material compatibility

Fastener material shall always be of equal or better corrosion resistance than the items being fastened, e.g. 316 stainless steel bolts must be used to fasten together 316 stainless steel fabrications or flanges.

Washers

Washers of similar material to the bolts shall be provided under each nut and setscrew head. Multiple washers or shims shall not be used. Spring washers or other approved locking arrangement shall be used on all fasteners subject to vibration.

Anti-seize compound

Before assembly, threads shall be treated with a nickel based, anti-seize/corrosion protection compound; Chesterton 725: Nickel Anti-Seize Compound, or equivalent. The thread shall be treated in the area under the final position of the nut. Compound on the exposed thread shall be cleaned off after installation. If it is found during inspection that compound has not been applied, the Contractor shall disassemble all fasteners and comply with this requirement.

Thread projection

Bolt threads shall project between 1 and 6 mm 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.

Corrosion protection

After installation the exposed surfaces of bolts not made of 316 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.

Anchor fasteners

Type and material

All anchor fasteners shall be of grade 316 stainless steel.

Anchor fasteners for water retaining structures and for brickwork shall be of the chemical anchor fastening type. Anchor fasteners for other applications may be of the expanding type or chemical anchor type.

Hook bolts

Grade 316 stainless steel hook bolts 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.

Alternative anchor bolts

The use of 316 stainless steel "Hilti Kwik Bolt" stud bolts or similar may be used as an alternative where approved by the Engineer. If steel reinforcing bars are encountered while the holes are being drilled, the Contractor shall knock a hole in the concrete around the steel and grout in a stainless steel hook bolt as described above.

Through-bolt anchors

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, these, together with associated washers and brackets, shall also be of grade 316 stainless steel.

Anti-seize compound

All threads shall be coated with an approved nickel-based, anti-seize/corrosion protection compound before assembly.

MEASUREMENT AND PAYMENT

All fasteners and fastening sets are to be included in the price for the item of equipment offered. The unit item offered will include the price of the fastener and fastening sets. Fasteners are to be included as ancillary equipment where reference is made to “ancillary equipment.”

SERIES M5 MEDIUM PRESSURE PIPES

SECTION M5001: MEDIUM PRESSURE PIPES

TABLE OF CONTENTS

6.2 Installation and Commissioning

SERIES M5 MEDIUM PRESSURE PIPES

SECTION M5001: GENERAL MEDIUM PRESSURE PIPES

SCOPE

This specification covers the supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of medium pressure pipes.

DESIGN SPECIFICATIONS

General

Steel pipe – general duties

Steel pipes for general non-corrosive, non-abrasive duties for liquid, air and gas shall be as follows:

Up to DN 150 - SANS 62 medium class

Over DN 150 - SANS 719

Unless otherwise specified, steel pipework and fittings shall be hot-dip galvanised and painted.

Steel pipework

Pipework up to DN 600 shall be in accordance with SANS 1476. Pipework for the conveyance of water shall, in addition, comply with CCT-WS 11 Standard Specification for Steel Pipe, Fittings and Specials.

Stainless steel

Stainless steel pipework shall be to ASTM 312. Schedule 10 pipes and fittings shall be used except where otherwise specified.

Steam pipework

Steam pipework smaller than DN 50 shall be of 316 stainless steel to ASTM A-312 Schedule 40 or approved equal. Steam pipework DN 50 and larger shall be manufactured to SANS 62 heavy class, ANSI B36.10 STD/Schedule 40 or to BS 1600 Schedule 40. Steel pipework shall be supplied with a suitable temporary corrosion protection both internally and externally in order to prevent corrosion during the storage, installation and pre-commissioning period. A primer similar to Plascon SNK 2, phenolic modified polyvinyl butyral self-etch primer, would be suitable.

Hydraulic and oil pipework

Hydraulic pipework shall be to BS 778 or equal. All hydraulic and oil pipes and fittings shall be thoroughly degreased, descaled and cleaned internally and externally after fabrication by abrasive blasting or pickling, thoroughly cleaned and rinsed, dipped in a hot iron phosphate solution and coated internally with a corrosion inhibiting, oil soluble preservative. After treatment and drying all openings shall be sealed until the pipes are installed.

Butt weld fittings

Steel butt welding pipe fittings shall be to ANSI B 16.9, BS 1965 or BS 1640 of the same schedule as the pipework or heavier. Butt weld fittings in stainless steel shall be to ASA B 36.19 for schedule 5S and 10S and ASA B 16.9 for schedule 40S and 80S. Alternatively, fittings may be to BS 1640.

Malleable cast iron

Malleable cast iron fittings shall be to SANS 14 (SANS ISO 49).

Cast iron

Cast iron pipes and fittings shall comply with BS 2035 (Class D) and shall be pressure tested in accordance with Clause 12 of that Standard. The requirements of the Standard's Clause 6 regarding freedom from defects and casting appearance and Clauses 8, 9 and 10 regarding casting accuracy will be strictly applied. The requirements of the Standard with regard to protection and flanges shall be modified to comply with this Specification. Also refer to Clause "Castings" of this Specification.

Copper pipes

Copper pipes shall be to BS 2871 or approved equal.

Plastic pipework

Polyethylene or Polypropylene pipes shall comply with SANS 533 and SANS 1315 respectively and shall carry the SANS mark. The contractor manufacturing and installing the pipework shall satisfy the requirements of SANS ISO 9002. PVC pipework is not acceptable except where specified.

An operating life of 50 years shall be designed for and appropriate derating factors shall be applied to suit the application. The rated maximum working pressure at operating conditions of the class of pipe selected shall be not less than 1,5 times the actual maximum operating pressure. If the material used has insufficient resistance to solar radiation (U.V. light) for the application, suitable protection must be provided to achieve the required life.

Note that nominal bores and pipe diameters specified must be regarded as the minimum inside diameter.

Pipework design

Pipe type and material

The type and material of pipe to be used will be given in the Detailed Specification.

Pipe diameters

Unless otherwise specified in the Detailed Specification, pipe diameters shall be based on the following velocities. The velocities shall be based on the compressed volume at the operating pressure in the case of steam, air and other gases. Valves and other ancillaries shall generally be of the same nominal diameter as the pipe. Non-standard sizes shall not be used.

FLUID	FLUID FLOW [ℓ/s]			
	0-2,5	2,5-15	15-100	100-500
	ALLOWANCE FLOW VELOCITY [m/s]			
LIQUID GRIT FREE:	0.75 max	1,25 max	1,5 max	2 max 1 min
HIGH SOLIDS OR GRIT:		0,8 min 1,5 max	1 min 1,75 max	2 max 25 max
STEAM	10 max	15 max	20 max	
AIR AND GAS above 10 kPa below 10 kPa	5 max 2,5 max	8 max 3 max	10 max 4 max	12 max 5 max

*Grit free liquids include potable water, final effluent, centrate, supernatant, etc. Liquids considered to have high solids content will include raw sewage, sludge and grit slurry.

If anomalies occur within the same system using the above table, the larger pipe diameter shall generally be used.

Coupling arrangement

Screwed fittings may be used on DN 50 and smaller provided that sufficient unions or flanges are provided for disassembly and removal of equipment. Reducing sockets and not reducing bushes shall be used where required.

All steel pipes larger than DN 50 shall be flanged or fitted with pipe couplings as applicable.

Suitable flexible couplings shall be incorporated wherever necessary to facilitate maintenance or isolate vibration. A flexible pipe coupling shall be provided on each pump suction. Flexible couplings shall be adequately restrained by harnesses as specified in the Clause "Flexible Pipe Couplings".

Draining, venting and purging

On liquid lines provision shall be made for draining and venting where necessary. Vents shall be provided at all vertical down bends on gravity lines. On gas lines provision shall be made for purging.

Condensate drains

Automatic condensate traps with isolating valves and valved by-passes shall be provided at all necessary points including ahead of any globe type valve, orifice plate or concentric reducer in a horizontal line, at each change of level and immediately ahead of the user equipment.
A suitable well of a diameter equal to the pipe diameter with a bottom drain shall be provided at each condensate removal point. Condensate traps and valves shall be accessible and condensate shall be piped to the nearest drain. Pipework shall be sloped in the direction of flow towards a drain point with a slope of 1 in 150 and care shall be taken to avoid sagging at any point.

By-passes

Isolating valves and valved by-passes shall be provided around condensate traps, pressure reducing valves and valves with solenoid or other actuation which do not have provision for manual operation.

Encased pipes

Pipework to be permanently encased in concrete, cement or similar shall be of cast iron or 316 stainless steel for steel and stainless steel pipework respectively. The encased portion must be a separate section flanged both ends with adequate clearance between the wall surface and the flanges. Victaulic type couplings may in some instances be permitted instead of flanges.

Pipe sections through walls below ground or water level shall be provided with a puddle flange the same diameter as a standard flange. The encased area shall in such cases be uncoated up to 30 mm inside the wall surface and coated to Specification from there on.

Isolation

The layout design shall make provision for isolation and easy removal of mechanical equipment.

Nozzles for fittings, gauges, etc.

Nozzles on pipework (for installation of gauges, transmitters, drain pipes, cooling water take-offs, air valves, etc.) shall be designed so that the pipework corrosion prevention system is not affected.

Nozzles shall consist of a flanged, welded tee-off of at least 100 mm in diameter, painted internally and provided with a non-corrosive blank flange, e.g. grade 316 stainless steel. The blank flange shall be provided with tapped holes suitable for the equipment installation.

A nozzle on cement-lined, carbon steel pipe work shall consist of a flanged, cement lined tee-off (of at least 100 mm diameter) and a non-corrosive blank flange.

Internally painted, small diameter carbon steel nozzles and screwed carbon steel tee-offs are both unacceptable as nozzles. Carbon steel pipe work may be provided with small diameter, grade 316 stainless steel nozzles which are welded into the pipe work if the Engineer considers this acceptable in the application.

MATERIALS OF CONSTRUCTION

Pipework installation

Appearance

Pipes and fittings shall be conservatively selected to suit the application, neatly installed, straight to line and level, adequately supported and shall operate without vibration.

Valve orientation

On sludge or raw sewage pipelines, check valves shall, wherever possible, be mounted horizontally and isolating valves with spindles vertical. Valve handwheels shall be arranged so that they are accessible to the operators.

Supports

No external loads shall be placed on items of mechanical equipment such as pumps, compressors, etc. Adequate provision shall be made for expansion and contraction due to variations in temperature or pressure.

A drawing or sample of proposed pipe supports shall be submitted to the Engineer for approval prior to manufacture.

Pipe supports shall be so located that when an item of mechanical equipment is removed, the associated valves and pipework are still adequately supported. Supports shall be provided close to heavy items such as valves.

3 mm thick neoprene strips shall be placed between pipes and supports or clamps to protect the paintwork and limit corrosion. Where roller or sliding supports are used to accommodate movement, suitable wear blocks shall be fixed to the pipe to prevent damage.

Where the Engineer approves the use of concrete pipe supports to be built by a civil contractor under a separate contract, these shall be constructed after installation of the pipework and temporary supports shall be provided by the Contractor in positions which will not interfere with the construction of the concrete supports.

Pressure testing

All pipelines shall be pressure tested to 1,5 times maximum working pressure. This shall be done before covering up the pipeline in any way where applicable and shall be witnessed by the Engineer.
Flanges

Standards

All standard flanges shall comply with SANS 1123. For flange sizes not included in the SANS standard, BS 4504 shall be used. Cast iron flanges and their mating flanges shall have flat faces. The flange table shall be as specified or, if not specified, selected to suit the maximum possible operating pressure but not less than Table 1000. Drilling and installation of flanges shall be "off-centre".

Flange fixing

Flanges DN 50 and smaller may be of the screwed on type. Metal flanges above DN 50 shall be welded on in accordance with BS 806 Type 6 unless otherwise agreed or specified.

Machining of flanges

All flanges shall be machined on the sealing face. Flanges cut from plate shall also be machined on the bore and outside diameter. Cast iron flanges shall also be machined or spot faced on the back of the flange to ensure a flat bearing surface for the fastener's head or nut and washer. All edges, including bolt-holes, shall be chamfered or rounded to a 2 mm radius.

Butt flanges

If the use of a loose hot-dip galvanized butt flange arrangement with stainless steel pipework is specified or approved by the Engineer, such arrangement and design shall comply with BS 4504 Table 6/6 or 10/6 as appropriate. The butt welded shouldered end for the pipe may be rolled from hot rolled stainless steel angle section. The hot-dip galvanized butt flange must be electrically insulated from the stainless steel pipework.

Rectangular flanges

The use of square or rectangular flanges shall be avoided and will not be accepted for pressures above 100 kPa. The thickness of flanges designed for positive or negative pressures between 20 and

100 kPa shall be not less than 75 % that of a circular flange of equivalent nominal opening area manufactured to Table 600 of SANS 1123. For pressures 20 kPa and below the flange thickness shall be to the Engineer's approval. Bolting shall in all cases be to the Engineer's approval.

Gaskets

The jointing material used on flange joints shall be of the replacement material for compressed asbestos fibre at least 3 mm thick complying respectively with BS 2494 or BS 1832, as applicable. No compressed asbestos fibre gaskets will be accepted. Full face gaskets shall be used for full face flanges. Inner bolt circle gaskets shall be used on raised face flanges and when clamping items such as wafer type valves between flanges inside the bolt circle. Properly designed O-ring seals are also acceptable.

Flexible pipe couplings

Coupling types

Where movement or misalignment must be allowed for, or if necessary for any other reason, rubber expansion joints may be used if approved by the Engineer. The flexible material used for rubber expansion joints shall be chosen specifically for maximum resistance to bursting.

Flexible couplings and flange adaptors may also be used if approved by the Engineer and these shall be supplied without centre register unless otherwise specified.

Flexible couplings for cast iron pipes and, where specified, for asbestos cement pipes, shall be of the cast iron short or long collar type. Flexible couplings for steel or stainless steel pipework may be of the "Victaulic" type or approved equal for grooved or shouldered end pipes.

Couplings for plastic pipes shall be of the clamp type employing buttressed pipe ends.

Pipe ends

Pipe ends shall be prepared strictly in accordance with the coupling manufacturer's recommendations. Where machining is required, as in the case of cast iron pipes, the length of machining on each pipe shall be approximately equal to the total length of the coupling to ensure that the coupling can be separated for pipe removal.

Supports and anchors

Pipework using flexible couplings shall be supported and anchored strictly in accordance with the coupling manufacturer's recommendations. Harnesses against separating forces shall be provided where appropriate to the approval of the Engineer. Where this restraint is not provided by the layout, other neat and positive means of harnessing shall be provided. A system incorporating additional flanges or lugs cast on in the case of cast iron, or welded on for steel, and connected by tie bars or positively fixed to anchors, will be accepted. Systems relying purely on friction will not be acceptable.

Corrosion protection

Cast iron couplings shall be painted. Steel couplings for gas applications shall be hot-dip galvanized. Steel couplings for fluid applications shall be coated in accordance with System – Hot Applied Thermoplastic or System - Fusion Bonded Epoxy.

Metal backing flanges for rubber expansion joints shall be of stainless steel or hot-dip galvanized steel.

Fasteners

Fasteners for Viking-Johnson type couplings shall be of grade 316 stainless steel. This includes coupling studs, stub studs (i.e. studs welded to the flanges of flange adaptors), washers and nuts.

Fasteners for other couplings shall be of stainless steel or hot-dip galvanized steel.

Underground protection

When couplings are part of a buried pipeline the couplings shall be enclosed with "Denso mastic" to a smooth finish, wrapped with "Denso tape" and then wrapped with a polythene sheet which is strapped in place. If the operating temperature is likely to exceed 70ºC the Denso paste and tape shall be replaced with a suitable grease or a suitable sealer.

TESTING AND COMMISSIONING

Works testing

Tests on completion

Performance testing will be carried out on the equipment after commissioning and adjustment. All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

The tests will be performed on the equipment over a single 8 hour shift. They shall consist of the following:

Visual inspection of the pipes to ascertain corrosion protection integrity.

Where applicable, deemed necessary or called for by the engineer, a dry film thickness test will be conducted.

The equipment will be considered acceptable when:

The minimum requirements of the standard specification for General Corrosion Protection has been met.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

MEASUREMENT AND PAYMENT

Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M6 PUMPS

SECTION M6001 : CENTRIFUGAL TYPE PUMPS

TABLE OF CONTENTS

SERIES M6 PUMPS

SECTION M6001 : CENTRIFUGAL TYPE PUMPS

SCOPE

This specification covers the design, supply, delivery, transport, handling, storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period for centrifugal type pumps.

DESIGN SPECIFICATION

2.1 Description

All centrifugal pumpsets shall be designed and supplied in accordance with ISO 9908 – Technical specification for centrifugal pumps - Class III. The Manufacturer / Supplier shall review the rated (guarantee) duties and offer his best technical and financial solution at the highest operational efficiency for each station, based on the type (i.e. end-suction, multistage or horizontal split casing), size and arrangement of pumpsets proposed.

Although all pumps shall be installed within an enclosed installation they must be designed and supplied such that they are able to operate under normal Southern African outdoor environmental conditions. The Supplier/Manufacturer shall specify and offer the recommended shaft sealing arrangement, either gland packing or mechanical seal as they deem to be suitable under the operating conditions specified.

All pumpset flanges shall as a minimum be pressure rated and drilled in accordance with SANS 1123 Table 1600/3. Should the casing design pressure exceed this pressure rating then the flange drilling requirements shall be upgraded accordingly.

The prime mover for all pumpsets shall be an electrical induction motor driven via a suitably rated flexible coupling. The operating speed of all pumps should preferably be less that 1500 rpm but must not exceed 3000 rpm.

Tenders will be assessed on the best technical and financial value offered. In adjudicating the tenders, in addition to price, account will be taken of:

Rated (guarantee) operating efficiency offered to be specified in the data sheets to be submitted with this tender;
Equipment offered;
Delivery period;
Ease of operation and maintenance;
Technical resources and previous project experience;
General soundness and robustness of design;
Reliability of components;
Availability of spares and after sales service; and
Any special conditions or qualifications put forward by the Tenderer.

The following National and International Specifications shall be applicable:

ISO 9905:1994	Technical specifications for centrifugal pumps – Class I
ISO 5199:2002	Technical specifications for centrifugal pumps – Class II
ISO 9908:1993	Technical specifications for centrifugal pumps – Class III
ISO 76:1987	Rolling bearings – Static load ratings
ISO 281:1990	Rolling bearings – Dynamic load ratings and rating life
ISO 2372:1974	Mechanical vibration of machines with operating speeds from 10 to 200 rev/s – Basis for specifying evaluation standards
ISO 3069:1974	End suction centrifugal pumps – Dimensions of cavities for mechanical seals and for soft packing
SANS 1123:2000	Pipe Flanges
ISO 7005-1:1992	Metallic flanges – Part 1: Steel flanges
ISO 7005-2:1988	Metallic flanges – Part 2: Cast Iron
ISO 7005-3:1988	Metallic flanges – Part 1: Copper alloy and composite flanges
ISO 1940-1:2003	Mechanical vibration -- Balance quality requirements for rotors in a constant (rigid) state -- Part 1: Specification and verification of balance tolerances
ISO 9906	Rotordynamic pumps – Hydraulic performance acceptance tests – Grades 1 and 2 *(ISO 9906 replaces ISO 3555 and ISO 2548)
*ISO 3555:1977	Centrifugal, mixed flow and axial flow pumps – Code for acceptance tests – Class B
*ISO 2548:1973	Centrifugal, mixed flow and axial flow pumps – Code for acceptance tests – Class C

MATERIALS OF CONSTRUCTION

Materials

Materials						
Medium	Raw Water (option 1)	Raw Water (option 2)	Potable Water (option 1)	Potable Water (option 2)	Sea Water (option 1)	Sea Water (option 2)
Volute casing	S.G. Iron	S.G. Iron	TBA	TBA	TBA	TBA
Casing wear ring	S.G. Iron	S.G. Iron	TBA	TBA	TBA	TBA
Impeller	Aluminium bronze	Stainless steel	TBA	TBA	TBA	TBA
Impeller wear rings	Aluminium bronze	Stainless steel	TBA	TBA	TBA	TBA
Pump shaft	High tensile steel	High tensile steel	TBA	TBA	TBA	TBA
Shaft protecting sleeve	High tensile steel	High tensile steel	TBA	TBA	TBA	TBA

Corrosion protection

Corrosion protection is to be advised. Contractor is to selects most appropriate corrosion protection technology when determining cost.

TESTING AND COMMISSIONING

Factory acceptance tests

A hydrostatic test shall be performed for pressure-containing parts of a pump at a test pressure of at least 1.5 times the basic design pressure. This pressure shall be maintained for a period of at least 10 minutes.

The Purchaser or his representative shall be entitled to witness the pressure tests (as required and indicated on the data sheets provided with this tender) and at least two (2) weeks notice shall be provided before such testing takes place. A test certificate shall be issued after the successful completion of such tests, in an approved format.

Each pump shall be subject to a hydraulic performance and NPSH test in accordance with ISO 9906, Class I or II, at an approved test facility. The Purchaser or his representative shall reserve the right to witness all tests (as required and indicated on the data sheets provided with this tender) and shall be granted full and complete access to all test data taken during the course of the test. They shall furthermore, be provided with copies of all test sheets, calibration certificates etc. upon completion of the tests. At least two (2) weeks notice shall be provided before such tests are undertaken.

Where pumps are supplied as complete pumpsets, these shall preferably be tested as such and shall be complete with own job motors.

It should be particularly noted that all test data and performance curves produced shall be presented in the units as described in the variation above.

In addition to the test point required to establish the guaranteed performance, a sufficient number of test points shall be measured so as to establish the shape of the full performance curve as presented in the Tender.

During the execution of the performance test, the mechanical operation of the pump shall be monitored with particular reference to abnormal temperature, noise, vibration and leaks.
Failure to achieve the rated (guarantee) point may render the equipment liable for rejection. Should this occur the manufacturer/supplier shall then be responsible to rectify the equipment to achieve such guarantees at own expense.

Site acceptance tests

Each pumpset shall be subject to a mechanical commissioning run to ensure that it is operating in accordance with its intended design duty and that there is no undue noise, vibration or excessive heating of the units.
SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

MEASUREMENT AND PAYMENT

Design and supply

Measurement of payment will be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rate shall include for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

Installation and commissioning

Measurement of payment will be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rate shall include for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, in complete working order.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

VARIATIONS AND OR ADDITIONS TO ISO 9908: FIRST EDITION 1993-11-01: Technical specifications for centrifugal pumps – Class III

3. Definitions

3.1 Rated conditions

Add to the Sub-Clause :

The rated (guarantee) conditions for all pumpsets pertaining to this tender are itemised and described in the Project Specification: Portion 1. These are furthermore outlined in the datasheets to be completed per pumpset to be submitted with this tender.

The pump selected shall be sized such that the rated (guarantee) duty is positioned as close as possible to the Best Efficiency Point (BEP) of the pumps hydraulic and shall be capable of at least 125% of the rated duty flow. The rated (guarantee) duty flow must be pitched no less than 60% and no greater that 110 % of the BEP flow.

4. Design

4.1 General

4.1.1 Characteristic Curve

Add to the Sub-Clause:

The pumps are to be selected so as to have stable, non-overloading characteristic curves.

Pump characteristic curves shall show head, efficiency, power demand and NPSH required, plotted against discharge flow rate in metric units at the rated impeller diameter and speed required to satisfy the rated (guarantee) duty.

Measurement	Preferred Unit	Symbol
Differential head	Meters	(m)
Discharge flow	Litres per second	(l/s)
Efficiency	Percent	(%)
Power absorbed	Kilowatt	(kW)
NPSHr	Meters	(m)
Impeller diameter	Millimeters	(mm)
Speed	Revolutions per minute	(rpm)

The performance curves shall indicate pump performance characteristics at maximum, minimum and rated impeller diameters.

Where two or more pumps are required to operate in parallel, care shall be taken to ensure that one pump can operate in isolation on the system without risk of damage to the pump itself or system within which it operates. This operating point shall be referred to as the “runout duty point’. Details of the hydraulic performances expected under these conditions shall be verified by superimposing the rated characteristics curve of the pumps offered onto the system curve (where) provided. This graphical data as well the runout hydraulic conditions to be specified on the data sheets provided, shall be submitted with this tender.

4.1.2 Net positive suction head (NPSH)

Delete the Sub-Clause and substitute:

The NPSHR shall be based on coldwater as specified in ISO 2548 and ISO 3555. The NPSHA must exceed NPSHR by a margin of at least 30% or 0.5 m, whichever is the greatest, at the rated (guarantee) point specified. The basis for use in performance curves is that NPSH corresponding to a drop of 3% of the total head of the first stage of the pump (NPSH3).

Where a pump may be subjected to operating under a runout duty point condition, the NPSHA must exceed NPSHR by a margin of at least 15% under this scenario.

4.2 Prime movers

4.2.1 Defined operating conditions

Delete the Sub-Clause and substitute:

The prime movers power output rating shall equal or exceed at least the following margins according to the pump's absorbed power demand at the rated (guarantee) point.

Margin	Description	Value
50%	For pumps requiring up to	2 kW
40%	For pumps requiring from	2 to 5 kW
30%	For pumps requiring from	5 to 10 kW
20%	For pumps requiring from	10 to 30 kW
15%	For pumps requiring from	30 to 100 kW
10%	For pumps requiring	Over 100 kW

Where a unit may be subjected to operating at a run-out duty point condition, the power output rating of the prime mover shall be at least 5% greater than the power absorbed by the pump at this point.

4.3 Critical speed, balance and vibration

4.3.2 Balance and vibration

Add to the Sub-Clause:

Rotating elements shall be statically and dynamically balanced according to ISO 1940-1:2003 to a balance quality grade of G2.5. Balancing certificates shall be submitted where specified, in an approved format.

A flat surface measuring at least 25 mm in diameter must be provided at both DE and NDE bearing housings in the horizontal and vertical planes such that a probe from a portable vibrometer may be positioned so as to measure resultant vibration amplitudes.

Failure to achieve the vibration limits specified may render the equipment liable for rejection. The Contractor shall be responsible to rectify the equipment to achieve the specified limits at his own expense.

4.4.4 Mechanical features

4.4.4.1 Dismantling

Add to the Sub-Clause:

The manufacturer/supplier must include for and indicate in their offer any special tools required for operation and or maintenance of the pumping units.

4.6 Forces and moments

Delete the Sub-Clause and substitute:

The manufacturer/supplier shall provide details of allowable external forces and moments on branches in the data sheets to be submitted with this tender.

4.7 Branch (nozzle) flanges

Delete the Sub-Clause and substitute:

Flanges shall be designed and drilled in accordance with SANS 1123. The rated pressure of the flanges shall be as stated in the data sheets

4.8 Impellers

4.8.1 Impeller design

Add to the Sub-Clause:

The rated impeller diameter shall not exceed 95% of full diameter. Similarly the rated impeller diameter shall not be less than 105% of the minimum diameter.

Pumps that are required to handle raw sewage or similar medium shall be capable of passing solids corresponding to an 80 mm diameter sphere as well as rags, paper and other stringy material without clogging.

4.12 Shaft Sealing

4.12.1 General

Add to the Sub-Clause:

The preference for either packed glands or mechanical seals shall be specified in the data sheets. If no preference is stated the supplier shall provide his standard design arrangement or alternatively advise otherwise.

4.13 Nameplate

Delete the Sub-Clause and substitute:

Nameplates shall be securely attached to the pump.

The minimum information required on the nameplate shall be name (or trademark) and address of the manufacturer or supplier, identification number of the pump (for example, serial number or product number), model type and size, rated (guarantee) flow, rated (guarantee) head, rated speed and actual impeller diameter.

4.16 Baseplates for horizontal pumps

4.16.1 General

Add to the Sub-Clause:

Baseplates are to be rigidly designed such that the combined unit (uncoupled pump, motor and baseplate) may be transported as a single item without any excess deflections or strains applied to any of these items. Suitable lifting lugs shall be provided on the baseplate design for transportation and lifting purposes. Lifting of the combined unit must not be carried out by slinging from the pump or motor.

Baseplates shall be supplied complete with holding-down bolts and sufficient steel packers to allow shimming for alignment and grouting. All shims are to be neatly cut so as not to protrude beyond the baseplate or motor‘s base/feet.

acking bolts shall be included in the baseplate design to aid in the alignment of rotating equipment.

4.16.2 Assembly of pump and driver on baseplate

Add to the Sub-Clause:

Pre-alignment of the pump and motor shall be carried out before transporting the combined unit to site. The alignment of these items shall be checked again after final installation and before the coupling and commissioning of the pump and motor sets are undertaken.

6. Shop inspection and tests

Delete the Sub-Clause and substitute:

A hydrostatic test shall be performed for pressure-containing parts of a pump at a test pressure of at least 1.5 times the basic design pressure. This pressure shall be maintained for a period of at least 10 minutes.

The Purchaser or his representative shall be entitled to witness the pressure tests (as required and indicated on the data sheets provided with this tender) and at least two (2) weeks notice shall be provided before such testing takes place. A test certificate shall be issued after the successful completion of such tests, in an approved format.
Each pump shall be subject to a hydraulic performance and NPSH test in accordance with ISO 9906, Class I or II, at an approved test facility. The Purchaser or his representative shall reserve the right to witness all tests (as required and indicated on the data sheets provided with this tender) and shall be granted full and complete access to all test data taken during the course of the test. They shall furthermore, be provided with copies of all test sheets, calibration certificates etc. upon completion of the tests. At least two (2) weeks notice shall be provided before such tests are undertaken.

Where pumps are supplied as complete pumpsets, these shall preferably be tested as such and shall be complete with own job motors.

It should be particularly noted that all test data and performance curves produced shall be presented in the units as described in the variation to Clause 4.1.1 above.

In addition to the test point required to establish the guaranteed performance, a sufficient number of test points shall be measured so as to establish the shape of the full performance curve as presented in the Tender.

During the execution of the performance test, the mechanical operation of the pump shall be monitored with particular reference to abnormal temperature, noise, vibration and leaks.

Failure to achieve the rated (guarantee) point may render the equipment liable for rejection. Should this occur the manufacturer/supplier shall then be responsible to rectify the equipment to achieve such guarantees at own expense.

7. Preparation for dispatch

7.2 Securing of rotating parts for transport

Add to the Sub-Clause:

The combined pump and motor set shall be transported uncoupled.

Annex A: Centrifugal pump – Data sheet

Add to the Sub-Clause:

The Centrifugal pump – Data sheets to be completed and submitted with this tender are presented with the Returnable Schedules.

Annex B: Enquiry, proposal and purchase order

B.1.1 Proposal

Add to the Sub-Clause:

The proposal shall include at least the following technical information:

List of all deviations to the pump specifications;

centrifugal pump data sheet completed in full;

preliminary outline drawing with installation information;

typical cross-section drawing or exploded view;

pump characteristic curve;

Superimposition of pump and system characteristic curves;

List of special dismantling considerations and or tools required for operation and maintenance procedures.

A full list of documents (to be submitted both with the proposal as well as after contract award) is presented in the list of Returnable Documents.

SERIES M6 PUMPS

SECTION M6015: SUBMERSIBLE TYPE PUMPS

SCOPE

This specification covers the design, supply, delivery, transport, handling, storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period for Submersible type pumps.

DESIGN SPECIFICATION

2.1 Description

All submersible pumps shall be designed and supplied in accordance with ISO 9001– Technical specification for submersible pumps. The Manufacturer / Supplier shall review the rated (guarantee) duties and offer his best technical and financial solution at the highest operational efficiency based on the type for pumping raw effluent.

The pump shall be water pressure –tight encapsulated flood proof motors in standard version with option of jacket for cooling system. The pump shall be suitable for dry and wet installations. The pump shall be fitted with a Vortex impellor with case hardened edges. The pump shall be manufactured in such a way that will enable the adjustment of the bowl towards the impellor to maintain maximum efficiency at all times.

The flow and pressure requirements must be calculated in accordance with the Technical Data Sheets. Where the Technical Data Sheets refer to a Contractor design, the flow and pressure is to be provided.

The operating speed of all pumps should preferably be less that 1500 rpm but must not exceed 3000 rpm.

Tenders will be assessed on the best technical and financial value offered. In adjudicating the tenders, in addition to price, account will be taken of:

Rated (guarantee) operating efficiency offered to be specified in the data sheets to be submitted with this tender;
Equipment offered;
Delivery period;
Ease of operation and maintenance;
Technical resources and previous project experience;
General soundness and robustness of design;
Reliability of components;
Availability of spares and after sales service; and
Any special conditions or qualifications put forward by the Tenderer.

2.2. Materials of Construction

Materials

Materials						
Medium	Raw Water (option 1)	Raw Water (option 2)	Potable Water (option 1)	Potable Water (option 2)	Sea Water (option 1)	Sea Water (option 2)
Volute casing	S.G. Iron	S.G. Iron	TBA	TBA	TBA	TBA
Casing wear ring	S.G. Iron	S.G. Iron	TBA	TBA	TBA	TBA
Impeller	Aluminium bronze	Stainless steel	TBA	TBA	TBA	TBA
Impeller wear rings	Aluminium bronze	Stainless steel	TBA	TBA	TBA	TBA
Pump shaft	High tensile steel	High tensile steel	TBA	TBA	TBA	TBA
Shaft protecting sleeve	High tensile steel	High tensile steel	TBA	TBA	TBA	TBA

2.2.2 Corrosion protection
Corrosion protection is to be advised. Contractor is to selects most appropriate corrosion protection technology when determining cost.

TESTING AND COMMISSIONING

Factory acceptance tests

A hydrostatic test shall be performed for pressure-containing parts of a pump at a test pressure of at least 1.5 times the basic design pressure. This pressure shall be maintained for a period of at least 10 minutes.

The Purchaser or his representative shall be entitled to witness the pressure tests (as required and indicated on the data sheets provided with this tender) and at least two (2) weeks notice shall be provided before such testing takes place. A test certificate shall be issued after the successful completion of such tests, in an approved format.

The Purchaser or his representative shall reserve the right to witness all tests (as required and indicated on the data, if given ,sheets provided with this tender) and shall be granted full and complete access to all test data taken during the course of the test. They shall furthermore, be provided with copies of all test sheets, calibration certificates etc. upon completion of the tests. At least two (2) weeks notice shall be provided before such tests are undertaken.
It should be particularly noted that all test data and performance curves produced shall be presented in the units as described in the variation above.

In addition to the test point required to establish the guaranteed performance, a sufficient number of test points shall be measured so as to establish the shape of the full performance curve as presented in the Tender.

During the execution of the performance test, the mechanical operation of the pump shall be monitored with particular reference to abnormal temperature, noise, vibration and leaks.
Failure to achieve the rated (guarantee) point may render the equipment liable for rejection. Should this occur the manufacturer/supplier shall then be responsible to rectify the equipment to achieve such guarantees at own expense.
Site acceptance tests

Each pump shall be subject to a mechanical commissioning run to ensure that it is operating in accordance with its intended design duty and that there is no undue noise, vibration or excessive heating of the units.
Spares

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

4. DESIGN

4.1 General

4.1.1 Characteristic Curve

The pumps are to be selected so as to have stable, non-overloading characteristic curves.

Pump characteristic curves shall show head, efficiency, power demand and NPSH required, plotted against discharge flow rate in metric units at the rated impeller diameter and speed required to satisfy the rated (guarantee) duty.

Measurement	Preferred Unit	Symbol
Differential head	Meters	(m)
Discharge flow	Litres per second	(l/s)
Efficiency	Percent	(%)
Power absorbed	Kilowatt	(kW)
NPSHr	Meters	(m)
Impeller diameter	Millimeters	(mm)
Speed	Revolutions per minute	(rpm)

The performance curves shall indicate pump performance characteristics at maximum, minimum and rated impeller diameters.

4.2 Prime movers

4.2.1 Defined operating conditions

Delete the Sub-Clause and substitute:

The prime movers power output rating shall equal or exceed at least the following margins according to the pump's absorbed power demand at the rated (guarantee) point.

Margin	Description	Value
50%	For pumps requiring up to	2 kW
40%	For pumps requiring from	2 to 5 kW
30%	For pumps requiring from	5 to 10 kW
20%	For pumps requiring from	10 to 30 kW
15%	For pumps requiring from	30 to 100 kW
10%	For pumps requiring	Over 100 kW

Where a unit may be subjected to operating at a run-out duty point condition, the power output rating of the prime mover shall be at least 5% greater than the power absorbed by the pump at this point.

4.3 Critical speed, balance and vibration

4.3.1 Balance and vibration

Add to the Sub-Clause:

Rotating elements shall be statically and dynamically balanced according to ISO 1940-1:2003 to a balance quality grade of G2.5. Balancing certificates shall be submitted where specified, in an approved format.

Failure to achieve the vibration limits specified may render the equipment liable for rejection. The Contractor shall be responsible to rectify the equipment to achieve the specified limits at his own expense.

5. MECHANICAL FEATURES

5.1 Dismantling

The manufacturer/supplier must include for and indicate in their offer any special tools required for operation and or maintenance of the pumping units.

5.2 Impellers

5.2.1 Impeller design

Vortex type with hardened edges.

The rated impeller diameter shall not exceed 95% of full diameter. Similarly the rated impeller diameter shall not be less than 105% of the minimum diameter.
Pumps that are required to handle raw sewage or similar medium shall be capable of passing solids corresponding to an 80 mm diameter sphere as well as rags, paper and other stringy material without clogging.

5.3 Shaft Sealing

5.3.1 General

The preference for either packed glands or mechanical seals shall be specified in the data sheets. If no preference is stated the supplier shall provide his standard design arrangement or alternatively advise otherwise.

5.4 Nameplate

Nameplates shall be securely attached to the pump.

The minimum information required on the nameplate shall be name (or trademark) and address of the manufacturer or supplier, identification number of the pump (for example, serial number or product number), model type and size, rated (guarantee) flow, rated (guarantee) head, rated speed and actual impeller diameter.

5.5 Shop inspection and tests

A hydrostatic test shall be performed for pressure-containing parts of a pump at a test pressure of at least 1.5 times the basic design pressure. This pressure shall be maintained for a period of at least 10 minutes.

MEASUREMENT AND PAYMENT

Design and supply

Measurement of payment will be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rate shall include for design, manufacture, factory testing, supply, delivery and storage on site of the unit.
Installation and commissioning
Measurement of payment will be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rate shall include for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, in complete working order.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M7: VALVES

SECTION M7001: GENERAL VALVES

TABLE OF CONTENTS

SERIES M7: VALVES

SECTION M7001: GENERAL VALVES

SCOPE

This specification covers the supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of valves.

DESIGN SPECIFICATION

General

This specification covers valves required to be used on the more common applications. Where special valves are necessary for specific applications, the Tenderer must select suitable valves and provide details with his tender submittals for approval by the Engineer.

Construction and design

Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation.

Valves shall be double-flanged unless unavailable or otherwise specified.

Valves and their method of actuation shall be designed to provide operation under the full pressure rating of the valve.

Operating direction

The handwheel, lever, etc. on valves, valve actuators and valve gearboxes shall be clockwise closing unless otherwise specified.

Position indication

All valves, including valves with gearboxes and valves with actuators, shall be provided with indication of current position as well as indication of closing and/or opening direction. Valves with configurations which make this information apparent will be acceptable.

Corrosion protection

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

Cast iron valve components, including valve bodies, shall be protected with System - Fusion Bonded Epoxy.

Fasteners

Valve and valve gearbox fasteners shall be of grade 316 stainless steel.

MATERIALS OF CONSTRUCTION

Cast iron gate valves (Wedge Gate)

Wedge gate valves shall be used on raw water and treated water duties but shall not be used on raw sewage, raw water, effluent, sludge and general duties where some solids may be present. The valves shall comply with the following:

The valves shall comply with SANS 664 or SANS 665, Class 10 or higher as required.

The valves shall be double flanged.

Valve bodies, handwheels and bonnets shall be manufactured from spheroidal graphite iron, free from blow holes and carefully fettled after casting to remove surface imperfections. Spindles shall be manufactured from or stainless steel or equal approved material according to the duty requirements. The body shall be provided with channel guides and the gate shall be provided with shoes. Guides and shoes shall be of copper alloy or stainless steel and shall guide the gate along the complete travel distance. Spindle seals shall be of the nitrite rubber 'O' ring type with bush insert and provided with an external scraper ring. Replacement of the seals shall be possible with the valve under pressure.

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

Valves shall have rising spindles unless otherwise specified or necessary. Non-rising spindle valves shall be fitted with indicators showing the valve opening position.

Hand-wheel size and construction shall permit easy opening of the gate when subjected to a differential pressure equal to the maximum operating pressure anticipated. Suitable gearboxes shall be fitted to provide easy opening when necessary. These gearboxes shall be grease filled.

Extensions spindles shall be manufactured from 316L stainless steel. Headstocks shall be manufactured from stainless steel 316L steel or cast iron and to a pattern approved by the Engineer.

Valves larger than DN 150 shall be provided with bypass arrangements.

Valves larger than DN 250 shall be provided with doors for inspection and cleaning.

Cast iron gate valves with resilient seals

Resilient seal gate valves may be used on raw sewage, raw water, effluent and general duties where some solids may be present but must not be used on high solid applications such as sludge and grit duties.

The valves shall comply with SANS 664 or SANS 665, Class 10 or higher as required.

The valves shall be double flanged. Valves shall have rising spindles unless otherwise specified or necessary because of space restrictions. Non-rising spindle valves shall be fitted with indicators showing the valve opening position.

Valve bodies, handwheels and bonnets shall be manufactured from spheroidal graphite iron, free from blow holes and carefully fettled after casting to remove surface imperfections. Spindles shall be manufactured from or stainless steel or EN57 or equal approved material according to the duty requirements. At least two spindle seals of the nitrile rubber “O” sealing rings in a corrosion resistant housing shall be provided, along with one nitrile rubber wiper ring to prevent the ingress of dirt. Replacement of the seals shall be possible with the valve under pressure.

Handwheels shall be of cast-iron.

Fixing lugs for end of travel limit switches shall be provided

Handwheel size and construction shall permit easy opening of the gate when subjected to a differential pressure equal to the maximum operating pressure anticipated. Suitable gearboxes shall be fitted to provide easy opening when necessary. These gearboxes shall be grease filled.

Valves larger than DN 150 shall be provided with bypass arrangements.

Knife gate valves

Knife-gate valves must be used on water sludges as well as on primary, waste activated and digested sludge duties. They shall also be used on other high solids application and may be used for duties specified under Clause "Cast Iron Gate Valves with Resilient Seals".

Valves shall be Insamcor HDH CI STD, or equivalent, with cast iron bodies, stainless steel blades, cast handwheels, and no carbon steel parts.

Valves for water sludges shall be anti-clockwise closing. Valves for primary, waste activated and digested sludges shall be clockwise closing.

Valves shall have chamfered blade edges and resilient body seals, and may have either rising or non-rising spindles. Gate position indication shall be provided if the overall design does not make this apparent. The blade shall be loaded through its central plane during opening and closing and this shall be achieved by the use of a clevis link or similar.

Blade scrapers shall be incorporated to protect the body seal and valve chest. As the valve is opened, the scrapers shall clean the blade surfaces before these contact the body seal. The scrapers shall be of a non-elastomeric, non-metallic material and shall be designed to cause minimal damage to the blade.

Valves shall be droptight in either flow direction. Suitable sealing shall be provided to prevent leakage from the valve and it shall be possible to adjust these seals while the valve is in line under pressure.

Internal and external surfaces of the valve body shall be protected with a water resistant, non-toxic and non-tainting, fusion bonded epoxy pipe coating in accordance with System - Fusion Bonded Epoxy.

Valves shall be double-flanged and shall suit the standard flange rating but may incorporate drilled and tapped fastener holes (the type of valve which is clamped between two flanges will be considered for acceptance only in positions where it is very likely that the pipe or flanged item on either side will never have to be removed or if isolation will not be necessary if it is removed). Fasteners may be studs or setscrews manufactured to suit the tapping depth.

Butterfly valves

Butterfly valves are for the use on air, gas and clean liquid duties and for the use on raw and potable water duties, shall comply with SANS 1849.

Butterfly valves shall be of the resilient seal type with suitably lined cast iron body and a lined or 316 stainless steel blade. Valve shafts and thrust pads for cast iron valves shall be of stainless steel 316L and seating rings of gun-metal or stainless steel 316L, or approved synthetic material to suit the application. Valves, except where stated, shall be resilient seal type with neoprene blade seal, suitable for the working pressure. Bearing bushes are to be of 'Vesconite,' Teflon or similar approved material and gland seals of neoprene. Hand lever valve actuation with a locking system for incremental valve setting from fully shut too fully open shall be provided for valves up to and including

DN 200. Valves larger than DN 200 shall be equipped with robust, weatherproof grease-filled gearboxes with an indicator to show the degree of valve opening.

Valves shall be air, gas and water tight when closed.

For normal usage, the valves may be of the type which is clamped between two flanges. Where it is necessary to remove equipment on either side for maintenance purposes, suitable spacer pipes must be provided or the valves shall be flanged and provided with drilled and tapped holes.
The valves shall be installed with horizontal disc shafts.

Check valves

General

A shut-off valve shall be installed downstream of each check valve.

The check valve installation shall ensure that flaps are able to open fully without being impeded by, for example, a shut-off valve, bend or pipework internal lining. Where a check valve is located close to another valve, an intervening spool piece with a minimum flange-to-flange length of 1,5 times the valve diameter shall be provided.

Bronze swing type check valves may be used for pipework up to DN 50.

Check valves for water

Check valves for treated water and raw water duty shall be of the double-flap, positive-closing type.

Bodies shall be of cast-iron or cast-steel. Flaps shall be of the light, leaf type, shall be of bronze or stainless steel with machined sealing faces, shall be specifically designed to be non-sticking, and shall have Teflon bearing washers. The gate, swing arm and hinge shall be designed to carry full shock loading on closure. Seals shall be of resilient material. The axis of rotation of the flaps shall be vertical, pins shall be of 316 stainless steel and closure shall be initiated by stainless steel springs, suitably rated for the duty so that closing is initiated prior to the onset of reverse flow. The valves shall seal effectively under all operating conditions and the design shall be such that the gate rests against the seat in the absence of flow or of differential pressure without the aid of the springs or external counterweights.

Positive, external indication of the position of both plates shall be provided.
Swing check valves

Swing check valves shall be used on all sewage, sludge or similar applications. Valves for use with sewage, effluent or sludge shall be self cleansing at the base of the gate.

Swing check valves shall be flanged, shall be of all iron construction suitable for a working pressure of at least 1 000 KPa, and shall be fitted with a side lever and adjustable weight. External levers and counterweights shall be fitted to the hinge shaft which shall be extended through the valve body and provided with nitrile rubber 'O' ring seals which may be replaced with the valve under pressure. The level and counterweight shall be provided with facilities for adjusting the angle and weight positions.

Orientation of the valve installation shall comply with the manufacturer's recommendation.

Pinch valves

All isolating valves at pump installations to have rising spindles.

Pinch valve sleeves shall be manufactured form high strength synthetic fiber or steel cord reinforcement. The sleeve liner is to be natural rubber. The sleeves are to be tested to twice their maximum working pressure and supplied with a test certificate. The closing mechanism is to be design for ease of operation under pressure. The valve is to be supplied with an indicator for open/close indication. Where called for, pinch valves may be used as control valves with either electro-mechanical, pneumatic or hydraulic operation.

Bronze isolating valves

May be used for isolating duties on clean air and liquid duties up to DN 50.

Bronze gate valves shall be to SANS 77 Ball or plug valves of appropriate construction may also be used where preferred.

Rubber diaphragm valves

To be used on sludge and other dirty or corrosive liquid duties requiring valves up to DN 350. May also be used on clean liquid duties.

Rubber diaphragm valves shall preferably be of the straight through type with the diaphragm made of natural rubber.

This type of valve shall not be used on the suction side of pumps or on any line subject to vacuum.

Needle valves (above DN 150)

Needle valves shall be used for the regulation of flow and/or pressure in pipelines containing water where the size is DN 150 or greater unless this is overridden by the requirements of the Detailed Specification. The configuration shall be double-flanged with co-axial flanges unless otherwise specified.

The seal seat and associated downstream parts shall be selected to prevent any cavitation for the application. Such parts shall be of stainless steel or copper based alloy.

Air valves

Air valves for water shall be of the non-slamming type, Vent-O-Mat, ARI or equivalent.

Air valves for sewage and similar duties shall be specifically designed for the application.

Air valves shall be installed above pockets designed to collect air. The pockets shall be designed in accordance with the requirements for nozzles in pipe-work. The diameter of the nozzle shall be at least half the diameter of the parent pipe work.

Air valves shall preferably be flanged and shall be provided with isolating cocks.

Corrosion Protection

Corrosin protection shall be carried out strictly in accordance with the Standard Specifciation for General Corrosion Protection.

All vavles unless otherwise specified are to conform to System – Fusion Bonded Epoxy.

TESTING AND COMMISSIONING

Tests on completion

Performance testing will be carried out on the equipment after commissioning and adjustment. All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

The tests will be performed on the equipment over a single 8 hour shift. They shall consist of the following:

Smooth and efficient operation of the valves.

Appropriate closing direction of the valves according to the above specification.

The torque doesn't exceed the torque stated in the data sheets.

The equipment will be considered acceptable when:

The equipment meets the duty requirements as defined in this section of the Specification and stated in the data sheets.

During the Defects Liability Period.

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.
MEASUREMENT AND PAYMENT

Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M7 VALVES

SECTION M7002: TELESCOPIC BELL-MOUTH VALVE

TABLE OF CONTENTS

SERIES M7 VALVES

SECTION M7002: TELESCOPIC BELL-MOUTH VALVE

SCOPE

This specification covers the supply, delivery, off loading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order for telescopic bell-mouths. Under full load, the yield strength and tensile strength of the materials must be within their limits.

DESIGN SPECIFICATIONS

Each telescopic bell-mouth shall be fitted with manual operated hand-wheels. The vertical travel shall be such that a distance from the top of the bell-mouth to 200mm below top water level (TWL) and 100mm above TWL can be accommodated in the arrangement. A baffle plate shall be incorporated to eliminate splashing sludge out of the chamber.

Each valve shall be fitted with adjustable travel limits and the torque on the hand-wheel shall be sufficient to function without overloading.

MATERIALS OF CONSTRUCTION

All piping shall be manufactured in 316L s/s, and the spindle shall be of a non-corrodible material suitable for the duty, with square thread spindle nuts manufactured in bronze or gun metal. The spindle shall be fitted with a clear polycarbonate weatherproof cover to visually see the degree of opening. Hand wheels shall be mounted such that the bell-mouths can be easily controlled by the hand wheel mounted on the headstock manufactured from either cast iron or aluminium. All mounting brackets and holding down bolts for the hand wheel shall be manufactured from 316 stainless steel. Proposed details for the hand wheel control mechanism and manner of operation are to be submitted with the tender.

The bell-mouth essentially consists of a pipe within a pipe. No metal-to-metal contact shall occur and the seal arrangement on the sliding section shall be suitable for long life in sewage sludge conditions. Should it be required to change the seal, it shall be accomplished without having to remove the complete bell-mouth.

TESTING AND COMMISSIONING

Tenderers shall provide sufficient information to permit evaluation of the performance of the equipment. Performance tests will be carried out once the plant is operating and a sum has been included in the Schedule of Prices for conducting these tests.

The test procedure shall be approved by the Engineer and contain the following minimum requirements:

Determination of maximum and minimum travel to suit the desludge operation required.

Efficient operation of bell-mouths in situ.

Testing of hand wheel torque required to operate the valve by one of the operators

The tests shall be undertaken over a period of time, as the sludge in each settling tank requires time to achieve the conditions they will be subjected to. The equipment shall be considered acceptable when the units effectively control the de-sludging operation as specified.

SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

MEASUREMENT AND PAYMENT

Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M9 SCREENING

SECTION M9002: HAND RAKED BAR SCREEN

TABLE OF CONTENTS

SERIES M9 SCREENING

SECTION M9002: HAND RAKED BAR SCREEN

SCOPE

This specification covers the design, supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of hand raked bar screens.

DESIGN SPECIFICATIONS

General

The screen must be able to handle various types of suspended solids such as pieces of timber, cloth, string or any other fibrous materials, metal objects, rocks, sheets of paper and any materials which are likely to be present in the influent under typical South African conditions. The
Bar spacing must be between 35-45 mm.

The hand raked bar screen shall be sufficiently robust to prevent bending and deformation of the bars under normal operating conditions and to have the required bar profile for minimal head loss. The bar spacing is to be as specified in the technical data sheets. Recesses in the walls and floor of the concrete channel are to be cast by the civil contractor for the screen to be of a minimum obstruction to the flow. The top of the screen is to be level with the top of the channel when installed. The civil contractor is to grout in the screen once installation has been completed. A hand rake with teeth in proportion to the bar spacing is to be provided along with the screen.

MATERIALS OF CONSTRUCTION

General

The screen is to be fabricated from stainless steel 316L and to be pickled and passivated. All fasteners are to be of stainless steel 316L. The screen must be mounted at 70 degrees.

Name plates

A name plate, placed in a viewable position, is to be provided with the following information:

Manufacturers name

Supplier’s name

Serial number

Type

TESTING AND COMMISSIONING

Performance testing will be carried out on the equipment after commissioning and training of the Council’s employees. The tests will be performed on the equipment over a single 8 hour shift.

These tests shall consist of the following:

Efficient operation of the screen under all operating conditions including simulation of capability using rocks, wood, metal, and other debris (within reason and simulating expected debris in the incoming flow) deposited into the channel ahead of the screen; and
Fast and efficient removal of screenings with the use of the hand rake without the teeth of the rake jamming in the bars of the screen.

The equipment will be considered acceptable when:

The above tests have been sufficiently met.

During Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

MEASUREMENT AND PAYMENT

Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit

Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M10 MECHANICAL FLUID CONTROL EQUIPMENT

SECTION M10001: FLUID CONTROL EQUIPMENT

TABLE OF CONTENTS

SERIES M10 MECHANICAL FLUID CONTROL EQUIPMENT

SECTION M10001: FLUID CONTROL EQUIPMENT

SCOPE

This specification covers the design, supply, delivery, off loading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order for penstocks. The equipment is to be designed in accordance to DIN Spec 19704. Under full load, the yield strength and tensile strength of the materials must be within their limits.

DESIGN SPECIFICATION

General

Equipment is to generally adhere to the below unless otherwise specified:

Equipment shall be of robust construction suitable for the required duty and shall be fabricated in stainless steel 316L Equipment is to be manufactured in stainless steel 316 in coastal areas or where the environment is highly corrosive. It is to be designed for minimum leakage and shall be provided with headstocks and rising spindles with wall mounted brackets. All equipment is to be hand wheel operated. Bevel gearboxes shall be provided. Gates shall move freely and smoothly in the frame and adjustment shall be provided using wedges manufactured from stainless steel or other approved non corrodible material. The wedges shall have a profile which will prevent seizure after long periods of immersion in a closed position. Frame sealing shall be arranged with the use of replaceable bulb section neoprene strips, and seals manufactured from a similar ultra violet resistance material shall be provided on the upstream face of all moving faces. The gate guides on channel penstocks shall extend upwards to fully accommodate the gate when fully opened.

Gate lifting spindles shall be of adequate diameter to open and close the gate against resistance without excessive deflection. The lifting nut shall be of bronze or gun metal with thread length equal to at least twice spindle diameter and cut with mating thread.

Covers shall be provided for the spindles. The covers shall accommodate the full range of travel of the spindle and shall include external brass position indicators and be manufactured from robust polycarbonate material and provided with stainless steel 316L mounting flanges bonded to the covers.

Wall mounted sluice gates

Wall mounted sluice gates shall be of robust construction suitable for the required duty and shall be fabricated in stainless steel 316L. Wall mounted gates are to be manufactured in stainless steel 316L in coastal areas or where the environment is highly corrosive. Wall mounted sluice gates are to be designed for minimum leakage and shall be provided with headstocks and rising spindles with wall mounted brackets. The wall mounted gates are to be hand wheel operated. Bevel gearboxes shall be provided. The gate shall move freely and smoothly in the frame. The frame sealing for all sides of the wall mounted sluice gates shall be arranged with the use of replaceable bulb section neoprene seals of the “music note” or “J” types. The tenderer is to state if the sealing is “on” or “off” seating on the technical data sheets.

Twistlock gates

Twistlock gates are similar to wall mounted sluice gates but are of a smaller size and where they are to be hand mounted. It will be able to be locked in any partially opened position by a cam mechanism forcing the gate against the frame. The same action is to be used for closing the gate. A head of 3 m

for seating and a head of 2 m for unseating may be used. They may be fabricated from cast iron, cast stainless steel or mild steel with corrosion protection. Bronze seating faces are to be used.

Channel gates

Channel Gates shall be of robust construction suitable for the required duty and shall be fabricated in stainless steel 316L. Channel gates are to be manufactured in stainless steel 316L in coastal areas or where the environment is highly corrosive. Channel gates are to be designed for minimum leakage and shall be provided with head frame and rising spindles. The channel gates are to be hand wheel operated or otherwise stated. Bevel gearboxes shall be provided. The gate shall move freely and smoothly in the frame. Channel gate seals are to be manufactured from Neoprene. Angle type neoprene is to be used for the vertical members while compression type is to be used in the invert.

Channel gate lifting spindles shall be of adequate diameter to open and close the gate against resistance without excessive deflection. The lifting nut shall be of bronze or gun metal with thread length equal to at least twice spindle diameter and cut with mating thread. In cases where the spindle is excessively long due to a deep channel or higher than usual head frame, the spindle is to be supported by guides to prevent buckling. Twin lifting spindles with interconnected gearboxes are to be used for very wide gates.

Covers shall be provided for the spindles on all channel gates. The covers shall accommodate the full range of travel of the spindle and shall include external brass position indicators and be manufactured from robust polycarbonate material and provided with stainless steel 316L mounting flanges bonded to the covers.

The frame of the channel gate is to be embedded into the channel. Provisions for blockouts in the channel are to be made by the civil contractor. Once the channel gate has been installed the civil contractor is to complete the necessary grouting in.

Weir gates (Downward Opening Weir Gates and Tilting Weirs)

Downward opening weir gates shall be of robust construction suitable for the required duty and shall be fabricated in stainless steel 316L Downward opening weir gates are to be manufactured in stainless steel 316L in coastal areas or where the environment is highly corrosive. Downward opening weir gates are to be designed for minimum leakage and shall be provided with head stock, rising spindles and wall mounts. The weir gates are to be hand wheel operated. Bevel gearboxes shall be provided. Sealing will be achieved through ultra violet resistant neoprene seals of the “tri angular” or “J” types between sections and the installed arrangement shall provide an effective seal under all depths of immersion.

If the head is greater than the height of the opening, four sided seals are to be used if the flow is to be completely shut off. Otherwise three sided sealing is to be used.

If the width of the gate is to be significantly greater than height of the gate, side extensions may be added to increase the effective height of the gate. In the case of not being able to add extensions to the gate, double lifting spindles with synchronized gearboxes are to be used.

Tilting weir gates shall be of robust construction suitable for the required duty and shall be fabricated in stainless steel 316L. Tilting weir gates are to be manufactured in stainless steel 316L in coastal areas or where the environment is highly corrosive Tilting weir gates are to be designed for minimum leakage and shall be provided with head stock, rising spindles and wall mounts. The weir gates are to be hand-wheel operated. Bevel gearboxes shall be provided. Along the hinged section, flat neoprene seals are to be fitted the installed arrangement shall provide an effective seal under all depths of immersion. Vertical travel shall not be more than 500 mm. A centrally mounted spindle is to raise and lower the tilting weir gate and it is to be hinged at the bottom.

Downward opening and tilting weir gates lifting spindles shall be of adequate diameter to open and close the gate against resistance without excessive deflection. The lifting nut shall be of bronze or gun metal with thread length equal to at least twice spindle diameter and cut with mating thread.

Covers shall be provided for the spindles on all downward opening and tilting weir gates. The covers shall accommodate the full range of travel of the spindle and shall include external brass position indicators and be manufactured from robust polycarbonate material and provided with stainless steel 316L mounting flanges bonded to the covers.

Hand stops and stop logs

They are to be for manual installation and removal by two operators and the mass of each section shall not exceed 25 kg. The maximum width is to be no more than 1000 mm.

Provision shall be made for the easy attachment of lifting hooks to the hand stop/stop log eyes under submerged conditions and two sets of lifting hooks shall be supplied under this contract.

Sealing will be achieved through ultra violet resistant neoprene seals between sections and the installed arrangement shall provide an effective seal under all depths of immersion.

The contractor shall design and supply a permanent frame manufactured from Aluminium sections to enable the storage and locking of hand stops.

The frame of the hand stop is to be embedded into the channel. Provisions for block-outs in the channel are to be made by the civil contractor. Once the hand stop has been installed the civil contractor is to complete the necessary grouting in.

Flap gates

Flap gates are used to prevent reversal of flow at the end of pipes or walls. Gates are to be double hung by stainless steel pins in bronze bushes.

Smaller sized flap gates are to be fabricated in cast iron or cast stainless steel and to have bronze or stainless steel sealing faces. Larger sized flap gates are to be fabricated from stainless steel, or adequately corrosion protected mild steel. Neoprene seals are to be used.

Sluice valves

Sluice valves are cast into the floor of reservoirs and tanks for draining them. They may be supplied in cast iron, cast steel, stainless steel, corrosion resistant steel or mild steel. Bronze, neoprene or stainless steel may be used for the seats. The operation is to be by means of a hand wheel.

Hand flushing valves

For draining fluid from tanks, hand flushing valves are appropriate for up to 3m of head and are to be of the quick opening lever operated type. They may be fabricated from either cast iron or cast iron stainless steel and be supplied with bronze seats.

Ground water relief valves

Ground water relief valves, where necessary, are cast into the floor of reservoirs, tanks, canals, etc. to relieve pressure caused by ground water. The maximum pressure head of 4 m is the recommendable

allowable pressure. The body is to be fabricated from cast iron or cast stainless steel. The flexible disc and sealing disc are to be neoprene.

Fasteners

All fasteners are to be manufactured from stainless steel 316L

Electric actuators

Where electric actuators are to be used, they are to conform to the below details and to the relevant specification for actuators.

Electric actuators shall be adequately sized to accommodate the seating and unseating requirements. Travel duration from open to close or close to open position shall not be greater than 60 seconds for electric actuators.

The differential between supply and feedback signal on electric actuators shall not exceed 0,05 mA.

Status feed back contacts are to be provided for remote indication of:

Open/closed position

Torque trip at intermediate position
Actuator fault

Hand operation

Name plates

A name plate, placed in a viewable position, is to be provided with the following information:

Manufacturer's name

Supplier's name

Serial number

Size and type

MATERIALS OF CONSTRUCTION

Corrosion protection

Corrosion protection shall be carried out in accordance with the requirements of the General Specifications for General corrosion Protection and to the following systems:

Stainless steels and 3CR12	:	Pickled and passivated
Mild steel	:	System - Fusion bonded epoxy coated
Aluminium	:	Anodised
Hand wheels	:	System A/1
Electric actuators	:	System B/1

TESTING AND COMMISSIONING

All channel gates, penstocks weir gates, tilting weirs and hand stops shall be checked for good installation and easy and correct functioning. All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

Performance testing will be carried out on the equipment after commissioning, adjustment and training of the Council's employees.

The tests will be performed on the equipment over a single 8 hour shift.

The tests shall consist of the following:

Correct operation.

Full opening and closing of the gate. Manual operation of a gate is to be achieved by one person at all times. Where there is actuation, the actuator is to achieve full opening and closing of the gate.

Visual inspection of gate sealing at their closed positions with liquid at the maximum level.

Electrical power use with a calibrated kWh meter (if equipment is actuated).

Installation and removal of hand stops under dry and maximum flow conditions.

The equipment will be considered acceptable when:

The equipment meets the duty requirements as defined in this section of the Specification.

The tests defined above prove the acceptable operation of the equipment.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

MEASUREMENT AND PAYMENT

Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M14 DISINFECTION AND CHEMICAL DOSING
SECTION M14001: STANDARD SPECIFICATION FOR SMALL TO MEDIUM SIZED GASEOUS CHLORINATION FACILITIES

TABLE OF CONTENTS

SERIES M14 DISINFECTION AND CHEMICAL DOSING
SECTION M14001: STANDARD SPECIFICATION SMALL TO MEDIUM SIZED GASEOUS CHLORINATION FACILITIES

Scope

This section of the Contract covers the design, supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of a small to medium sized gaseous chlorination system to dose chlorine at a rate not exceeding 3 kg/h. The equipment includes but is not limited to the following:

Chlorinators complete with ancillary equipment; pipe work and fittings
Manifold for chlorinators for chlorine storage drums including feed pipe work.
Support cradles and mass indicators for monitoring chlorine inventory.
Overhead chlorine drum hoist and associated equipment
Motive water pumps, pipe work and fittings
Ambient chlorine detection equipment to detect leaks
Chlorine residual analyser(s) to control the dosing rate

Local control panel (LCP), including all cabling to chlorine and ancillary equipment within the chlorine building
One set of safety equipment for the chlorination facility
Treated water flow meter
The installation is to comply with all the requirements of SANS 10298:2005. The details of the equipment required are given in the data sheets that form part of this specification. The equipment supplied shall form a complete working system and shall be suitable for integration with and efficient operation in combination with equipment to be supplied under other sections of this Contract as described elsewhere in this document.
This specification is to be read in conjunction with the Data Sheets that form part of this specification. All equipment described in this specification is to be provided unless specifically noted to the contrary in the Data Sheets.
Design
General arrangement and description
Chlorine in solution will be dosed into the treated water at the indicated dosing point. The chlorinator shall be of the wall mounted vacuum type, of simple and rugged design. Pressure reducing valves, indicators calibrated in kg/h, injector assembly and diffusers if applicable are to be part of the associated equipment to be supplied. The chlorinators are to automatically shut off in the event that the motive water is not supplied to the system. The chlorinators are to be provided with all necessary equipment for safe and efficient dosing.
Chlorine will be extracted from the chlorine storage drums located in the chlorine storage room. The drums are to be mounted on cradles with mass indicators. The chlorine supply drums are to be connected to a common manifold and be provided with manual isolating and inter-connecting functions. Automatic change over from one drum to the next is to commence once a drum empties during normal operation.
Treated water for motive water purposes will be provided at a point outside the chlorine house as indicated on the drawings. The Contractor shall be responsible for connecting to the terminal point of the pipe and providing the necessary filters and pressure reducing isolating and valves for effective control of feed water to the injector unit. Tenderers shall determine the quantity and pressure of motive water required.
Heaters shall be provided on the discharge pipe from each chlorine drum to eliminate liquid chlorine and frosting from occurring provided if required by the maximum dosing rate and ambient winter temperatures at the site.
Particular care shall be taken to obviate the possibility of leakage of chlorine gas under all possible conditions likely to be encountered during operation of the plant. All materials used in the manufacture of plant and pipe work shall be resistant to the corrosive action of chlorine either in gaseous or solution form. Any materials showing signs of corrosion during the maintenance period will be rejected and shall be replaced by the Contractor at his own expense with plant or material which is resistant to corrosion as shown by the retest, which remedial work shall continue until complete satisfaction is given to the Engineer.

Duties
Chlorine is required for disinfection of the treated water. The chlorinators shall be fed off chlorine drums, of which two will be connected at any one time. The chlorinators will be operated in a duty-standby arrangement. The required motive water shall be taken from the treated water system. Should higher pressures be required than the supplied motive water, tenderers are to include motive water pumps to meet the required pressure and duty.
The chlorinators shall have a turn down ratio as indicated in the Data Sheets. Automatic adjustment of the chlorine feed rate shall be provided in proportion to the treated water flow rate as measured by the flow meter if required by the Data Sheets. The flow measurement value will be in the form of a 4-20 mA signal and the dosage controlled by the PLC. As either the flow rate varies and/or the dosage rate is changed, the total flow rate of chlorine shall be set proportionally.
The local control panel shall provide analog output signals to indicate system pressure, weight of chlorine drums, and a digital alarm signal for unacceptable ambient chlorine levels.
Equipment Specifications

Chlorine storage support cradles and mass indication
Two support cradles are to be fabricated from mild steel with a mass measurement system integrated into the frame to measure the mass of the cylinders. Where load cells are specified in the Data Sheets these cells shall provide a 4-20 mA output converted to kilograms.

Chlorine drum crane
A hoist and trolley shall be provided, suitable for unloading, loading and moving the chlorine drums inside the chlorine building. It shall be suitable for a safe working load as indicated in the data sheets. It shall comply with the requirements of the Machinery and Occupational Safety Act No.6 of 1983, and those sections of the Factories Machinery and Building Works Act No. 22 of 1941 not repealed by Act No. 6 of 1983.
The crane shall be designed in accordance with the latest editions of BS 466 and BS 2573: Part 1. Refer to the standard specification for lifting equipment.
Where an electrically driven hoist is specified in the Data Sheets, it shall be operated from pendant-type controls, hanging no higher than 1200 mm from the floor of the building. The crane shall be marked with its safe working load clearly legible from floor level.
Pipe work, valves and fittings
The construction of all chlorine pipelines shall be in accordance with the general requirements for gases under pressure and shall comply with the Occupational Health and Safety Act (OHS Act), 1993 (Act No. 85 of 1993) and the Mines and Works Act, 1956 (Act No. 27 of 1956). All pipe work, valves and fittings are to be suitable for a chlorine environment and be rated 1.5 times the maximum allowable pressure in the system. Chlorine solution and motive water pipe work shall be uPVC pressure piping and comply with SABS 966 and be Class 16. All isolation valves shall be of the quarter turn ball valve type. Valves connecting the flexible connectors to the drums shall be needle valves.
Chlorinator
The chlorine metering system will operate under vacuum produced by an injector on the feed water supply system. The injector shall dispense the chlorine solution into the water at the dose point. The equipment shall be such that no chlorine gas is discharged into the atmosphere. The chlorinator shall shut off automatically when the feed water supply stops.
The chlorinator shall comply with the following:
The cabinets shall be manufactured from fibreglass or other material not subject to corrosive attack by chlorine gas and shall be floor mounted.
The cabinet cover shall be removable, giving clear access to all components inside the chlorinator.
All controls shall be eye level.
The unit shall be equipped with glass flow metering tube graduated in kg/hr. The flow of gas through the tube shall be infinitely adjustable by manually setting the flow control valve to the desired flow rate.
The unit shall be fitted with gauges to indicate the gas inlet pressure to the pressure regulator, the injector vacuum and the motive water pressure.
All gas and solution piping, valves and the like to connect the various items of equipment and convey the solution to the point of application including feed water piping and fittings shall be provided.
The equipment supplied shall be capable of automatic adjustment in accordance with flow to be dosed as indicated by a 4 to 20 mA signal from the flow meter or control system.
The following accessories are to be supplied with the chlorinator:
One spare metering tube for the applicable range;
50 mm dial pressure gauge and gauge cock;
Moisture trap/filter assembly;
Gas piping manifold for connection of chlorinators to two standard drums;
Chlorine solution piping to dosing point including diffuser if required;
Wall-mounted chlorine cylinder instruction chart, mounted in wood/glass frame;
Wall-mounted plastic engraved warning board.
Injector feed water and dosing pipe work
The chlorinators shall obtain motive water for the injector feed from the treated water provided at the site. The motive water provided may contain small amounts of suspended solids and an in-line Y-

strainer shall be provided between the motive water take off point and the chlorine dosing plant. Chlorine solution shall be dosed into the water at the dosing point shown on the drawings. The Limit Of Contract for the pipe work from the chlorine building to the chlorine dosing point will be as shown on the drawings. The Contractor shall connect to this pipe immediately upstream of the dosing point. Where required by the installation the Contractor shall provide the diffuser pipe work at the injection point.
The motive water installation shall be complete including all isolating valves and fittings and shall terminate as shown on the drawings.
Automatic Change over Panel
The automatic change over panel shall automatically change over from the duty to the standby bank of drums when the pressure in the duty bank drops to a preset pressure. Change over shall occur in such a manner as to prevent backflow of chlorine. The change over panel shall provide a clear indication as to which bank of drums is in service and that change over has occurred and the information shall be indicated on the HMI linked to the existing SCADA where specified in the Data Sheets.
Safety equipment
A Drager or equally approved full face gas mask and respirator, suitable for operation with chlorine gas, with two replacement canisters, two pairs of gloves and one drum isolating valve repair kit shall be provided in a waterproof casing mounted on the outside wall of the chlorine building at the entrance to the building.
A chlorine leak detector shall be mounted in the chlorine drum room complete with sampling fan, gas indicator and audio-visual alarm. The apparatus shall measure the concentration of chlorine in the atmosphere at a level of 300 mm above floor level. The concentration of chlorine in the atmosphere shall be indicated on a digital readout mounted in the chlorinator room and at the HMI. An alarm shall be indicated both locally in the equipment room and at the panel HMI when the concentration of chlorine in the atmosphere exceeds a preset concentration.
A combination safety shower/eyewash shall be provided located at a position of not more than 15 m from the chlorine building. The facility shall comply with the U.S. ANSI Standard Z358.1-2009 for emergency eyewash and shower equipment. The shower shall utilise potable water and comply with the following primary requirements:
The emergency shower shall deliver a pattern of water with a diameter of at least 50 cm at 150 cm from the shower head.
The shower head shall be located between 200 and 240 cm from the floor. The minimum volume of spray should be 75 litres/minute for a minimum time of 15 minutes.
The shower shall be able to be activated in less than 1 second and remain operational without the operator's hand on the valve. The valve should not be more than 170 cm above floor level.
The eyewash shall deliver fluid to both eyes simultaneously at a flow of not less than 1.5 litres/minute for 15 minutes.
The eyewash shall be located between 85 and 115 cm from the floor and a minimum of 15 cm from the wall or nearest obstruction.
Signage
An instruction chart in the languages listed in the Data Sheets is to be supplied by the contractor which gives clear instructions as to the operation and maintenance of the chlorine equipment, chlorine drums, change-over procedure, gas leakage and detection along with all safety and first aid measures. An instruction sign board with pictures is to be included along with the instruction board in the stated languages. The instruction charts shall be mounted on the wall of the chlorine building.
The applicable National Occupational Safety Association (NOSA) and emergency procedures as well as the South African Chlor-Alkali Manufacturer’s Association (SACAMA) wall charts shall be appropriately displayed. The following signage shall also be provided:
Symbolic safety chart (2 No) mounted at the entrance to the cylinder and equipment rooms indicating the following:
No unauthorised entry
Warning: Poisonous substance hazard
Mandatory: eye protection, face protection, respiratory protection, hand protection, foot protection
Information: Direction to safety shower and eyewash

A works instruction chart with basic instructions on the use of the system.
An emergency plan chart available from Polyfin
The wall charts shall be weather resistant, non-fade and durable.
Scrubber System
A scrubber system shall be provided and shall comprise of one or two caustic gas scrubbers with sufficient capacity to deal with the leakage of one chlorine drum without recharge. It shall be provided with sampling points to draw caustic samples for monitoring purposes.
The gas extraction system and piping shall be suitable for the intended duty and shall have sufficient capacity to recycle the chlorine laden air from the drum store through the gas scrubber vent.
The invert of the suction piping shall be located approximately 300 mm above the drum room floor with evenly spaced drop pipes just above floor level. The diameter of the drop pipes shall be suitably sized to ensure and even draw from each drop pipe.
The equipment supplied shall include:
The gas scrubbers
All suction piping to draw from the chlorine drum store
Delivery piping from the extraction blower to the scrubber and from the scrubber to the chlorine drum store
The extraction blower or fan regardless of whether a scrubber is required shall be provided. Extraction fans are required on the chlorine storage and operations room. The extraction system shall be designed to exchange the air in the room in less than four minutes.
Control Philosophy
Control automation where required shall be in accordance with the specifications given in the sub-sections below.
Setting of dose rate using the readout of residual chlorine and rate of flow
The total residual chlorine concentration measured by the instruments supplied under the contract shall be used to control chlorine dosing. If the residual chlorine deviates from a preset band, the system shall adjust the dose rate.
The treated water flow rate shall be measured by means of a flow meter to be installed under the contract. In order to maintain process stability, each adjustment of the chlorine dose rate shall take place after a time period allowing for the retention time in the system.
Setting of dose rate using the readout of rate of flow
Provision shall be made to enable the operator to set the “base” dose rate at the control panel. The rate of chlorine dosing shall be adjusted automatically in accordance with the change of flow rate as measured by the flow meter, and the preset “base” dose. An alarm shall be provided if the chlorine residual deviates from the preset band.
Mass indication
The mass of chlorine in the duty and standby banks shall be indicated on the HMI.
Chlorine leak detection, extraction fan and gas scrubber
The level of chlorine gas as indicated by the leak detector shall be indicated at the HMI.
When the concentration of chlorine gas in the drum store exceeds a preset level:
An alarm shall be indicated at the panel and an indicator light shall illuminate at the entrance to the chlorine building and shall remain lit until the concentration drops to a preset low level.
The chlorine motive water pumps shall stop and chlorination shall cease.
The gas scrubber shall switch on and continue to operate until the chlorine concentration in the chlorine drum store drops to a preset low level.
Fasteners
All fasteners are to be suitable for their application in a highly corrosive chlorine environment according to the General Specification. Holding down bolts are to be provided by the contractor.
Electrical installation and instrumentation
The local control panel is to receive the power feeder for the chlorination equipment as well as the flow measurement signal for flow proportional dosing. The local control panel is to interface with the rest of the plant. The local control panel is to communicate to the control room the pressure in the chlorine system, weight of the chlorine drums and the level of ambient chlorine in the chlorine room.
The main electrical contractor is to supply the power to the local control panel. All electrical cabling for

supply of power to the chlorination equipment in the chlorine room is to be supplied under this contract.
Switches to activate the extraction fans and lighting shall be located externally near the door. All lights, plugs motors and other electrical fixtures inside the chlorine building shall be corrosion proof in compliance with IP65 to prevent deterioration from chlorine gas.

Motors
All motors shall have IP55 protection, anti-condensation heaters and be wired for direct online starting.
Corrosion protection
Corrosion protection shall be carried out in accordance to the standard specification for corrosion protection. Before final fasteners, the final coat of polyurethane enamel is to be applied to all pipe work after installation. The colour coding is to be advised by the engineer.
TESTING AND COMMISSIONING
Operator training
During the testing and commissioning procedure, the Contractor shall train the operators in the operation and maintenance of the equipment. Prior to the commencement of operator training, a draft copy of the Operating and Maintenance Manual shall be available on site. On completion of commissioning, the manual shall be updated in the light of experience gained during the commissioning of the plant and the final copies shall be submitted.
Training shall cover the following aspects:
The operation of all items of equipment
Maintenance of the equipment
Training in safety and emergency procedures
Fault finding on the equipment
Training in the operation and maintenance of all items of safety equipment
Tests on completion
As a minimum, the following shall be undertaken before commissioning:
Cleaning and drying of the system
Air or nitrogen pressure test to 1,5 times the maximum design pressure.
Commissioning
All equipment shall be tested to demonstrate its compliance with the specification and the details contained in the Data Sheets. The chlorinators shall be tested throughout the dose range. All instruments shall be correctly calibrated and the repeatability demonstrated. Performance tests of the equipment shall be performed over an 8 hour shift and as a minimum the following shall be undertaken.
Measurement of chlorine dosage rate in response to flow signals and dosage settings.
Measurement of vacuum induced by chlorine injection unit.
Measurement of power absorbed.
The equipment will be considered acceptable if the measured values do not deviate from those stated in the Data Sheets by more than 5% and when:
The tests above prove the acceptable operation of the equipment.
No chlorine leaks are shown in the delivery pipe work at a pressure of 12 bar.
During the Defects Liability Period
Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.
5. Spares and Accessories
A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be provided according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.
As a minimum the following equipment shall be provided:
One spare flow rate meter for each machine
One spare flexible tank connection for each machine
Three sets of all special gaskets to fit all joints and unions
One set of clamps for all hose connections

One residual-chlorine comparator employing permanent colour standards or equal approved
Two emergency repair kit for chlorine tanks
One set of all special tools required for adjustment, operation, maintenance and disassembly. All tools shall be high-grade, smooth
A grease gun or lubricating device for each type of grease required
Wall mounted steel tool box complete with flat key locks, two keys and tool clips. Tools are to be high-grade smooth forged alloy tool steel.
One 120 ml bottle of ammonia
Measurement and Payment
Design and supply
The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.
The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit
Installation and commissioning
The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.
The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.
Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

This specification covers the design, supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of:

Chlorinators complete with ancillary equipment and pipework within the chlorine building;
Manifold for chlorinators for 1 tonne chlorine cylinders including feed pipe work;

SERIES M20 LIFTING EQUIPMENT

SECTION M20001: OVERHEAD TRAVELLING CRANES

TABLES OF CONTENTS

SERIES M20 LIFTING EQUIPMENT

SECTION M20001: OVERHEAD TRAVELLING CRANES

SCOPE

This specification covers the design, supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of overhead travelling cranes.

DESIGN SPECIFICATION

General

The Tenderer shall inspect the drawings to determine what steps need to be taken for installation of the crane and shall plan work on Site accordingly. Design requirements for installation of the crane rails shall be provided by the Contractor.

Construction of the crane shall be in accordance with ISO 16880, SANS 10160, SANS 10162 and SANS 1431.

Overhead travelling cranes

The Contractor may use a crane during the installation of other equipment on condition that all testing and certification for the complete lifting installation, including supporting structure, has been successfully completed.

The hoist shall be supported on and travel along a fabricated steel crane beam structure. The crane beam shall be supported on and travel along crane rails. The rails shall be supported along their full length, either on a concrete ring beam or on additional hot-dip galvanised steel beams.

The Contractor's proposed method of fixing the crane rails shall be submitted to the Engineer for approval.

The crane's safe working load rating shall be stated in the tender submission.

The crane long travel, cross travel and hoist shall be electrically-powered or manually operated as stated in the Technical Data Sheets.

The crane duty shall be stated in the Technical Data Sheets.

Unless otherwise stated, the lowest hook level shall be room floor level and all operating chains shall fall to one metre above this level.

All materials shall be new and unused and suited to the application. Structural steelwork shall comply with the requirements of SANS 1431 and the grade used for structural members shall be 350 W.

Site welding will not be acceptable. All welding shall be continuous unless otherwise approved in writing by the Engineer. No crevices will be permitted. All welding slag and weld spatter shall be removed and welds shall be ground smooth prior to coating. All welds shall be free of blowholes. Sharp edges resulting from cutting operations shall be rounded to a radius of at least 3 mm and open pockets which are inaccessible for preparation and coating will not be permitted.

The crane beam and end carriages shall be designed with suitable dimensions, wheel spacing and gusset plates or diagonal bracing to prevent cross-whipping.

End stops with rubber buffers shall be fitted to prevent the hoist from moving off the travelling beam and to limit the long travel along the rails.

Lubrication systems shall be designed to exclude dirt and moisture and all gear wheels shall be fully enclosed.

Bearings shall be mounted in properly sealed plummer blocks or in totally enclosed and sealed housings, grease-lubricated and provided with grease nipples in both cases. The open type bearing units with exposed "lubricated for life" bearings will not be acceptable.

The safe working load shall be permanently marked on the crane hook and on both sides of the girder.

The hoist, if powered, shall comply in all applicable respects with the Occupational Health and Safety Act.

An overload prevention device, such as a clutch which slips upon overloading, shall be incorporated. The bottom hook shall swivel on a ball or roller bearing through 360º and shall be fitted with a safety latch. The bearing shall have a protective skirt.

Lifting chain is preferred, but corrosion protected steel wire rope is acceptable for higher loads.

A chain box for the unloaded length of lifting chain shall be provided.

The crane rails shall be supported on and secured to the concrete or steel gantry beams and shall be installed true to span, level, aligned, and shall be straight to within the permissible deviations given in ISO 16880 over their entire length. The crane rails shall be made from standard rail sections. Rails manufactured from square section steel bar will not be acceptable. Rails shall be joined using fish-plates, with at least four fasteners, to provide a continuous path for the travel of the crane wheels. The rails shall be hot-dip galvanized after all fabrication work.

The distance between rail supports shall not exceed 1 000 mm and supports shall be anchored using grade 316 stainless steel bolts.

Where specified, a personnel platform for two people shall be provided on the crane structure. The platform shall be bolted to the crane beam structure and shall be removable. The steel sections which form the crane beam shall be provided with welded lugs to which the platform shall be bolted. The complete platform and all guard-railing shall be hot-dip galvanised after fabrication. The platform itself shall be designed so that a person standing on it will be able to replace the electric lamps. A hot-dip galvanised steel ladder shall be provided for accessing the platform. The platform floor shall have a minimum width of 500 mm.

Hoists

Hoists shall be provided with a slipping clutch, or equivalent, which shall ensure that it is not possible to overload the hoist.

Powered hoists shall hold the load upon power failure; i.e. shall feature fail-to-safe braking.

Fasteners

Crane rail anchor bolts shall be M16 or larger and shall be of grade 316 stainless steel. Fasteners smaller than 12 mm shall be of 316 stainless steel. All other fasteners, including high-tensile fasteners, shall be of stainless steel or shall be hot-dip galvanized.

Before assembly, the threads of all bolts and studs shall be coated with an approved nickel-based, anti-seize corrosion protection compound.

MATERIALS OF CONSTRUCTION

Corrosion protection

The crane beam and end carriages shall be zinc-sprayed and sealed in accordance with the below systems. Smaller items, such as cable brackets and protective covers, shall be hot-dip galvanized accordingly.

System	Details	Item
System C/2	Zinc sprayed	Crane beam
System – hot Dipped Galvanised	HDG	Smaller items

Where the Tenderer prefers to offer corrosion protection systems other than those specified, these may be offered as an alternative with full details of such recommended systems. The Council reserves the right to reject such offers if considered inadequate by the Engineer.

The Contractor shall arrange for the crane to be inspected by the Engineer at the fabricator's premises prior to preparation for corrosion protection.

The crane final colour shall be Golden Yellow, B49.

The inspection of corrosion protection systems shall be done in accordance with the Standard Specification for Corrosion Protection.

Installation

The crane and rails, when erected and installed, shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.
In the alignment of equipment or structures, the use of multiple shims will not be permitted. All shimmed feet shall be neatly grouted to provide corrosion protection.

The full length of the rails shall be grouted in cases in which the rails rest on a concrete ring beam. A suitable gap between the rails and the beam shall be provided for application of the grout. The grout shall be applied strictly in accordance with the manufacturer's instructions. The grout shall be neatly finished with a 45º chamfer. The Engineer shall be notified prior to application of the grout.

Grouting shall be done using a non-shrink cementitious grout, ABE Duragrout 1000 or equivalent, to the approval of the Engineer and in accordance with the manufacturing instructions.

TESTING AND COMMISSIONING

All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

Works testing of the individual assembled items of equipment shall be undertaken at the manufacturer's premises to demonstrate the effective operation of the crane.

Before being put into use the crane shall be load tested in position by the Contractor to 1.25 times the maximum safe working load and the Contractor shall arrange for this test to be witnessed by the Engineer. The Contractor shall then supply a test certificate once the crane passes the load test.

Performance testing shall be carried over a single 8 hour shift and shall consist of the following:

Measurement of power absorbed by all motors; and
The vibration measured at each point does not exceed the level prescribed in ISO 10816.

The equipment will be considered acceptable when:

The Contractor supplies the Engineer with a certificate from the manufacturer which:

Certifies that the crane has been manufactured in accordance with the requirements of the Occupational Health and Safety Act;

Specifies the design standards used;

States the safe working load and the test load, and;

This certificate shall be provided to the Engineer prior to delivery of the crane to Site.

Where a power test is required, the power absorbed by each motor at duty point does not exceed the values stated in the Technical Data Sheets;
The equipment meets the duty requirements as defined in this section of the Specification; and
Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in ISO 10816, as given in the General Specification for the appropriate class of machine.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.
SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

MEASUREMENT AND PAYMENT

Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M20 LIFTING EQUIPMENT

SECTION M20002: CHAIN BLOCKS AND CRAWL BEAMS

TABLE OF CONTENTS

SERIES M20 LIFTING EQUIPMENT

SECTION M20002: CHAIN BLOCKS AND CRAWL BEAMS

SCOPE

This specification covers the supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period for chain blocks and crawl beams.

DESIGN SPECIFICATION

Chain blocks

The chain block casing is to be fabricated from cast iron or high strength grade alloy steel with hot dipped galvanised finish and painted to System E/4. The chains are to be high strength alloy steel and hot dipped galvanised for corrosion protection. A slipping clutch, or equivalent, is to be fitted to ensure that it is not possible to overload the chain block. A trolley, along with all ancillary equipment, is to be provided with the chain block for operation on the crawl beam.

The safe working load (SWL) is to be clearly displayed on either side of the casing of the chain block.

Crawl beams

Crawl beams shall be fastened to hot-dip galvanised steel support structures using hot-dip galvanised fasteners and it shall be noted that high-tensile, hot-dip galvanised fasteners are available in South Africa.

Crawl beams shall be anchored to concrete using grade 316L anchor bolts. The anchor bolts shall, preferably, be through-bolted. If chemical anchor is used, every anchor shall be load-tested prior to installation of the beam. A nickel-based anti-seize compound shall be applied to bolt threads prior to fastening of the nut and galled fasteners shall be removed and replaced.

Stoppers must be fitted to the open end of the crawl beams so the crawl cannot derail.

The permissible allowable payload must be painted onto the beam.

The safe working load (SWL) of the crawl beam is to be clearly displayed.

MATERIALS OF CONSTRUCTION

Corrosion protection

The corrosion protection of the chain blocks are to be as specified by the supplier.

Crawl beams shall be hot-dip galvanised after all fabrication. If the beam is drilled or welded or the zinc coating is damaged by any other fabrication technique, the complete beam shall have the zinc removed by abrasive blasting and it shall be returned to the galvanisers for hot-dip galvanising. Repair using cold-applied zinc products will not be acceptable. Final painting of the crawl beam shall be to System E/4.

TESTING AND COMMISSIONING

All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

Before being put into use, the crawl beam and chain block shall be load tested by the Contractor to 1.25 times the maximum safe working load and the Contractor shall arrange for this test to be witnessed by the Engineer. The Contractor shall then supply a test certificate once the crane passes the load test.

Performance testing shall be carried over a single 8 hour shift and shall consist of the following:

The requirements stated in the Technical Datasheets

The equipment will be considered acceptable when:

The crawl beam and chain block passes the load tests.

The Contractor supplies the Engineer with a certificate from the manufacturer which:

Certifies that the crane has been manufactured in accordance with the requirements of the Occupational Health and Safety Act;

Specifies the design standards used;

States the safe working load and the test load, and;

The equipment meets the duty requirements as defined in this section of the Specification.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

PAYMENT AND MEASUREMENT

Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M20 LIFTING EQUIPMENT

SECTION M20003: DAVITS AND WINCHES

TABLES OF CONTENTS

SERIES M20 LIFTING EQUIPMENT

SECTION M20003: DAVITS AND WINCHES

SCOPE

This specification covers the design, supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of davits and winches.

DESIGN SPECIFICATIONS

Davits

Davits shall be column mounted with swivelling booms and designed to suit the application. The arrangement shall permit easy and safe lifting of the load to a convenient height not less than 500 mm clear of ground level or high enough to permit the load to be swung clear of any obstruction through an angle of at least 180o.

The davit shall be designed for a maximum safe working load at least 50 % above the calculated actual load requirements. The maximum stress permitted in any component at the design load shall be the lesser of:

One quarter the ultimate tensile stress for the material; and
One half the yield stress or 0,2% proof stress of the material (as applicable).

The contractor's design calculations shall be submitted to the Engineer for inspection before manufacture may proceed.

Where a portable davit is specified, the construction shall be as light as possible while still complying with the above. Shall be collapsible to make it easy to carry, and be easily removed from or remounted on permanent fittings which shall be provided in the various positions where the davit is to be used.

Each davit shall be provided with a winch rigidly fixed to the davit at a convenient height and position. When portable davits are to be used for lifting submerged or otherwise inaccessible equipment the required length of rope shall be provided for each item of equipment, with the bottom end attached to the equipment (load) and, during normal operation, with the upper end detached from the winch, neatly coiled and tied in a convenient position. A protection system shall be provided which will prevent the rope from being dropped and lost when being attached to or detached from the winch.

Guide pulleys to suit the arrangement shall be provided. These pulleys shall be machined with a groove having a radius 5 to 7,5% greater than the rope radius and with a flare angle of 52o. The pulley sheaves shall have a diameter at the bottom of the groove of not less than 25 times the wire rope diameter. The groove depth shall be twice the rope diameter or greater.

Operating cross bars, locking arrangements, fixing arrangements, etc., shall not represent a hazard to passers by in any way. If necessary, operating levers shall be hinged so that they can be swung out of the way when not in use.

2.2 Winches

Hand cranked winches shall be rated for a safe working load at least 100 % in excess of the calculated load. All gears, clutches, etc., shall be enclosed in a robust cast iron or cast steel casing which shall be grease filled and sealed against ingress of dirt and moisture. The winch shall be

designed to hold the load stationary when the hand crank is released during raising or lowering. In addition, a locking arrangement to lock the position of the load shall be provided.

The force required to operate the winch at its maximum rated load shall not exceed 100 N.

The radius at which the handle operates shall preferably be adjustable. A double handled crank or two opposing cranks shall be provided when necessary to ensure easy operation in all positions possible with the mounting arrangement provided.

MATERIALS OF CONSTRUCTION

Davits

The davit shall be manufactured from mild steel, be hot-dip galvanised and painted to System E/4 when not in use near water but shall be fabricated from 304L or 316L stainless steel when in use near water. All fasteners, pins, shafts, shackles, hooks, etc., shall be of 316L stainless steel. Guide pulleys and shafts shall be made of 316L stainless steel or other approved corrosion resistant material, and use suitable non-metallic bearings which do not need to be lubricated.

The swivelling arrangement shall be properly designed for easy operation, shall be accurately fitted and shall not be subject to corrosion problems. Bushes made of nylon, "Vesconite" or other suitable non-metallic material shall be used and any metallic rubbing mating face shall be of 316 stainless steel.

Winches

The wire rope and all attachments shall be of 316 stainless steel with a safety factor of at least 6. The wire rope shall be long enough to reach the lowest required position with at least 3 turns left on the drum. The drum size shall easily store the full rope length. The inside diameter of the drum shall suit the rope diameter in accordance with good engineering practice approved by the wire rope manufacturer.

The maximum safe working load shall be clearly and permanently marked on the winch. The drum support brackets, all exposed fasteners, shafts, handles, pins, etc., shall be 316 stainless steel and the casing shall be hot-dip galvanized or zinc-sprayed (to a thickness of 150 µm) and then painted System E/4.

TESTING AND COMMISSIONING

Performance testing will be carried out on the equipment.

The safe working load shall be clearly and permanently marked on the davit jib, winches and shackles. Before being put into use each davit assembly shall be load tested in position by the Contractor to 1.1 times the maximum safe working load and the Contractor shall arrange for this test to be witnessed by the Engineer. All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The Contractor shall then supply a test certificate once the davit passes the load test.

The tests will be performed on the equipment over a single 8 hour shift.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

MEASUREMENT AND PAYMENT

Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

PART C: ELECTRICAL WORKS

PS2: STANDARD SPECIFICATION FOR ELECTRICAL WORK

CONTENTS

GENERAL REQUIREMENTS:

E241 LOW VOLTAGE ELECTRIC MOTORS 401

E200.1 SCOPE OF WORK

The scope of work for the electrical portion of the Works is set out in the Project Specification*** and associated drawings and schedules.

This Standard Specification shall be read in conjunction with the Project Specification where referenced in the Project Specification***. In the event of conflict the Project Specification shall take precedence over this Standard Specification.

E200.2 ELECTRICITY SUPPLY

2.1 The electricity supply will be made available by the Supply Authority as described in the Project Specification, and the Contractor shall ensure that the completed Works complies with the Supply Authority's requirements regarding voltage, current and quality of supply limits, and with any other requirements which may be imposed by the Supply Authority.

2.2 The electrical characteristics of the electricity supply will be as specified in the Project Specification***.

2.3 Where specified in the Project Specification***, the Contractor shall make application for the electricity supply, liaise with the Supply Authority to plan and coordinate work, liaise with the Supply Authority regarding protection settings, and attend technical meetings and provide inputs for the planning of switching operations.

E200.3 GENERAL

3.1 Standard Specification

This Standard Specification specifies the detail requirements for plant, and the standard of workmanship and quality of materials, for the electrical portion of the Works as varied by the Project Specification.

Where this Standard Specification and the Project Specification refer to "relevant codes and specifications", it shall be taken to refer to those listed in the table contained in Clause E200.5 and the normative references listed in SANS 10142, as applicable.

The use of the triple asterisk "***" after the words “Project Specification” is intended as a prompt for the Specifier only, and does not infer an intention to cross-referencing.

3.2 Definitions

3.2.1 "Extra low voltage" shall mean voltages of 50 V or less.

3.2.2 "Low voltage" shall mean voltages not exceeding 1 000 V.

3.2.3 "Medium voltage" shall mean voltages exceeding 1 000 V.

3.2.4 "Supply" shall mean manufacture, procure, store off site as necessary, deliver to site, and off-load, position, stack and store on site as necessary.

3.2.5 "Install" shall mean set out, erect, mount, align, fix, connect, adjust, test and commission and hand over in proper working order.

3.2.6 "Provide" shall mean supply and install.

3.2.7 "Installation" shall mean the electrical installation covered by this document.

3.2.8 "Approved" shall mean acceptable to the Employer in the sole opinion of the Engineer.

E200.4 COMPLIANCE WITH REGULATIONS AND STANDARDS

4.1 The electrical installation shall comply with the latest revisions and amendments of the following:

4.1.1 The South African Bureau of Standards Code of Practice for the Wiring of Premises, SANS 10142, referred to herein as the "Wiring Code".

4.1.2 The Occupational Health and Safety Act and Regulations (Act No 85 of 1993) in its entirety.

4.1.3 The Municipal By-laws and Regulations and any regulations of the electrical supply authority.

4.1.4 The Local Fire Office regulations.

4.1.5 Regulations of Telkom.

4.1.6 The relevant codes and specifications as defined under Clause E200.3.

4.1.7 The regulations of the local gas supplier where applicable.

4.1.8 The standard regulations of any Government Department or other statutory body where applicable.

4.2 No claims for extra costs arising from failure of the Contractor to comply with any of the regulations and standards listed above will be considered.

4.3 Where conflict appears to exist between any of the regulations and standards listed above and the Specification, such conflict shall be referred to the Engineer in writing for his ruling.

4.4 Immediately after award of the Contract, and at any time thereafter as may be necessary, the Contractor shall notify all relevant authorities, pay fees and take any other steps which may be required or prescribed to execute the Works.

The Contractor shall copy related correspondence to the Engineer who shall be kept informed at all times. This shall not, however, release the Contractor of his responsibilities.

E200.5 STANDARD SPECIFICATIONS

All the equipment and materials shall conform to the relevant SANS, NRS, or IEC Specifications and the latest revisions thereof, where applicable. For equipment and materials not covered by the following table, reference shall be made to the list of normative references in SANS 10142.

DESCRIPTION		SANS	IEC	NRS
1.	SWITCHGEAR AND CONTROL GEAR			
1.1	HV switches for rated voltages above 1 kV and less than 52 kV	60265-1		
1.2	A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV	62271-200		
1.3	HV a.c. switch-fuse combinations	62271-105		
1.4	HV a.c. contactors and contactor-based motor starters	60470		
1.5	Common specifications for HV switchgear and controlgear standards	60694		
1.6	A.C. insulation-enclosed switchgear and control-gear for rated voltages above 1 kV and up to and including 52 kV	62271-201		
1.7	Metal-enclosed switchgear for rated a.c. voltages above 11 kV and up to and including 36 kV	1885		
1.8	HV a.c. circuit breakers	62271-100		
1.9	Metal-clad switchgear for rated voltages above 11 kV and up to and including 24 kV - Part 2 : Standardized panels			003-2
1.10	Moulded-case circuit breakers	156		
1.11	LV switchgear and controlgear assemblies - Part 1 : Type-tested and partially type-tested assemblies above 10 kA	1973-1 60439-1		
1.12	LV switchgear and controlgear assemblies - Part 2 : Busbar trunking systems	60439-2		
1.13	LV switchgear and controlgear assemblies – Part 3 : Type-tested and partially type-tested assemblies up to and including 10 kA	1973-3		
1.14	LV switchgear and controlgear assemblies – Part 8 : Safety of MTAs above 10 kA	1973-8		
1.15	LV switchgear and controlgear assemblies - Part 5 : Particular requirements for assemblies intended to be installed outdoors in public places - cable distribution cabinets	60439-5		
1.16	LV switchgear and controlgear - Part 2 : Circuit breakers	60947-2		
1.17	LV switchgear and controlgear - Part 3 : Switches, disconnectors, switch-disconnectors and fuse-combination units	60947-3		
1.18	LV switchgear and controlgear -			

DESCRIPTION		SANS	IEC	NRS
	Part 4 - 1 : Contactors and motor starters (electro-mechanical) Part 4 - 2 : Contactors and motor starters (semi-conductor)	60947-4-1 60947-4-2		
	Part 5-1 : Electromechanical control circuit devices	60947-5-1		
	Part 5 - 2 : Proximity switches	60947-5-2		
	Part 5 - 5 : Electrical emergency stop device with mechanical latching function	60947-5-5		
	Part 6 - 1 : Automatic transfer switching equipment	60947-6-1		
1.19	Earth-leakage protection units - Part 1 : Fixed earth-leakage protection circuit breakers	767-1		
1.20	RCCBs without integral overcurrent protection for household and similar use - Part 1 : General rules	61008-1		
1.21	Switches for appliances - Part 1 : General requirements	61058-1		
1.22	AC disconnectors and earthing switches above 1 kV	62771-102		
1.23	Busbars	1195		
1.24	Metal-enclosed ring main units for ac voltages 1 kV to 24 kV	1874		
2.	TRANSFORMERS AND MINISUBS			
2.1	Power transformers	60076		
2.2	Dry-type power transformers		60726	
2.3	Distribution transformers	780		
2.4	Semiconductor converters - Part 1 - 3 : General requirements and line commutated convertors - Transformers and reactors	60146-1-3		
2.5	Convertor transformers - Part 1 : Transformers for industrial applications	61378-1		
2.6	Safety of power transformers, power supply units and similar - Part 2 - 4 : Particular requirements for isolating transformers in general use	61558-2-4		
	Part 2 - 6 : Particular requirements for safety isolating transformers in general use	61558-2-6		
	Part 2 - 15 : Particular requirements for isolating transformers for the supply of medical locations	61558-2-15		
2.7	Miniature substations	1029		
3.	CABLES			

DESCRIPTION		SANS	IEC	NRS
3.1	The selection, handling and installation of electric power cables of rating not exceeding 33 kV (Parts 1 to 14)	10198		
3.2	Impregnated paper-insulated metal-sheathed cables for rated voltages 3,3 kV to 33 kV	97		
3.3	XLPE-insulated cables for voltages from 6,6 kV to 33 kV	1339		
3.4	Paper-insulated metal-sheathed cables for voltages up to 18/30 kV			
	- Part 1 : Test on cables and their accessories		6055-1	
	- Part 2 : General construction requirements		6055-2	
3.5	Electric cables with extruded solid dielectric insulation for fixed installations (300 / 500 V to 1900 / 3300 V)	1507		
3.6	Flexible electric cables for use in mines			
	- Part 1 : LV (640/1100 V and 1900 / 3300 V)	1520-1		
	- Part 2 : HV (6,6 kV to 33 kV)	1520-2		
3.7	Flexible cords and cables	1574		
3.8	Materials of insulated electric cables and flexible chords (Parts 1 to 7)	1411		
3.9	Mechanical cable glands	1213		
3.10	Single core arc welding cable	1576		
3.11	Lugs and ferrules for insulated electric cables - Part 1 : copper conductors	1803-1		
3.12	Power cables with extruded insulation and their accessories from 1 kV to 30 kV - Part 4 : Test requirements on accessories	60502-4		
3.13	Accessories for MV power cables			053
4.	CURRENT AND VOLTAGE TRANSFORMERS			
4.1	Instrument transformers			
	- Part 1 : Current transformers	60044-1		
	- Part 2 : Inductive voltage transformers	60044-2		
	- Part 3 : Combined transformers	60044-3		

DESCRIPTION		SANS	IEC	NRS
	- Part 5 : Capacitive voltage transformers	60044-5		
5.	EARTHING AND LIGHTNING / SURGE PROTECTION			
5.1	Earth rods and couplers	1063		
5.2	Design and installation of an earth electrode	10199		
5.3	Neutral earthing in MV industrial power systems	10200		
5.4	Protection of structures against lightning	10313		
5.5	Protection against lightning			
	- Part 1 : General principles	62305-1		
	- Part 2 : Risk management	62305-2		
	- Part 3 : Physical damage to structures and life hazard	62305-3		
	- Part 4 : Electrical and electronic systems within structures	62305-4		
5.6	Surge protective devices connected to LV power distribution systems - Part 1 : Performance requirements and testing methods	61643-1		
5.7	Surge arrestors - Part 1 : Non-linear resistor type gapped surge arrestors for a.c. systems	60099-1		
5.8	Surge arrestors - Part 4 : Metal-oxide surge arrestors without gaps for a.c. systems	60099-4		
6.	METERS, INSTRUMENTS AND RELAYS			
6.1	Meter cabinets	60439-5		
6.2	Electrical instruments and meters		60051	
6.3	A.C. electromechanical watt-hour meters	62052-11		
6.4	Electrical relays - Part 3 : Single input energizing quantity measuring relays with dependent or independent time		60255-3	
6.5	Electrical relays - Part 20 : Protection systems		60255-6	
6.6	Watt-hour meters - A.C. electronic meters for active energy	1799		
6.7	Electricity metering equipment – static meters	62053-21 to 23		
7.	CAPACITORS			

DESCRIPTION	SANS	IEC	NRS
7.1 Shunt capacitors for a.c. power systems having a rated voltage above 1000 V			
- Part 1 : General - Performance, testing and rating - safety requirements - Guide for installation and operation		60871-1	
- Part 2 : Endurance testing		60871-2	
- Part 3 : Protection of shunt capacitors and shunt capacitor banks		60871-3	
- Part 4 : Internal fuses		60871-4	
7.2 Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1000 V			
- Part 1 : General - Performance, testing and rating - Safety requirements - Guide for installation and operation		60831-1	

E200.6 BUILDER'S WORK

6.1 Building and Casting-In

The Contractor shall be responsible for placing in position all wireways, conduits, conduit boxes, etc., for the building contractor to build in/cast in, provide attendance to the building contractor during building-in/casting-in, and ensure firm fixings acceptable to the building contractor and accurate positioning.

6.2 Chasing

6.2.1 The Contractor shall chase only where it is impossible to build in/cast in.

6.2.2 No face-brick or finished surface may be chased without the permission of the Engineer and the building contractor.

6.2.3 No structural concrete may be chased without the permission of the Engineer and the building contractor.

6.2.4 The building contractor will make good all chases and openings in building work.

6.2.5 The Contractor will be held responsible for any damage caused by him to the building work or any other service.

6.3 Ducts, Sleeves and Openings

6.3.1 The Contractor shall provide attendance to the building contractor with the installation of ducts, sleeves, manholes, openings and any other building work associated with the electrical installation to ensure correct and accurate positioning.

6.3.2 No openings or cuts may be made in structural concrete without prior permission of the building contractor and Engineer.

6.3.3 The Contractor shall in good time provide to the building contractor dimensions, details and positional information for frames, pipe sleeves, recesses, access ways, servitudes, apertures and openings for equipment installed under this Contract.

E200.7 DRAWINGS, MANUALS, LITERATURE, TUITION, SPARES AND TOOLS

7.1 The Engineer's drawings covering the various sections of the installation are listed in the schedule of drawings. The working drawings of the Contract shall, however, consist of the following, where applicable:

7.1.1 The Engineer's drawings;
7.1.2 The Architect's drawings;
7.1.3 The Structural Engineer's drawings;
7.1.4 The Engineer's drawings of the other disciplines, as applicable.
7.1.5 The drawings of other services installations that are relevant for co-ordination and installation.
7.1.6 The installation drawings of other Contractors and Subcontractors where applicable.

7.2 Unless otherwise specified, three sets of the Engineer's drawings will be issued to the Contractor for construction purposes. Any further copies may be purchased from the Engineer.

7.3 The Contractor shall submit four copies (or as required in the Project Specification***) of shop drawings to the Engineer for examination and to demonstrate compliance with the Contract. Shop drawings shall include drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are prepared by the Contractor, Manufacturer, Supplier or Distributor and which illustrate some portion of the work.

The Engineer's examination of shop drawings or samples shall not relieve the Contractor of responsibility for any deviation from the requirements of this Contract unless the Contractor has informed the Engineer in writing of such deviations at the time of submission of shop drawings or samples and the Engineer has given written approval for the specific deviation, nor shall the Engineer's examination relieve the Contractor of responsibility for errors or omissions in the shop drawings or samples or for responsibility for erection or installation fit.

7.4 The Contractor shall submit to the Engineer four copies (or as required in the Project Specification***) of marked-up structural drawings, or other drawings, showing changes and/or additional requirements to be made in the structure in order to accommodate equipment installed under this Contract.

7.5 The Contractor will not be allowed to rely on the Engineer for as-installed information which he may have compiled, to produce record drawings.

7.6 Drawings to be entitled "Record" shall bear the signature of the Contractor, or his authorised representative, and the date.

7.7 The Contractor shall obtain from the Engineer, if available, a CD containing the Engineers' drawings, which have been drawn on a PC-based CAD system for the preparation of record drawings to be provided by the Contractor. One set of paper prints of the record drawings shall be provided for verification by the Engineer. A CD containing the record drawings shall be provided upon completion of the contract. Otherwise the Engineer will issue a set of Engineer's drawings to the Contractor at completion of the installation. The Contractor shall mark these drawing to indicate the record of the installation.

7.8 A set of final layout and schematic record drawings shall be provided in a purpose made holder inside the door of each distribution board and motor control centre, or where no doors are

fitted, to the front plate of the cabinet. The frame shall be adequately sized to receive the equivalent of two A1 size drawings folded to a nominal size of A4.

For MV switchboards, MCCs and main LV distribution boards the Contractor shall provide laminated as-built drawings of single-line diagrams in aluminium/wooden frames fixed to the wall of the room housing the switchboards/MCCs.

7.9 The Contractor shall submit to the Engineer four (or quantity as specified in the Project Specification***) manuals bound between hard covers including the following :-

1) Dimensioned drawings of the layout of the equipment and systems.

2) Wiring diagrams cross referred to the drawings described above, and to the Engineer's layout drawings and single-line diagrams.

3) All Test Certificates for tests done at the factories and on the site.

4) System and equipment descriptions.

5) Operating instructions.

6) Maintenance, adjustment and calibration instructions with preventive maintenance schedule and fault-finding procedures.

7) Spare parts list with names and address of component suppliers and price list of all components and a list of recommended spare components to be kept in stock.

The Contractor shall submit preliminary copies of the manual to the Engineer for scrutiny.

7.10 The Contractor shall provide thorough tuition of the Employer's staff in the operating and maintenance of the plant forming part of the Works.

7.11 When specified in the Project Specification*** the Contractor shall allow in his price for photographs to be taken with a digital camera on monthly basis, for the duration of the Contract, of all the areas and plant forming part of the Works. The photographs shall be properly dated with comments e.g. access to substation not possible etc. A CD with the photographs shall be handed each month to the Engineer at the site meeting. These photographs may be used for the evaluation of claims.

7.12 The Contractor shall provide all tools required for operating and/or maintaining the Works as specified in the applicable Standard Specification and the Project Specification***.

E200.8 INSPECTION, TESTS AND COMMISSIONING

8.1 On completion of erection and installation on site the Contractor shall perform all the tests that may be required by the Engineer in his presence to ensure that the Works are ready for handing over and putting into regular use.
8.2 Near completion, inspect and test the services installation in accordance with the Wiring Code, the Regulations of the Supplier of Electricity and the Occupational Health and Safety Act 85/1993. Record test results on printed test sheets and submit to the Engineer.

8.3 Testing of the electrical installation shall be in accordance with the Project Specification, but shall include the following:

- Ensure correct polarity, phase rotation and balance load between the phases. Verify polarity and phase identification.

- Continuity and resistance of earth conductor including all bonding conductors.

- Continuity of ring circuit.

- Earth electrode resistance.

- Insulating resistance.

- Earth fault loop impedance test.

- Operation of earth leakage protection devices and circuit breakers.

8.4 After inspection and testing, timeously arrange for any inspection and test by the Supplier of Electricity if required, and assist as necessary the Inspector of the Supplier of Electricity by providing access, tools, instruments and attendance.

8.5 Replace any portion of the electrical installation that does not comply with the Wiring Code or the Specification. Such replacement shall be done at the Contractor's expense.

8.6 Submit a "Certificate of Compliance by an accredited person" Annexure 1 in terms of the Occupational Health and Safety Act 85/1993, Electrical Installation Regulation 1992, to the Employer and forward a copy to the Engineer.

8.7 Carry out additional special tests as required by the Engineer and provide the required test equipment.

8.8 Timeously advise the Engineer of all inspections and tests as the Engineer reserves the right to witness such inspections and tests.

8.9 Provide access, tools, instruments and attendance, to assist the Engineer who may perform verification tests at any time.

8.10 The Engineer shall have the power at any time to examine any part of the Works or materials intended for use in or on the Works either on site, or at the place of manufacture or storage.

8.11 On completion of the works, the Contractor shall submit four indexed volumes of all test certificates to the Engineer for tests done at factories and on site. (To be included in the manuals).

8.12 The Contractor shall be responsible to calculate all relay settings. The settings shall be submitted to the Engineer for approval at least two weeks before the commissioning of the works commences. The settings shall be substantiated by calculation sheets and graphs where applicable.

8.13 The Contractor shall check that all protection relays and overload devices are properly set to protect equipment such as motors, cables and capacitors etc., before the system is energised or any motors are switched on. Where overload devices are overrated or the ranges of relays insufficient to protect equipment, the Engineer shall be informed and the equipment shall not be energised.

8.14 Inspections, Tests and Commissioning with Reference to Material and Equipment

8.14.1 Factory Tests and Inspections

The manufacturer shall perform all routine tests in the factory as described by SANS, IEC and/or BSS as well as the manufacturers own standard routine tests on all materials, equipment and auxiliary equipment. Type tests shall be performed as described in the relevant equipment specifications.

The Contractor shall submit a list of tests and inspections to be performed on the equipment for approval.

The Contractor shall perform any additional standard tests that may be required by the Engineer.

The Engineer shall indicate which tests shall be witnessed by a representative of the Employer and the Engineer.

The Contractor shall submit four copies of the test certificates with the test results of all the tests performed to the Engineer not later than the delivery date of the equipment.

8.14.2 Site Tests

On completion of erection and installation on site the Contractor shall perform all the tests that may be required to ensure that the Works are ready for handing over and putting into regular use.

Contractors shall provide their own test equipment which shall be of accepted standards.

The Contractor shall submit a list of tests and inspections to be performed on the equipment for approval.

The Contractor shall perform any additional standard test that may be required by the Engineer.

All the tests shall be witnessed by a representative of the Employer and the Engineer.

Four copies of site test certificates shall be submitted to the Engineer within 7 days after completion of each test.

8.14.3 Arrangements for Witnessing Tests

The Contractor shall make arrangements with the Engineer for tests to be witnessed.

Timeous (at least two weeks, or as specified in the Project Specification***) notice shall be given to avoid undue delays in the completion of tests.

Arrangements for tests on site shall be made only after the Contractor has pre-commissioned the equipment and satisfied himself that it is in running order.

E200.9 FIRE EXTINGUISHERS. FIRST AID KITS DANGER AND INSTRUCTION SIGNS FOR SUBSTATIONS

9.1 Fire Extinguishers

9.1.1 Unless otherwise specified, 5 kg type fire extinguishers or nearest standard sizes offered by manufacturers, shall be supplied for substation building.

9.1.2 Fire extinguishers shall be of the CO2 type or of a type approved for the fighting of fires where electrical apparatus and oil fires are involved.

9.1.3 Unless otherwise specified, fire extinguishers shall be provided as follows:

1) Medium voltage switchrooms: one extinguisher per 30 m² of floor area.
2) Low voltage rooms: one per room.
3) Transformer rooms: one per transformer.

9.1.4 Fire extinguishers shall be mounted on suitable wall mounted brackets.

9.1.5 Fire extinguishers shall be installed next to exit doors wherever possible.

9.2 First Aid Kits

9.2.1 Industrial type first aid kits as supplied by St John Ambulance or the South African First Aid Society, shall be provided for substation buildings.

9.2.2 The first aid kit shall be housed in a suitable metal box with internal trays and a metal lid.

9.2.3 The first aid kit shall be mounted on a suitable wall mounted shelf next to the substation main exit door.

9.2.4 One first aid kit shall be provided for every substation building.

9.3 Danger Signs and Notices

9.3.1 All outside doors of all substations and all substation yard entrance gates shall be provided with a sign showing a lightning strike.

9.3.2 Suitable notices prohibiting unauthorised persons from entering premises shall be provided on all doors and gates of substation buildings and yards.

9.3.3 The following notices shall be provided and mounted against walls inside substation buildings:

1) A notice prohibiting unauthorised persons from handling or interfering with electrical apparatus.
2) A notice containing directions as to resuscitation of persons suffering from the effects of electrical shock.

3) A notice containing directions as to procedure in case of fire.

9.3.4 One set of notices called for above shall be provided and installed for each substation building

9.3.5. The notices shall be displayed at a prominent position inside the building.

9.3.6 The notices shall be made from suitable plastic with engraved lettering.

E200.10 NAMEBOARDS

When specified in the project specification*** name-boards shall be supplied, delivered and erected by the Contractor. The Engineer will indicate the dimensions of the nameboards to the Contractor. The name-boards shall be constructed of timber with masonite front, all of sufficient robustness and rigidity to the satisfaction of the Engineer, and shall be manufactured and finished as set out on the drawing. The Contractor can purchase the CESA emblem from Consulting Engineers South Africa.

E201 MATERIALS

1. Materials and equipment used in this Contract shall, where possible, be of South African manufacture and shall comply with this specification and relevant SANS, BSI and IEC Specifications and shall be approved and installed to the satisfaction of the Engineer.

2. The Contractor shall submit samples of all materials and equipment for examination by the Engineer before installation, unless prior consent to the contrary has been obtained in writing from the Engineer. Such samples will be held for comparison with equipment and materials installed and will be released on satisfactory completion of the Contract. Similar equipment and material shall be of the same manufacture and interchangeable and be standard products from established manufacturers.

3. Where a certain manufacturer's material or equipment is specified, listed in the Schedules or noted on the drawings, such materials or equipment shall be provided as specified, except where an alternative is allowed.

4. Where certain products of a specified manufacturer are unobtainable, substitutes may be offered, but shall only be supplied after written consent by the Engineer.

5. Where the words 'or approved equivalent' follow a manufacturer's name and catalogue reference, the materials shall be of the specified manufacture and reference, or, if the Contractor wishes to use a substitute the onus shall be on the Contractor to prove such substitute is equivalent to the specified manufacture and reference. The decision as to the acceptance of such substitute shall rest solely with the Engineer, whose decision shall be final. If the Engineer instructs the Contractor to install the materials of the specified manufacture and reference, then no alteration to the Contract value or rates will be allowed.

6. Where a detailed specification for material or equipment is not provided, the Contractor shall select such material or equipment to comply with normal practice and to suit the particular application in all respects.

E202 FINISHING AND PAINTING OF MATERIALS AND EQUIPMENT

1. The Contractor shall select materials and their finishing to avoid corrosion.

Exterior applications within 50 km of the coast shall be deemed corrosive.

Aluminium shall be anodized to SANS 999 - 1986 Grade A for exterior and Grade B for interior applications.

2. Unless otherwise specified, finish steel as follows:

Interior Applications and Non-corrosive Exterior Applications

Galvanize to SANS 121 or paint by :

- Preparing surface

- Priming with zinc chromate of dry film thickness of 25 microns (minimum)

- Applying two final coats of high gloss enamel paint to SANS 630 Grade 1, each coat of dry film thickness of 25 microns (minimum).

Exterior Corrosive Applications

- Hot dip galvanize to SANS 121

- Prepare surface and prime with calcium plumbate of dry film thickness of 25 microns (minimum);

- Apply undercoat to SANS 681 Type 2

- Apply two final coats of high gloss enamel paint to SANS 630 Grade 1, each coat of dry film thickness of 25 microns (minimum).

NOTE: Measure dry film thickness to SANS Standard Test Method 140 or 141.

Hot-dip galvanize steel after all fabrication. Reinstate damaged hot-dip galvanizing with hot zinc spraying. Reinstate damaged electro-galvanizing with two coats of zinc-rich paint.

Any unpainted steel shall be chromium-plated or similarly plated to approval.

3. Where required paint aluminium surfaces as follows :

- Thoroughly clean.

- Apply a self-etch primer Plascon Hi-Sheen or approved alternative.

Apply two final coats of high gloss enamel paint to SANS 630 Grade 1, each coat of dry film thickness of 25 microns (minimum).

E203 FIXING OF MATERIALS

1. Fix surface-mounted luminaires, metal draw boxes, switched socket outlets and disconnectors, metal channels, wiring troughs or trays, cable trays, saddles, conduiting and accessories, brackets, braces, trunking and all other surface-mounted material and equipment as described below :

1.1 Concrete (in situ) - expanding cast-in, or gun-bolted, metal screw-fasteners.

1.2 Precast concrete - only with permission of the Engineer.

1.3 Brickwork - expanding, or built-in metal screw fasteners.

1.4 Ash brick - "J bolts" or approved alternative.

1.5 Steelwork - drilled, gun-bolted, or tapped and screwed metal screw fasteners; or steel gun-bolt nails or, where permitted by the Engineer, welding.

1.6 Woodwork - woodscrews, not nails.

1.7 Hollow tiles - spring toggles of not less than 6 mm diameter, but only with permission from the Engineer.

1.8 Exposed to weather - solid brass or stainless steel screw-fasteners.

2. Where any equipment or material is to be mounted on the surface of ceilings, false ceilings, dry wall partitions, or other specialized surfaces, mount such equipment or material only as specified by the Engineer or as approved by the Engineer in writing.

3. Where sizes of fasteners etc. are not specified, submit samples and proposals to the Engineer for approval.

4. Do not gun-bolt into ash bricks, brickwork or precast concrete, except as permitted by the Engineer in writing.

5. The Contractor will be held responsible for any damage to Builder's work due to unauthorized inadmissible gun-bolting.

6. Do not use plastic plugs, wooden plugs or any other soft substance plugs.

"Fischer", or approved alternative hard nylon plugs of not less than 6 mm diameter may be used for fixing light materials to suitable surfaces.

Plugs shall not be installed in mortar joints between bricks.

7. Provide suitable washers under screw heads and nuts.

Install materials in accordance with manufacturer's instructions and recommendations in all respects including type, size and spacing of fixings.

E204 ENCLOSURES FOR DISTRIBUTION BOARDS, MOTOR CONTROL CENTRES AND OTHER ELECTRICAL SERVICES PANELS

1. GENERAL

1.1 This specification covers sheet metal enclosures for distribution boards (DBs), motor control centres (MCCs) and panels for other electrical services such as telephone, fire detection and intruder alarm systems.

1.2 This specification shall be read in conjunction with the following standard specifications to provide a complete specification for LV DBs and MCCs:

- E205 : LV switchgear and controlgear
- E206 : Busbars
- E207 : Current transformers
- E208 : LV motor protection
- E209 : Wiring in DBs, MCCs and panels
- E210 : Wiring- and cable terminations
- E211 : Glands and gland plates
- E213 : Switchboard accessories
- E214 : Nameplates and labels
- E215 : Metering and indication equipment

1.3 For MV MCCs, the following specifications shall also be read in conjunction with this specification and those listed under Clause 1.2:

- E225 : MV disconnectors and earth switches
- E226 : MV contactors
- E227 : Voltage transformers
- E228 : MV protection and relays

1.4 The Project Specification*** sets out which DBs, MCCs and panels shall be provided under the contract.

1.5 Unless otherwise stated in the Project Specification***, MCCs and floor-standing distribution boards shall be Form 4a to SANS 60439.

Enclosures shall be completely vermin-proof and unless otherwise stated in the Project Specification*** indoor enclosures shall have the following ingress protection:

IP44 with doors closed
IP2X with doors open
IP2X between compartments.

Outdoor enclosures shall have IP65 ingress protection with doors closed.

1.7 Enclosures containing heat-generating equipment shall be ventilated to prevent thermal damage to any equipment, and to prevent the temperature within the cabinet from exceeding the maximum allowable temperatures of the equipment and materials in the enclosure.

1.8 Wood or artificial wood products shall not be used inside enclosures as mounting panels or for partitions, except in accordance with Clause 3.1 (e).

1.9 Sufficient space shall be provided in enclosures for internal wiring, incoming and outgoing cabling, and cabling for any future circuits.

1.10 Whilst certain equipment may be installed abutting, undue cramping of wiring and equipment is not permitted. A minimum clearance of 75 mm shall be maintained between rows of equipment, between equipment and the top, bottom and sides of compartments.

DIN rails shall be installed at least 125 mm apart between horizontal centres.

1.11 For the purposes of evaluating clearances and creepage distances, and hence the size of the enclosure and its compartments, the environment shall be taken as Pollution Degree 3 unless otherwise specified in the Project Specification***.

2. CONSTRUCTION OF FLOOR-MOUNTED ENCLOSURES

2.1 Material and Fabrication

(a) The enclosure shall be fabricated from 3CR12 sheet metal unless otherwise stated on the Project Specification***. Outer panels and doors shall be 2 mm thick and internal partitions 1,6 mm thick.

(b) The sheet metal shall be suitably bent, braced and welded where necessary to form a rigid structure. Holes, doors, covers, rails, framework, etc. shall be accurately formed to provide a true and plumb structure when completed. Where welding is necessary the excess material shall be ground to the parent surfaces to present a smooth and blemish-free surface for painting.

(c) All screws employed in the manufacture of the enclosures shall be grade 316 stainless steel with machined threads. No self threading screws or self setting rivets (pop rivets) will be permitted. Where the thickness of material for screw tapping is less than 5 x screw pitch, an externally knurled, threaded insert shall be installed to accept the machine screw. The insert shall be fitted with a hydraulically operated tool, and properly clinched, to ensure it will not rotate in the sheet steel. The inserts shall also be manufactured from grade 316 stainless steel.

Alternative methods of providing suitable screw anchorages in sheet steel may be considered, such as captured or welded nuts, but the detailed alternatives shall be submitted for consideration at the time of tendering.

(d) Enclosures shall be made up of vertically separated sections which shall be divided into compartments to accommodate equipment for motor drives, instrumentation, switchgear for main and sub-main feeder switches, etc.

Each compartment shall be a minimum of 600 x 380 mm totally separated from the adjacent compartments with sheet steel barriers welded or bolted into position and where wiring is required to pass through these barriers, brass crushed holes shall be provided.

(e) A complete enclosure shall be mounted on and bolted to a hot-dipped galvanised 100 x 50 x 6 mm channel steel base with mitred external corners. The fixing bolts shall be 316 stainless steel M10 bolts.

(f) The height of an enclosure shall not exceed 2 100 mm when mounted on its base.

2.2 Doors

(a) The enclosures shall be fitted with doors on the front, back and ends as called for in the Project Specification***.

(b) All doors shall be arranged to stand off from the face/rear of the enclosure. Each door shall be properly stiffened and shall be twice returned at the periphery. The second return shall be gusseted in the corners to further brace the door.

Large doors (e.g. those fitted to the rear of individual sections) shall be further stiffened with "top hat" section channels welded to the inside of the door.

(c) Each door shall be mounted on pin type hinges and shall be secured by means of a lever operated tapered tongue catch or catches (hinges and catches shall be Perano, Barker Nelson or equal approved). The lever shall be provided with an external stop to prevent rotation in excess of 360° and to provide a padlocking facility (a hole in the stop and a hole in the lever).

(d) Where doors are mounted adjacent to one another the spacing shall be arranged to permit each door to open through at least 150°, without fouling the adjacent door. A stop shall be provided which shall prevent the door from opening further to avoid damaged paintwork.

(e) Doors fitted with flush mounted equipment shall be properly braced and stiffened to support the equipment. The hinges shall be easily able to support the mass added to the door when the flush fitted equipment is installed.

(f) Where coverplates are provided behind the doors, the coverplates shall be adequately recessed to permit the spindle on the lever to drive the tapered tongue catch into a slot in the framework of the board without fouling the coverplate. The space between the back of the door and the face of the coverplate shall be nominally 80 mm.

(g) Coverplates shall be fabricated as for the doors and shall be further stiffened to compensate for the machine-punched circuit breaker slots. The coverplates shall be secured at the top edge with at least two square key driven catches whilst at the lower edge they shall be located with two 6 mm diameter tapered dowel pins located in holes drilled in the architrave. Each pin shall be fitted with a 1,2 mm thick spacer washer. Both the pins and the washers shall be welded to the cover.

2.3 Corrosion Protection

The enclosures shall be painted with a high quality polyurethane-based powder coat suitable for interior and exterior conditions and applied by electrostatic spray. The sprayed powder coat shall be baked in accordance with the paint manufacturer's specification.

The enclosures shall be painted white internally and a biscuit colour (B64 to SANS 1091) externally unless otherwise stated in the Project Specification***.

The dry film coat shall be as uniform as possible but shall not be less than 50 microns nor more than 100 microns. The finish shall be high gloss with a minimum of surface defects / blemishes, and acceptance shall be at the Engineer's discretion.

2.4 Busbar Chambers

(a) A totally enclosed busbar chamber shall be provided throughout the length of enclosures for main DBs and MCCs. The busbar chamber shall be fitted with front, back and top covers to give full access to the busbars. The top covers shall be bolted on and the front and back covers secured with square-key latches, with one catch per cover being lockable with a padlock.

(b) The busbar chamber shall be so positioned at the top, that each and every connection is easily accessible and sufficient space is provided to easily operate a torque wrench on each bolt / nut.

(c) Dielectric barriers shall be provided in the busbar chamber at every second section. The dielectric may not be split and installed as separate parts, but shall instead be slotted to allow the busbars to pass through. The slotted holes shall be fitted with U-shaped rubber gasketting to ensure a snug fit. These dielectric barriers may not be employed to support the busbars. The dielectric shall be bolted to the sheet steel at the periphery of the busbar chamber.

The penetrations for circuits into or out of the busbar chamber shall also be provided with similar dielectric barriers at the points of penetration.

(d) Where specified in the Project Specification*** the space normally used for the busbar chamber shall be divided into two separate, totally isolated chambers: a busbar chamber and a wiring channel for signal and communication cabling / wiring.

The wiring channel shall be 100 mm deep and shall be separated from the busbar chamber with a 1,6 mm thick sheet steel partition.

3. CONSTRUCTION OF WALL-MOUNTED ENCLOSURES

3.1 Material and Fabrication

(a) Both flush-and surface-mounting enclosures shall consist of a tray and an architrave frame on which the chassis, front panel and any door are mounted, except that surface-mounted enclosures of width and height both not greater than 400 mm need not have an architrave frame.

(b) Enclosures shall generally be constructed of sheet steel of minimum thickness of 1,2 mm except that cabinets of width and height both not greater than 400 mm may be constructed of sheet steel of minimum thickness of 0,8 mm.

Where called for in the Project Specification***, 3CR12 steel shall be used.

(c) Wall trays of flush-mounting enclosures shall be fitted with expanded metal spot welded to the rear and metal straps welded to the sides to ensure bonding with the structure of the wall.

(d) Trays of surface-mounting enclosures shall be slightly larger than the architrave frame and shall have a return to present a flat surface to the architrave frame.

(e) A mounting panel of 20 mm thick, fine grade, knot-free pine shall be fitted to the back of panels for telephone and electronic building services.

3.2 Doors and Cover Panels

(a) Doors shall be provided for wall-mounted enclosures unless otherwise stated in the Project Specififcation***.

(b) Doors shall be constructed of the same thickness and material as the remainder of the enclosure.

(c) Door hinges shall facilitate removal of doors without the use of tools. Hinge or hinge-pins shall not be removable when doors are closed.

Unless otherwise specified in the Project Specification***, doors shall be fitted with handles and spring-loaded catches without locks.

Where locks are specified, they shall be "Union", "Yale", "Solid" or an approved alternative, with master key facilities for the entire services installation and separate keys for each cabinet. Two keys for each enclosure and four master keys shall be provided.

(e) Where doors are fitted with locks, the operating handle or toggle or the main disconnector or local disconnector shall be accessible and operable without opening the door.

(f) Cover panels shall be secured by means of catches with square keys, or approved equivalent, quick-release fasteners and shall be fitted with chromium-plated knobs to facilitate removal.

Visible nuts shall be chromium-plated dome nuts. Visible bolts, washers or other fasteners shall be chromium-plated. Self-tapping screws will not be permitted.

(g) Cover panels shall have machine-punched openings for instruments and for equipment operating handles and toggles.

Openings shall be provided for spare accommodation which shall be blanked off by escutcheon blanks or clamped steel plates.

4. INSTALLATION

(a) The Contractor shall check the dimensions of access ways and the space provided for DBs, MCCs and other panels on the latest architectural drawings to ensure that the enclosures are appropriately designed.

(b) Unless otherwise stated in the Project Specification***, floor-mounted enclosures shall be mounted over cable trenches. Trench bridging supports shall be provided at the ends of the enclosure and at every second section. The supports shall be manufactured in the form of a top-hat section from 3 mm thick steel and then hot-dip galvanised.

E205 LOW VOLTAGE SWITCHGEAR AND CONTROLGEAR FOR DISTRIBUTION BOARDS, MOTOR CONTROL CENTRES, CUBICLES AND PANELS

1. GENERAL

Switchgear, controlgear and instrumentation shall be rated for the system voltage, frequency, number of phases, load current and applicable maximum prospective fault current as specified on the drawings and the Project Specification***.

2. SURGE ARRESTERS

2.1 Surge arresters shall be provided for each phase in all boards, connected to each phase of the incoming cables.

2.2 Surge arresters shall conform to the relevant SANS codes and other Specifications, shall bear the SABS mark, and shall be solidly earthed directly onto the cubicle earth bar by means of a copper strap and be as short and straight as possible.

3. AIR CIRCUIT BREAKERS (ACBs)

3.1 ACBs shall be of the metal-clad, withdrawable type complying with the relevant codes and specifications. Unless otherwise stated in the Project Specification***, the ACBs shall be three pole.

3.2 ACBs shall have an adjustable thermal overload trip unit and an adjustable magnetic short-circuit trip unit. All trip units shall be direct acting. Both trip units shall be replaceable by units of different ratings.

The ACBs noted on the drawings as "selective" shall incorporate an adjustable time-delay on the magnetic short-circuit trip unit.***

3.3 ACBs shall be designed for trip-free manual closing and electrical tripping of the type specified in the project specification or drawings, e.g., shunt, remote or under voltage tripping; delayed contacts; AC or DC coil voltage***.

3.4 Interlocking shall be provided to ensure that an ACB is fully isolated before access to any live terminals can be obtained.

3.5 ACBs shall be horizontally withdrawable allowing full maintenance and tests without the breaker having to be removed from the withdrawal mechanism.

3.6 Interlocks shall be provided to allow an ACB to be operated in the withdrawn maintenance/test position, and to prevent the circuit breaker from being closed unless fully in the engaged or test position and from being moved when the mechanism is closed.

Special equipment should not be required to remove the circuit breaker from its withdrawal mechanism for transporting. If special equipment is required, it shall be provided with the circuit breaker.

3.7 Lockable safety shutters shall be provided to screen the fixed contacts and shall operate automatically with the movement of the circuit breaker.

3.8 All non-current-carrying metal parts of the circuit breaker shall be solidly interconnected and connected to an earth contact which shall engage with a copper plate connected to the main earth bar of the cubicle, and the arrangement shall be such that the circuit breaker frame is earthed before the circuit breaker contacts engage with the live fixed contacts.

3.9 A mechanically operated "ON/OFF" or ("I/O") position indicator shall be incorporated.

3.10 Facilities for padlocking in the "off" position shall be provided.

3.11 Two normally open and two normally closed spare auxiliary contacts shall be provided, unless otherwise noted. It shall also be possible to install a change-over contact if required at a later stage. Auxiliary contacts shall be capable of making and carrying continuously 1A ac or dc. They shall be capable of breaking 500 VA AC at 0,2 PF and 20 watts DC at an L/R of < 40 ms.

3.12 Where noted on the drawings*** special purpose interlocking (key/mechanical/electrical) shall be provided between ACBs.

3.13 Unless otherwise stated in the Project Specification***, the ACBs shall have a one second fault withstand rating.

4. MOULDED CASE CIRCUIT BREAKERS (MCCBs)

4.1 Moulded case circuit breakers shall comply with the relevant codes and specifications. MCCBs shall be of flush panel mounting type.

4.2 MCCBs with ratings of 100 A and less shall be suitable for mounting on a DIN rail.

4.3 MCCBs with ratings in excess of 100 A for non-motor loads shall each have an adjustable thermal overload trip unit and an adjustable magnetic short-circuit trip unit. Both trip units shall be replaceable by units of different ratings. MCCBs for motor starter circuits shall be of the current limiting type with an adjustable magnetic short circuit trip unit.

4.4 MCCBs with ratings of 600 A or more and MCCBs inside MCC cubicles shall have extension type operating handles, which shall be interlocked with the enclosure compartment doors to prevent the door being opened unless the MCCB is in the off position.

4.5 Mechanically coupled single-pole circuit breakers used as double or triple-pole circuit breakers are not acceptable unless overload releases are internally coupled.

4.6 The fault current interrupting rating of MCCBs shall not be less than the maximum prospective fault current and not less than 5 kA.

4.7 Neutral bars associated with each bank of MCCBs in distribution boards shall be positioned below each bank and shall be wired in the same sequence as the MCCBs.

4.8 MCCBs with shunt release shall have an auxiliary contact arranged to interrupt the shunt release current at the end of the opening operation. MCCBs with an under-voltage release shall be equipped with a time delay relay when specified***.

4.9 MCCBs shall be fitted with the specified number of spare auxiliary contacts.*** Where spare auxiliary contacts are not called for, it shall nevertheless be possible to fit at least one normally open and one normally closed contact or a change-over contact at a later stage. Auxiliary contacts shall be capable of making and carrying continuously 1A ac or dc. They shall be capable of breaking 500VA ac at 0,2 PF and 20 watts dc at an L/R of < 40ms.

4.10 Where called for, MCCBs shall be capable of remote closing using the specified control voltage.***

4.11 MCCBs shall be lockable in the "off" position. A separate locking device may be used for this facility if so stated in the Project Specification***.

4.12 Current limiting MCCBs will not be allowed unless otherwise stated in the Project Specification***.

4.13 Where MCCBs are of the current limiting type the Contractor shall determine, and offer suitable ratings in collaboration with the MCCB supplier, to ensure discrimination and adequate short-circuit current capability. Calculations shall be submitted with the tender indicating the degree of current limiting and discrimination achieved as well as techniques used. Full details shall be submitted of the current limiting characteristics of each MCCB rating offered.

4.14 MCCBs for direct current application shall be of the current limiting type and shall have at least one pole in the positive and one pole in the negative circuit. Where additional poles are required in series to meet requirements of the specified application, the series connections between poles of like polarity shall be such that they cannot be removed without special tools.

5. DISCONNECTORS

5.1 All disconnectors shall be of the "load-break-fault-make" type i.e. be switch disconnectors complying with the relevant SANS specification.

5.2 The disconnectors shall have the ratings specified on the drawings***.

5.3 Disconnectors with ratings of 600 A or more and disconnectors inside MCC cubicles shall have extension type operating handles, which shall be interlocked with the enclosure compartment doors to prevent the door being opened unless the disconnector is in the off position.

5.4 Disconnector handles shall have an integral key lock or padlocking facility.

5.5 The fault carrying capability of the disconnectors shall be equivalent to or higher than the fault level of the associated busbar but not less than 5 kA.

6. SWITCHES AND SELECTOR SWITCHES

6.1 Switches and selector switches shall be switch disconnectors complying with the relevant SANS specification.

6.2 Switches and selector switches shall be capable of carrying, making and breaking the full rated current and of making onto the maximum prospective fault current.

6.3 The fault rating of switches and selector switches shall not be less than the maximum prospective fault current and not less than 5 kA.

6.4 The operating knob and indicator plate shall be manufactured of insulating material and the switch positions shall be clearly and indelibly marked thereon.

6.5 The switches and selector switches shall be provided with substantial contacts and the terminals shall be clearly marked and arranged for easy wiring.

The voltmeter or ammeter selector switch shall be mounted directly below the associated volt or ammeter.

6.6 Voltmeter selector switches shall be arranged so that voltages between phases, and phases to neutral, can be read. Voltmeter selector switches shall be of the break-before-make type.

The voltmeter selector switch shall have one "off" and six "metering" positions and shall be suitable for panel mounting in such a way that the operation knob and indicator plate can be mounted on the front of a panel and the switch itself at the back of the panel.

6.7 Ammeter selector switches shall be of the make-before-break type with one "off" and four "metering" positions arranged to read the current in each phase and in the neutral. When in the "off" position the metering circuit shall be short-circuited.

The physical construction of ammeter selector switches shall conform to that of voltmeter selector switches.

6.8 Switch enclosures shall be provided with an interlocked cover to ensure that the switch is in the "OFF" position before the cover can be opened for inspection or fuse removal. It shall not be possible to close the switch without the cover being closed.

6.9 Switches shall be provided with a clear "ON/OFF" or "I/O" position indicator.

7. BUS-SECTION SWITCHING DEVICES

7.1 Bus-section switching devices shall be interlocked with the incoming switchgear by means of a special-purpose key interlocking facility when specified or indicated on the single-line diagrams.***

7.2 Bus-section switching devices of rating less than 1000 A shall be disconnectors unless otherwise indicated on the single-line diagrams.***

7.3 Bus-section switching devices rated 1000 A and higher shall be air circuit breakers incorporating magnetic short-circuit trip units without thermal overload trip units.

7.4 Busbar selector or change-over switches shall be provided with suitable position indicators.

8. TIME SWITCHES

8.1 The contacts of time switches shall be silver-to-silver or other approved single-pole changeover contacts rated at 16 A and operated by a spring-driven clockwork, electrically wound with a spring reserve of 8 hours minimum.

8.2 Time switches shall be fitted with a manual overriding switch.

8.3 An external bypass switch shall be provided in each time switch circuit.

8.4 Time switches shall have the following features :

- daily programmable with minimum 30 minute "on" and "off" control facilities;

- weekly programmable with day omission facilities of minimum 12 hours, i.e. mornings or afternoons.

8.5 The whole mechanism shall be totally enclosed in a dust-proof enclosure.

9. PHOTO SWITCHES

9.1 Photo switches shall comply with the relevant codes and specifications.

9.2 Photo switches shall have silver to silver or other approved single-pole changeover contacts rated to switch a reactive load of 1800 VA at 230 V and 50 Hz.

9.3 An external bypass switch shall be provided in each photo switch circuit.

9.4 The photo-electric cell shall switch streetlights on when daylight drops to approximately 40 lux and it shall switch off at approximately 80 lux.

9.5 The photo-electric cells shall have a time delay of not less than 30 seconds.

9.6 Photo-electric cells shall be completely waterproof and shall be of robust construction.

9.7 The material of the cover shall not crack, deform or deteriorate in any way whatsoever and shall be colour-fast in all weather conditions.

9.8 The photo-electric cells shall be provided with built-in lightning arresters.

9.9 Samples of photo-electric cells shall be submitted to the Engineer for approval prior to the ordering thereof.

9.10 The prices for the installation of photo-electric cells shall include the supply and delivery and the connection of cables, etc., from the photocells to LV cubicles, DBs or minisubs.

10. FUSE-COMBINATION UNITS

10.1 The fuse-combination units shall be of the switch-disconnector-fuse (SDF) type and shall comply with the relevant codes and specifications, and shall be fitted with high rupturing capacity (HRC) cartridge type fuses-links complying with the relevant codes and specifications.

10.2 SDFs shall be capable of breaking the full rated current and shall have a fault current rating of not less than the maximum prospective fault current and not less than 10 kA for one second.

SDFs which rely on the fuses to reduce the fault current through the switch portion to provide a higher fault current rating are not acceptable.

10.3 Fuse-combination units with the fuses mounted in the cover of the unit, with the cover forming the operating lever, are not acceptable.

10.4 SDFs shall be of the double air-break, quick-make, quick-break type and shall have a spring mechanism smoothly driven by springs on both sides of the mechanism.

10.5 The fixed contacts shall be shrouded and arranged so that when the switch is in the open position the double-break isolates the HRC fuse links so that they can be replaced in complete safety.

10.6 SDFs shall be triple-pole units unless otherwise indicated on the single-line diagrams.***

10.7 All components shall be capable of continuously carrying rated current without excessive temperature rise.

10.8 SDFs shall be provided with interlocks such that :

a) the cover panel cannot be opened whilst the switch is closed; and

b) the unit cannot be operated with the cover open unless an interlock is purposely defeated.

10.9 An SDF shall have a handle and an ON/OFF position indicator mechanically operated by the moving contacts to ensure accurate and positive indication.

10.10 Facilities for padlocking in the "off" position shall be provided.

10.11 In all cases, the top terminal of fuses shall be the live terminal.
10.12 Six spare fuses shall be provided for each rating fitted.

11. FUSE LINKS AND HOLDERS

11.1 Fuse links shall be high-rupturing capacity (HRC) cartridge type fuse links conforming to the relevant codes and specifications.

11.2 HRC fuse link holders shall be of the withdrawable type and shall conform to the relevant codes and specifications.

11.3 Each fuse link and holder shall incorporate a visual inspection eye for fault location.

11.4 Fuses protecting a specific instrument shall be mounted as a group in close proximity to the relevant instrument.

11.5 A label with the rating of each fuse shall be mounted in close proximity to the relevant fuse holder or fuse switch.

11.6 Striker pin switches shall be provided if specified in the Project Specification in order to trip the associated breaker or contactor to prevent the occurrence of single phasing.***

11.7 Six spare fuses shall be provided for each rating fitted.

11.8 The spare fuses shall not be used by the Contractor during erection, commissioning or maintenance.

12. EARTH LEAKAGE PROTECTION UNITS

12.1 Earth leakage protection units shall conform to the relevant codes and specifications.

12.2 All single and three phase socket outlet circuits shall be provided with earth leakage protection devices unless specifically excluded in the Code of Practice for the Wiring of Premises.

12.3 All units shall have test push buttons and, unless otherwise specified or indicated on the single-line diagrams, the sensitivity shall be 30 mA.***

12.4 Earth leakage protection units shall be arranged to disconnect the faulty circuit from both phase and neutral of a single phase system, and from all three phases of a three phase system.

13. CONTACTORS

13.1 All contactors for low voltage shall be of the electro-magnetic operated air-break type with specific requirements as specified in the Project Specification or drawings e.g. ac or dc coil voltage, dip-proofing, latched contacts etc.***

13.2 Contactors shall comply with the relevant codes and specifications. Category AC3 or DC2 shall generally be used, whichever is applicable. Category AC4 and DC3, whichever is applicable, shall be used for heavy plugging and inching duty systems, e.g. cranes, etc.

13.3 Contactors shall have suitable capacities for direct-on-line starting, star delta starting or any other form of starting, whichever is specified in the Project Specification and the drawings.*** The contactors shall be rated for at least 130% of the associated load current.

13.4 Each contactor shall be provided with at least two normally open and two normally closed auxiliary contacts, unless otherwise specified.

13.5 Contactors shall be suitable for remote and automatic operation where specified.*** Where the number of auxiliary contacts required for remote and automatic operation is greater than can be accommodated on the contactor, an auxiliary relay or on additional contactor, shall be provided.

13.6 Each contactor shall be capable of carrying, making and breaking overcurrents during the operating time of its own overcurrent tripping devices at a recovery voltage of 90% of the specified system voltage.

13.7 All Contactors for starting squirrel-cage motors direct-on-line shall be rated to break 10 times the full-load running current of the motor.

The contactor shall be co-ordinated with the short circuit protective device to ensure adequate protection for the specified operational current, voltage and the corresponding utilisation category*** according to Type 2 Co-ordination as per SANS 60947.

E206 BUSBARS

1. Busbars, metal-enclosed busbar trunking systems and connections shall comply with the relevant codes and specifications.

2. The main busbars, distribution busbars, risers and droppers shall be of hard drawn high conductivity copper, having a constant rectangular cross section throughout. They shall be rated as specified in the Project Specification or indicated on the single-line diagrams***, but the rating shall not be less than specified for the main incoming circuit breaker or disconnector. Where busbars are fed directly from a transformer, the busbar rating shall be 125% of the transformer rating.
3. The busbars shall be designed to withstand for 3 seconds the mechanical and thermal stresses associated with the prospective short-circuit current specified in the Project Specification or indicated on the single-line diagram***.

4. Where busbars terminating at the end of switchboards are intended for future extension***, these busbars shall be predrilled to accommodate the extension. Where pre-fitted space is specified for future equipment***, the busbars in the proposed position shall be predrilled and nuts and bolts shall be provided to accommodate the future busbars or cables feeding the equipment.

5. The main busbars shall be mounted horizontally with the longer dimension in the vertical plane. Joints in busbars shall be avoided as far as possible, but where they are necessary, the joint shall be formed by offsetting one of the bars by a deviation equal to its own thickness to overlap the adjoining busbar. The length of the overlap shall be equal to twice the width of the bar, and the joint shall be secured with a minimum of 4 hexagon-headed bolts, washers (plain and spring) and nuts. All joints shall be tightened to the correct torque before switchboards are delivered to site, and again checked just prior to commissioning.

6. Spacing of busbars shall not be less than twice the longer dimension of the busbar and not less than 50 mm between busbars, and 150 mm to the enclosure.

7. Busbars shall be mounted on substantial moulded epoxy or resin insulators fixed with robust steel brackets. Bare conductors shall be so spaced that with all clamps, lugs and lead-offs in position,

the spacing between any conductor and earth shall not be less than 40 mm. Parallel busbars shall be separated by a minimum distance equal to the thickness of each single busbar. Parallel busbars shall be connected together at spacings of not more than 450 mm to equalise current distribution.

8. The minimum clearances between current carrying parts and between current carrying parts and other metal parts shall be in accordance with the relevant codes and specifications.

9. Busbars shall be mounted at least 100 mm away from the nearest equipment. Special attention should be given to spacing between fuse-switches and busbars.

10. All busbars shall be covered with coloured heat-shrinkable material. The colour shall correspond to the colour of the supply phase. Busbars may alternatively be covered with two coats of coloured insulation paint. Busbar joints shall be covered with a suitable non-hardening compound and then taped with coloured PVC tape. Busbars shall be radius-edged where they change direction. PVC tape shall not be allowed for phase identification.

E207 CURRENT TRANSFORMERS

1. Current transformers shall comply with the relevant codes and specifications and shall be marked clearly and indelibly as specified therein on a rating plate securely attached to the transformer.

2. Each panel shall be equipped with the current transformers as specified in the Project Specification and or drawings. ***
3. Current transformers shall be suitable for a system with an effectively earthed neutral or a non-effectively earthed neutral as specified in the Project Specification***.

4. For current transformers with a system voltage less than 3,6 kV the insulation level shall be determined by the rated short duration power frequency withstand voltage e.g. 2 kV for a 400V system.

5. Current transformers with system voltages greater than 3,6 kV shall be insulated to withstand test voltages defined by the rated lightning-impulse and short-duration-power-frequency voltages and shall be as follows for indoor switchgear :

HIGHEST VOLTAGE FOR EQUIPMENT R.M.S.	RATED LIGHTNING-IMPULSE WITHSTAND VOLTAGE	RATED POWER-FREQUENCY SHORT DURATION WITHSTAND VOLTAGE
kV	(Peak) kV	(r.m.s.) kV
3.6	40	10
7.2	60	20

12	95	28
24	125	50
36	170	70

6. The short-time thermal and dynamic current rating of current transformers shall not be less than that of the associated circuit breaker, isolator or busbar.

7. The rated primary currents of current transformers shall be 10, 15, 20, 30, 50 and 75 Amperes or their decimal multiples.

8. The current transformers secondary ratings shall be 5A unless otherwise specified.***

9. Current transformers shall be accessible and easily removable. All current transformers of any one type and rating shall be identical and interchangeable with one another.

10. The class of insulation of current transformers shall be Type A (maximum temperature rise 60°k) unless otherwise specified.

11. Protection current transformers shall be of the low reactance type having toroidal cores with fully distributed secondary windings. Turns compensation shall not be utilised on protection current transformers.

12. The error in turns ratio on any tapping of a Class X current transformer shall not exceed ±0,25%.

13. The same set of current transformers shall not be used for both indication instruments and protective relays, separate cores having a low saturation factor (<than 5 preferably) shall be used for metering.

14. The VA ratings shall be sufficient to operate the various metering equipment and relays but shall not be less than 10 VA.

15. The accuracy limit factor of the protection current transformers shall be 15 unless otherwise specified.

16. The following classes of current transformers shall be used.

FUNCTION	DESCRIPTION	CLASS
1. Metering	kVA, kW and KWh meters	0,5

2. Indication	Ammeters	1,0
3. Protection	Over-current, earth fault and thermal overload	10P
4. Special Protection	Differential protection, Restricted earth fault and pilot wire protection	X

17. The arrangement of the current transformer cores with respect to the primary terminals and mechanism of the circuit breaker shall be approved by the Engineer prior to manufacture.

18. Where it is not possible to easily read the rating plates of current transformers, additional rating plates shall be located on the rear inner panel of the breaker cubicle relay compartment for each current transformer where they can be easily read. These shall be a duplicate of the rating plates which appear on each current transformer. In addition the phase colour with which each current transformer is associated shall appear beneath each rating plate. Information shall be provided on the above rating plates to indicate which secondary terminals are associated with which winding. This information shall be in addition to that called for in the relevant codes and specifications.

The information on the additional plates shall include the relative arrangement of the current transformer cores with respect to the circuit breaker terminals and shall also indicate their polarity.

19. Secondary windings of current transformers shall be earthed to the approval of the Engineer at one point only. Each group of current transformers (i.e. protection, metering, etc.) shall be earthed directly to the earth bar by way of isolating links of the type where the link cannot be removed from the terminal. These links shall be readily accessible and safe with the circuit breaker in the isolated position. They shall not be in a live compartment.

20. All current transformer connections shall be brought to a terminal block in an easily accessible position inside the switchgear relay panel.

If remote metering is specified in the project specification***, then the metering current transformer shall also be wired to an easily accessible terminal block at the back of each panel. A metering test block with special links shall be provided to make changes to the remote metering circuits possible without the danger of opening the CT's on load.

21. Each LV current transformer shall be of the ring type and be provided with a robust mounting bracket and approved terminal studs on the circumference of the coil for the connections. The current transformers shall be mounted on rigid supports in such a manner that the axis of the coil is in a vertical plane to facilitate the threading through of the interconnecting wiring to the relevant switchgear.

22. Current Transformer Testing

Test certificates shall be submitted to the Engineer and be included in manuals. Test shall be executed in accordance with the relevant codes and specifications.

22.1 Type Tests

Type tests are not required if the manufacturer holds certificates of type tests on a similar transformer. Type test certificates shall be provided upon request by the Engineer.

22.2 Routine Tests : General

22.2.1 Verification of terminal markings and polarity tests.

22.2.2 Insulation test shall be made on the windings as specified as follows :

- Power frequency tests on primary windings and measurements of partial discharges.

- Power frequency tests on secondary windings and between sections of primary and secondary windings.

- Overvoltage interturn tests.

22.3 Additional Routine Tests for Measuring Current Transformers

- Tests shall be performed to verify limits of current error and phase displacement.

22.4 Additional Routine Tests for Protection Current Transformers : Class 10P

- Tests shall be performed to verify limits of current error and phase displacement.

- Tests shall be performed to verify limits of composite error.

- Secondary winding resistance corrected to 75°C.

22.5 Additional Routine Tests for Special Purpose Current Transformers : Class X

Routine tests shall be performed to verity and establish the following:

- Rated knee-point e.m.f.
- Exciting current.
- Secondary winding resistance corrected to 75°C.
- Turn ratios.

A magnetising curve shall also be provided to the Engineer for Class X current transformers prior to the installation of current transformers in the switchgear.

23. Witnessing Of Tests

It should be noted that inspection and witnessing of tests shall not relieve the Contractor of his responsibilities for meeting all the requirements of the specification, and it shall not prevent subsequent rejection if such material or equipment is later found to be not in compliance with the specification.

24. Additional Information To Be Submitted With The Tender

The manufacturer shall submit with the tender the following additional information:

- A typical drawing showing the assembly of the current transformer and its core and winding.

25. The following colours shall be used :

NUMBER OF PHASES	PHASE COLOUR	NEUTRAL COLOUR	EARTH COLOUR	SPECIAL PURPOSE COLOUR
1	Red	Black	Green/Yellow	Orange
2	Red and White	Black	Green/Yellow	Orange

3	Red, White and Blue	Black	Green/Yellow	Orange
4 and more	Any base colour except Green, Yellow and Orange with serial numbers (numerals or words)	Numbered as for the phase colours	Green/Yellow	-

26. The switchgear manufacturer shall provide necessary copper flexible or bar connections between the riser terminals and the cable terminals. The switchgear riser terminals shall be properly tinned.

27. Connections to the busbars shall be effected by means of the correct clamps or lugs with soldered connections or with connections crimped with the correct equipment.

28. The neutral busbar cross-section shall be equal to that of the phase busbars, and may not be reduced without the approval of the Engineer.

29. Unless fully tested in accordance with SANS 60439-1, the current density of copper busbars shall not exceed 2A/mm² for currents up to 1600 A, or 1,6A/mm² for currents above 1600 A.

30. All terminations onto busbars and busbar interconnections shall be bolted with cadmium-plated high tensile bolts, washers, spring washers and nuts. In corrosive areas, substitute lock nuts for spring washers. The largest possible size bolt that will fit into holes in lugs and fixing holes of equipment shall be used in every instance. Bolts shall be of sufficient length that at least two but not more that five threads protrude beyond the nut. Connections shall be kept as short and straight as possible and where dissimilar metals are connected means shall be provided to prevent electrochemical reactions and corrosion.

31. The maximum current density in busbars and connections shall be such that in no part of the switchgear equipment including circuit breakers, isolating equipment, busbars, current transformers, cable boxes, and connections shall exceed a temperature of 60°C i.e. a temperature rise of 20°C at an ambient temperature of 40°C.

32. Busbars shall be properly insulated and sufficiently supported to withstand the maximum fault current at the points where they pass through panels or partitions of the switchboard. This shall preferably be achieved by means of resin bound synthetic wood or similar material with cut-outs which fit tightly around the busbars. The insulating panel shall be firmly bolted to the frame. Busbars or "droppers" that pass through internal partitions in the switchboard shall be similarly insulated and supported.

33. Earth Bars

A main earth bar shall be mounted at the bottom along the full length inside the switchboard and may be bolted to the framework of the switchboard. For back access switchboards, the earth bar shall be mounted at the rear. The steelwork of a switchboard and in particular gland plates shall be solidly and effectively bonded to the main earth bar. Earth bars shall have sufficient ways for all the earth conductors and, in addition, 30% spare space shall be provided.

Switchboards with short-circuit ratings in excess of 5 kA shall be equipped with a copper earth bar with a cross section not less than S = 0,006 x I mm² where “S” is the area in mm² and “I” is the maximum prospective fault current in Amps. However, in main DBs and MCCs, the earth bar shall not be less than 70 mm x 8 mm in cross-section, and shall be fitted with earthing studs in each section of the enclosure.

Switchboards with short-circuit ratings not exceeding 5 kA shall be equipped with an earth bar comprising box terminals with pressure shoes on a rectangular copper bar measuring at least 2,5 mm x 12,5 mm mounted on insulating pedestals. An earthing stud shall be welded to the metal tray of the

distribution board. An earthing conductor equal in cross-sectioned area to the incoming earthing conductor shall connect this earthing stud to the earth bar.

34. Busbar trunking

The neutral bar shall have a cross- sectional area equal to the phase bars.

An earthing bar shall be provided.

The busbar trunking shall be finished in the colour as specified in the Project Specification.***

The busbar trunking shall be vermin-proof and noiseless under load and completely maintenance-free.

Busbar trunking shall have rated short-time withstand current for one second equal to the indicated maximum prospective fault current.

The Contractor shall submit type tests for current rating, rated short-time withstand current, and impedance characteristics to the Engineer.

Pressure test low voltage busbar trunking after installation and before commissioning at 2 kV for one minute between phases, between phases and neutral and between phases and earth.

Confirm route access and dimensions on site and compile shop drawings. Submit shop drawings to the Engineer.

Bus trunking installed outdoors, in hostile or hazardous environments shall be IP65 enclosed or as specified***.

Epoxy or polyester moulded, enclosed bustrunking shall be subject to the Engineers approval. Test certificates according to the relevant cables and specification shall be submitted as required.

The Contractor shall allow in the pricing for a complete system including all inter-connectors, flexible links, terminations and suitable brackets to fix the busbars to structures.

E208 LOW VOLTAGE MOTOR PROTECTION AND RELAYS

1. Motors up to and including 55 kW

1.1 All three phase motor contactors shall be provided with three pole thermal overload relays which are selected for the applicable motor ratings as specified***.

1.2 The overload relays shall have inverse time current characteristics which comply with the relevant codes and specifications. Where motors have exceptional long starting times the tripclass shall be selected to ensure that tripping doesn't occur during motor starting.

1.3 The overload thermal relays shall be phase loss sensitive and shall be provided with a manual reset button.

1.4 All three phase motors shall be provided with suitable phase failure relays providing protection against:

- Single phasing.
- Phase reversal.

- Phase angle errors.
- Unbalance supply voltage.

1.5 When motors for pumping installations or submersible pumps are specified, an underload or undercurrent relay with suitable current transformers shall be provided.

1.6 Where relays are mounted inside panels and the trip indicators on the relays are disabled due to the loss of control voltage when cubicle doors are opened, additional signal lamp indicators shall be provided on the cubicle doors otherwise the relays shall be flush mounted on the doors.

2. Motors Larger Than 55 kW

2.1 Motors larger than 55 kW shall be protected with electronic motor protection relays (MPR). The relay shall make provision for the minimum protection functions as follows:

- Thermal overload with thermal capacity memory.

- Single phasing.

- Phase sequence.

- Restart control (The cooling characteristics of the motor shall be accurately simulated to block starting until the motor has cooled down sufficiently for both hot and cold starts).

- Stall protection.

- Underload or undercurrent protection shall be provided for all motors used for pump installations. Where this feature does not form part of the relay a separate relay providing an underload function shall be provided.

- When earth fault and short circuit functions are specified*** the trip signals shall be wired to trip the backup circuit breaker unless positive proof exists that the contactors are capable of breaking the present and future fault currents. Otherwise these trip signals shall be delayed by the MPR to ensure that the fuses blow before the contactor is tripped.

- Special care shall be taken in the selection of motor protection relays when reduced current starters, e.g. soft starters or variable speed drives are specified. Contractors shall submit to the Engineer written confirmation obtained from the manufacturer of the relay that the relay offered is suitable for the application.

- Where relays are mounted inside panels and the trip indicators on the relays are disabled due to the loss of control voltage when cubicle doors are opened additional signal lamp indicators shall be provided on the cubicle doors otherwise the relays shall be flush mounted on the doors.

2.2 When specified*** that the motor windings are equipped with thermistors a suitable thermistor overload relay shall be provided (motors between 55 kW and 150 kW). Care shall be taken that the total resistance of the thermistors when connected in series do not exceed the tripping range of the relay.

The relay shall have contacts for a manual reset button and a LED display trip indicator which shall be mounted on the front of the panel.

Unless otherwise specified the thermistor overload relay shall be suitable to function in conjunction with thermistors with a temperature reference value of 140°C (Class B motor winding temperature rise).

When thermistors are specified*** for winding temperature alarms the thermistor overload relay shall be suitable to function in conjunction with thermistors with a temperature reference value of 130° {Class B motor winding temperature rise}.

2.3 When specified in the Project Specification*** that the motor windings and the bearings are equipped with platinum resistance detectors (RTD's) Pt-100 Ω (Usually specified for motors above 150 kW), a suitable temperature controller for each RTD shall be provided with the following features:

- Adjustable present process temperature value and adjustable set temperature value in separate four digit LCD displays.
- An adjustable alarm output with indicator.
- Temperature range 0 - 150°C.
- Trip indicator.
- Relay control and alarm outputs.
- Dielectric strength : 2 kV for 1 minute.

Unless otherwise stated the temperature controllers for the windings shall be set for the protection of a class B motor winding temperature rise.

i.e.	Alarm	:	130°C
	Trip	:	140°C

The bearing temperature controllers shall be set as follows:

i.e.	Alarm	:	85°C
Trip		:	90°C

When specified*** the unit shall be provided with a 4 - 20 mA output to transmit the process value or other output as may be required.

All the temperature controllers specified for one motor shall all be mounted in a 19 inch rack as a unit and shall be flush mounted on the cubicle door of the relevant motor.

The unit shall be provided with an override key switch to facilitate the exchange of a temperature controller without causing the motor to trip.

Temperature controllers shall be equipped with 2 pole "two in one" 3 wire surge arresters providing protection from phase to earth and from neutral to earth. Surge arresters shall comply with the relevant codes and specifications.

E209 WIRING IN DBs, MCCs AND PANELS

1. In general all internal wiring in the cubicles shall be carried out in 600V PVC insulated copper multi-strand conductors. If the internal ambient temperature of the cubicle is likely to exceed 50°C silicon rubber insulated stranded copper conductors shall be used. The minimum cross-sectional area for control circuits shall be 1,5 square mm and 2,5 square mm for load and CT circuits. The current carrying capacity of conductors shall be determined in accordance with the relevant codes and specifications taking the appropriate correction factors for ambient air temperatures, grouping and condition of use into account.

2. Where several conductors are used, these shall be neatly grouped and bound together in groups not exceeding 10 conductors and shall be arranged in neat vertical or horizontal rows or installed in PVC trunking with slotted sides. Wiring shall follow the board construction features as far as possible without the twisting or crossing of conductors.

3. No joints will be allowed in internal wiring, and all connections to busbars or earth bars shall be made with approved tinned copper cable lugs soldered or crimped to the ends of the conductors and bolted to busbars by means of cadmium-plated high tensile steel bolts and nuts provided with spring washers.

Connections of conductors to equipment i.e. circuit breakers, isolators or contactors shall be made by a ferrule of correct size or by the soldering of the end of the conductor. Conductors connected to terminal blocks need not to be soldered or ferruled.

Conductors terminating on meters, fuse holders and other equipment with screwed terminals shall be fitted with pre-insulated lugs. The lugs shall be soldered or crimped to the end of the conductor. The correct amount of insulation shall be stripped from the end to fit into the terminal. Strands may not be cut from the end of the conductor.

Crimping tools used shall be of the ratchet type and indent an identifying symbol on the terminal insulation.

4. All wiring is to be kept free and away from any exposed terminals or other uninsulated current carrying parts. Wiring shall also be kept free from metal edges and shall be protected where they cross metal edges. Grommets shall be installed in each hole in the metalwork through which conductors pass. Connections to equipment on swing doors shall be arranged so as to give a twisting motion and not a bending motion to the conductors.

5. Only wires of the same potential shall be grouped together and power control circuit wiring shall be in separate wiring channels. Wiring channels shall not be more than 60% full.

6. Wires shall be clearly marked at all termination points in accordance with the numbering of the board manufacturer's wiring diagram, by means of suitable markers.

7. Additional red cable markers marked "T" in white shall also be fitted on wires associated with trip circuits.

8. When the board main disconnector or local disconnector is switched off, no live incoming or other wiring shall be accessible. The incoming terminals shall be screened or inaccessible. Where connections are taken from the incoming sides of the main switch, they shall be screened by a screen marked "ISOLATE FEEDER BEFORE REMOVING SCREEN". If any circuits are energised from other sources, clear warning notices to that effect shall be fitted and such terminals shall be clearly marked.

9. All control terminals shall be accessible from the rear, except in the case of front access boards.

10. Where neutral connections are looped between the terminals of instruments a common lug or ferrule shall be used to ensure that the neutral is not broken when the instruments are removed.

11. The supply end connections to all equipment shall always be at the top and the load end connections at the bottom.

12. Solid copper busbars shall be used to connect equipment to the main busbars where the current rating exceeds 200A and shall be insulated by means of at least two half lapped layers of PVC tape.

13. A maximum of two conductors shall be used per equipment terminal.

14. Where small leads are connected directly onto busbars, such as for voltmeters, etc. they shall be provided with a 20A fuse mounted directly on the busbar and a 2 Amp fuse at the piece of equipment on the front of the panel.

15. Unless otherwise approved the following insulation colours shall identify wiring :-

Red phase of 3-phase circuits	-	red	
White phase of 3-phase circuits	-	white	
Blue phase of 3-phase circuits	-	blue	
Live of single-phase circuits	-	red	
Neutral	-	black	
Earth		-	green/yellow
Alarm circuits	-	orange	
AC control circuits		-	red
DC control circuits		-	blue
Instruments		-	grey

In DBs and MCCs, accessible PVC wireways shall be provided for wiring between compartments. Signal cabling shall be run in galvanised steel conduit.

Internal wiring shall be kept separated from external wiring and, as far as possible, the internal serving of cables entering the enclosure shall be left around conductors until the cable enters the compartment to which it is connected.

Low current signal cables shall be kept separate from power cables up to the point where the conductors are connected to the terminals on the equipment. Where required, sheetmetal wireways shall be provided to ensure this separation.

E210 WIRING- AND CABLE TERMINATIONS AND TEST TERMINAL BLOCKS

1. General

1.1 Electrical terminal blocks shall comply with the relevant codes and specifications and shall be indelibly marked as stated in this specification in respect of ratings, conductor sizes and identification symbols.

1.2 Terminal metal parts, bolts and screws shall be of non-corrosive material, enclosed in fire resistant, moulded plastic insulating bodies. No metal part shall project beyond the insulating material to ensure protection against accidental contact by personnel, against short circuits and tracking.

1.3 The terminal blocks shall have a temperature rating of at least T40 for indoor and T55 for outdoor switchgear.

2. Rail-Mounted Wiring Terminal Blocks

2.1 The construction of the terminal blocks and mounting rail shall be of robust construction as to ensure a firm and positive location of the terminal blocks. It shall be possible to add additional terminal blocks or replace blocks within the terminal sequence without having to disconnect or dismantle the terminal block or adjacent terminal blocks, or having to loosen any fastening device at the rear of the mounting rail. The terminal blocks shall be held in position by means of an end barrier or a shield to insulate the open end.

2.2 It shall be possible to use terminals for different sizes of conductors on the same mounting rail. Where smaller terminal blocks occur adjacent to larger terminal blocks, suitable shielding barriers shall be inserted to cover the terminals that might otherwise be exposed.

2.3 Terminals shall be sized and rated to match the conductors that are connected to them.

2.4 Each terminal blocks shall have provision for clip-in numbering or labelling strips to be installed, together with clear protective caps and shall be clearly marked in accordance with the Board Manufacturer's drawings and wiring diagrams.

2.5 All outgoing circuits of the switchboards shall be provided with suitable terminal strips of the shoe clamping type, a rating of at least 15A and wired in such a manner that all incoming cables installed at the site can easily be connected. Terminals which rely on pinch screws rotating on wire strands shall not be acceptable.

2.6 Terminal strips for auxiliary power, control alarm and trip circuits etc. shall be kept separate to ensure that cables can be made off without disturbing power cables.

2.7 Full details and samples of terminal strips shall be submitted to the Engineer for prior approval.

2.8 Petroleum-jelly filled pilot cables shall be terminated and jointed in moisture-proof, blocking type terminations/joints which shall prevent the ingress of moisture, as well as the escaping of petroleum-jelly from the cable. Epoxy-filled terminations and joints will be acceptable. However, prior approval of terminations and joints shall be obtained from the Engineer.

3. Power Cable Terminals

3.1 The terminal strip shall consist of a metal mounting strip onto which cable connecting modules are fixed. The terminals for power cables shall be have bolt fixing, complete with arc shields and suitably rated for the applicable cable sizes. For cables up to and including 10 mm^2, clamp type terminals may be provided, but the type where the clamp screws are in direct contact with the conductor will not be acceptable.

3.2 The terminals for power cables shall be large enough for the terminating lugs of the cable sizes specified.

3.3 Terminals for power circuits, including the neutral connection, shall be arranged in a straight horizontal line with adequate clearance between live and earth connections with the cable lugs fitted. Rigid barriers, not the thin flexible type, shall be provided between terminals.

3.4 Diagonal or vertical arrangement of terminals for power circuits will not be accepted.

3.5 Where aluminium core cables are used, suitable tinned, copper or aluminium lugs with Densal paste shall be used for the termination.

3.6 The cost for the supply and delivery of lugs and paste shall form part of the price for the erection of the cabinets.

3.7 The terminal strip for power cables shall be positioned at least 50mm from the gland plate. The terminals to which a cable will be connected, shall be directly above/below the specific cable gland for bottom/top entry respectively.

3.8 Where terminals are mounted more than 400mm from the gland plate, provision shall be made for bracing and for fixing the leads of smaller cables to prevent vibration.

3.9 The terminals of each individual circuit shall be clearly labelled with the circuit name and number.

4. Test Terminal Blocks

4.1 Switchboards shall be equipped with a test terminal block, when specified in the Project Specification***. The test block shall be mounted directly below the ammeters and voltmeters on the front panel of the board and shall be wired in series with these instruments.

E211 GLANDS AND GLAND PLATES FOR PVC AND PILOT CABLES

1. Glands

1.1 Mechanical cable glands and flameproof glands shall comply with the relevant codes and specifications.

1.2 When specified in the project specification*** glands shall be weatherproof, dust ignition proof, hose-proof or for use on type 'e' enclosures i.e. use in explosive gas atmospheres.

1.3 Glands shall be provided with brass locknuts and double outer sealing in corrosive environments. Areas which are classified as highly corrosive shall be equipped with H-C (Hydrocarbon resistant) or UV-C (Ultra-Violet and chemical resistant) seals as may be applicable.***

1.4 Glands and components shall be manufactured of non-corrosive material such as nickel plated brass.

1.5 Adjustable cable glands of the correct size designation shall be provided in switchboards for all cable types as specified.

1.6 Glands shall be equipped with cable or armour gripping devices as may be applicable and shall be constructed to ensure electrical earthing continuity between the armour of the cable and the gland plate or the metallic structure. Glands shall be provided with an earthing bond attachment of acceptable rating.

1.7 It shall be possible to convert glands for armoured cables to be suitable for unarmoured cables by replacing the cone bush and compression ring with a rubber compression bush and rings.

1.8 Where cables with metal screens or metal sheaths are specified the gland shall be designed to earth the screen or sheath through the gland on the earth bar. It shall be possible to bring earth continuity conductors through glands for ECC cables without having to cut grooves in the barrel or cone bush. Suitable replacement parts shall be used.

1.9 Glands for outdoor use shall be equipped with a waterproofing shroud and an inner seal kit.

1.10 All pilot cable ends shall be made off in glands as prescribed by the manufacturer, of correct size and complete with neoprene shrouds if used outdoors at minisubs or outdoor cubicles. The armouring shall be clamped between substantial tapered sections, which form an integral part of the gland, secured by lock nuts to give a earth connection.

2. Gland Plates

2.1 Gland plates for cable entries to boards will be from above and/or from below as specified in the drawings of project specifications.***

2.2 Gland plates shall be at least 200 mm above the normal floor level.

2.3 Gland plates shall be from non magnetizing material where single core cables are terminated to the boards.

E212 CABLE TERMINATIONS, JOINTS, CABLE END BOXES, ENCLOSURES AND CLAMPS FOR CABLES RATED 3,3 kV AND ABOVE

1. Cable terminations and enclosures shall comply with the relevant codes and specifications.

2. Suitable cable end boxes or terminations and clamps shall be provided for the types and sizes of cables as set out in the project specification.***

3. The Contractor shall confirm with the Engineer the size and type of cable end box or termination to be used, depending on the choice of PILC cable or cross-linked polyethylene cable and copper or aluminium core cable before the manufacture of the panels or switchboards.

4. The type of termination kits and joints used on paper insulated or XLPE cables shall be those recommended and accepted by the cable manufacturers.

5. If approved by the Engineer, heat shrink type cable terminations and joints may be provided.

6. Tender prices for switchgear shall include for the supply of wooden cable clamping blocks to support the cable inside the switchgear panel where heat shrink terminations are used.

7. The switchgear manufacturer shall provide the necessary copper flexible or bar connections between the riser terminals and the cable end box terminals. The switchgear riser terminals shall be properly tinned.

8. Heat shrink terminations shall be completely non-tracking and U.V. stabilized to ensure long life.

9. Outdoor heat shrink terminations shall be equipped with sheds to increase flashover distances as recommended by the supplier for the specific voltage.

10. Where XLPE cables are used, the switchgear manufacturer shall provide suitable tinned lugs, bolts, nuts and washers for the sizes of cables specified.

11. Where paper insulated cables are used, the switchgear manufacturer shall provide suitable cast aluminium or sheet steel fabricated compound filling cable end boxes suitable for the sizes of cables specified.

12. Where applicable cable end boxes with sealed stem bushings shall be provided. Cable boxes shall be large enough for phasing out cables. Special manufactured cable end boxes shall be used for cables larger than 120 mm².

13. Terminations or joints shall be packed as complete kits, clearly marked in respect of suitability for cable type, insulation, construction and voltage. Each kit shall be accompanied by a detailed set of the manufacturers' installation instructions. The terminations and joints shall be made off strictly in accordance with these instructions with the correct tools.

14. The Contractor, at the time of Tendering, and in the appropriate schedule, shall state the equipment with which each jointer will be equipped. Failure to complete this schedule may prejudice the Contractor's offer.

15. Only electricians who can provide a Certificate of Competence issued by the manufacturer of the accepted termination and joint kits shall be allowed to make off terminations and joints. Costs incurred due non-compliance shall be borne by the Contractor.

16. The Engineer reserves the right at any stage during the contract to instruct that any completed joint be opened for the purpose of carrying out an interior inspection. Should the workmanship of the joint be such that it fails to pass an inspection, the remaking of the joint shall be carried out at full cost to the Contractor. Should the workmanship pass the inspection the cost of making good the opened joint shall be to the Employer's account.

17. A loop of approximately 7,0 metre long shall be left, where possible, at each cable end where high voltage cables are laid underground for distances exceeding 60 metres.

18. Conductor joints shall preferably be done by means of suitable ferrules which shall be properly sweated onto the conductors. Crimped ferrules will only be allowed if the crimping tools and workmanship are approved by the Engineer. Suitable ferrules flux shall be used for aluminium cables.

19. On underground through joints, suitable ferrules shall be used for connecting the cores together. The strands shall be thoroughly tinned before being sweated onto the ferrules. In the case of aluminium cores, the strands shall be thoroughly tinned and sweated into the ferrules using suitable solder flux.

20. The joining of copper conductors to aluminium conductors shall be achieved by the use of properly tinned and sweated cores and ferrules respectively. The correct type of ferrules shall be used.

21. All cable joints shall be of the water blocking type for the prevention of the ingress of moisture from one cable to the next through the joint.

22. The electrical continuity of all the conductors, screen and armouring shall not be impaired by cable joints and the earth continuity shall be accomplished within the joints, i.e. no external earth continuity conductor that will be subject to corrosion, is acceptable. The joints shall be completely covered by a watertight sheath to prevent corrosion.

23. Cable ends shall be long enough for the making off of cable ends into cable through-joint boxes and/or cable end boxes. Excessive waste shall be avoided by the Contractor.

24. Cable connections throughout the system shall follow the same phase rotation, and all cores on the system shall follow the undernoted identification:-

Red Phase : Core No. 1
Yellow Phase : Core No. 2
Blue Phase : Core No. 3

25. Where paper-insulated cables are made off into cable end boxes, the lead cover and armouring shall both be made off into a wiped joint. A 70 mm² stranded copper conductor shall be connected to the cable armouring inside the wipe. The copper conductor and armouring shall be properly cleaned and tinned before the connection is made. The other end of the copper conductor shall be connected to the earthing system by means of a suitable tinned lug. Wiped joints may be replaced by a mechanical assembly approved by the Engineer.

26. Compound shall conform to the relevant codes and specifications. Oil filling compounds shall not be acceptable.

27. Where anti-electrolytic cables are used the cable joint boxes shall be insulated from earth by means of rigid PVC pipes to be put over the joint boxes. The open ends of the pipes shall be sealed with a hard-setting bitumastic compound. Where the environment is sandy, the pipes with joint boxes shall be put onto reinforced concrete slabs. The costs for the supply, delivery and installation of the pipes and/or concrete slabs shall be included in the prices for making off the joints.

28. Lead sheets, or other approved material, approximately 75 mm wide, shall be clamped around the high voltage cables at every cable end box and cable joint box and underneath every cable marker. The following information shall be engraved on the sheets.

a) Voltage, e.g. : 11 kV
b) Sizes, e.g. : 185 mm² Al or Cu.
c) Designation, e.g : Substation 1 - Substation 2

Only the designation shall be engraved if the manufacturer has already printed the other information on the cable.

29. The installation Contractor shall pre-plan the laying of high voltage cables in order to avoid the installation of a through-joints inside premises. No joints inside premises shall be allowed.

30. Sealing of cable ends

The ends of cables which are cut shall immediately be sealed by means of plumbed lead end caps should there be a delay before jointing is to take place.

The sealing of cable ends by means of rubber or bituminised tapes shall not be allowed. Heat shrink caps may be used provided the seal is correctly applied. Where cable ends were left open for 24 hours or more, the cable ends shall be tested for moisture ingress.

E213 SWITCHBOARD ACCESSORIES

1. Control Push Buttons

1.1 General

1.1.1 Push buttons shall comply with the relevant codes and specifications.

1.1.2 Push buttons shall be provided by a single reputable supply and shall be selected for the required rating, contact action, duty, environmental conditions e.g. temperatures and vibrations and mounting characteristics e.g. flush mounted, enclosed, self-contained, illuminated, etc.

1.1.3 All push buttons shall be of the same physical dimension and shall be interchangeable between normally open and normally closed contacts. Push buttons shall preferably also be interchangeable with indicator lamps, key switches, etc. All push buttons shall be provided with replaceable lenses.

1.1.4 Push button terminals shall be suitable for conductor sizes to be used. Push button assemblies mounted on doors of control boards shall be enclosed to prevent inadvertent contact with the terminals and when the doors are open.

1.1.5 Contacts shall be silver-tipped or be constructed of an approved high quality material.

1.1.6 Push buttons shall be labelled by means of removable legend plates clearly indicating it's function. Legend plates shall be interchangeable.

1.1.7 When specified*** keylock push buttons shall be supplied with duplicate keys. The removal action of the key shall suit the application.

1.1.8 Illuminated push buttons shall comply with the specification for indicator lamps and lights.

1.2 Motor Control Centres

1.2.1 All motor control cubicles shall be provided with "STOP/START" push buttons as follows (or as specified in the Project Specification):

- Start Button : Green
- Stop Button : Red

1.2.2 When specified in the Project Specification*** or indicated on drawings the following push buttons shall be provided:

- Trip Reset Button : Black
- Emergency Stop Button : Red with yellow background
- Lamp Test Button : White
- Any Other Function Button : Pale Blue

1.2.3 Start push buttons shall have normally open contacts. Stop push buttons shall have normally closed or normally open contacts, as may be required.

1.3 Switchgear

When specified in the Project Specification*** or indicated on drawings push buttons shall be provided as follows :

- Electricity Controlled Switchgear

Open Button : Green (O)
Close Button : Red (I)
- Reset Button : Black
- Lamp Test Button : White
- Any other Function Button : Pale Blue

2. Signal Lights

2.1 General

2.1.1 Indicator lights shall comply with the relevant codes and specifications.

2.1.2 Indicator lights shall be provided as specified in the Project Specification*** and indicated on drawings.

2.1.3 Similar cluster multi-led (8 chip) long life signal lamps shall be provided for all indications.

2.1.4 LED's shall be selected and rated for the specified control voltage and shall be equipped with a suitable current limiting protection resistor. Each LED shall be provided with a Zener transient protection diode. Suitable LED's are type MDA 22 for AC applications under 110V and DC applications, and type MAC 22 for AC applications above and including 110V as obtainable from Mimic Crafts. Equivalents shall be submitted for approval by the Engineer.

2.1.5 Indicator light lenses shall be of the same size, shall have a minimum diameter of 22 mm and shall be of the front removable screw type. The lamps shall be replaceable from the front of the panel without the use of tools. Indicator light construction shall be suitable for the operating environment and shall be equipped with interchangeable lenses.

2.1.6 Indicator lights shall be labelled by means of a removable legend plate clearly indicating it's function. Legend plates shall be interchangeable.

2.1.7 Two spare lamps shall be provided for each type and colour lamp used on the boards unless otherwise specified.

2.1.8 The spare lamps shall not be used by the Contractor during erection, commissioning or maintenance.

2.2 Motor Control Centres

2.2.1 When specified in the Project Specification*** or indicated on the drawings, the following indicator lights shall be provided:

- Drive stopped, power available : White
- Drive running : Green
- Drive tripped : Red
- Emergency stop activated : Yellow
- Moisture ingress : Blue

2.3 Switchgear

2.3.1 The following lens colours shall be used :

- Circuit Breaker, Isolator closed or abnormal state : Red
- Circuit Breaker tripped (caution) : Yellow
- Circuit Breaker open (ready for operation) : Green
- Interlocking : White
- Other functions : White

Painted lenses shall not be acceptable.

2.3.2 Where indicating lamps are supplied from the substation batteries, it shall be separately wired to an easily accessible terminal block at the back of the board and shall not form part of the wiring of the spring charge mechanisms of equipment or tripping circuits. The indicator lights shall be wired to a lamp test push button mounted on one of the cubicles, preferably a buscoupler or an incomer. The lamp test circuit shall be equipped with a timer (0-10 min) to prevent the unnecessary drainage of batteries.

3. Semaphores

3.1 Semaphores shall be provided if specified in the project specification.***

3.2 Semaphores shall be of the electrically operated, totally enclosed type, suitable for the operation with the specified control voltage.

3.3 The semaphores shall be of the continuously energised type which will take up an abnormal position when de-energised, e.g. 45 deg. to the horizontal.

E214 NAME PLATES AND LABELS

1. Name Plates

All equipment shall be provided with a manufacturer's name plate/plates fixed in an easily accessible and readable position on equipment or inside cubicles showing the following data.

1.1 The manufacturers name or trademark.

1.2 Type, designation or identification number or other means of identification making it possible to obtain relevant information from the manufacturer of equipment.

1.3 SABS or IEC Designation.

1.4 Rated operational voltage.

1.5 Short circuit strength in kA.

1.6 Degree of protection IP rating.

1.7 Maximum current carrying capacity of busbars.

1.8 Maximum current carrying capacity of equipment.

1.9 Voltage transformer ratio (where applicable).

1.10 Current transformer ratio, burden, class and knee point voltage (where applicable).

1.11 Current transformer connection instructions for various CT ratios (where applicable provide separate nameplate close to the relevant terminal blocks).

2. Labelling

2.1 Labels shall generally have black lettering on a white background. Danger and safety notices shall have red lettering on a white back- ground and be in both official languages.

2.2 Labels shall be engraved "trafolite", aluminium or an approved alternative secured with screws, not glue, or in an approved aluminium guide rail.

2.3 Lettering shall generally be 6 mm high except that of "main switch", "hoofskakelaar", "local switch" and "plaaslike skakelaar" which shall be 10 mm high. The lettering of labels indicating names of panels shall be 20 mm high.

2.4 Each cubicle shall also be provided with labels of similar wording at the back of the cubicle.

2.5 Where possible labels shall not be fixed to removable panels or doors.

2.6 The manufacturer shall consider the wording on the drawings as preliminary only and shall obtain the correct final wording from the Engineer before the labels are manufactured.

2.7 All equipment situated inside the board, e.g. contactors, relays, fuses, timers and time switches, shall be clearly labelled indicating function and circuit controlled.
2.8 Typical labels are as follows :-

2.8.1 Cabinet: cabinet description.

2.8.2 Incoming cables/busbar: size and origin.

2.8.3 Main disconnector: "main switch", "hoofskakelaar" and danger notice.

2.8.4 Local disconnector: "local switch", "plaaslike skakelaar" and danger notice.

2.8.5 Fuses and combination fuse switches: circuit designation and fuse rating.
2.8.6 Circuit breakers: circuit designation and overcurrent adjustment where applicable.

2.8.7 Earth leakage protection units: circuit designations.

2.8.8 Contactors, relays, time-switches, timers, control fuses, etc: designation of control circuit and circuits controlled, function and fuse ratings.

2.8.9 Push buttons: circuit designation and function.

2.8.10 Indicating lamps: circuit designation and condition.

2.8.11 Instruments and selector switches: circuit designation and phase colour.

2.8.12 Meters (kVA and/or kWh): circuit designation and phase colours where applicable, reading description, and a single multiplication factor for each reading.

2.8.13 Terminal blocks: terminal designations and function.

2.8.14 Current transformers: ratios and terminal designations.

3. Legend Cards for Distribution Boards or Cubicles and Motor Control Centres

3.1 Install an index card in a holder, with a 2 mm thick transparent acrylic panel, screwed or welded inside a door, or where no doors are fitted, to the front plate of the cabinet. The legend card shall list the outgoing circuit designations in accordance with the layout and schematic drawings, functions and outlet locations.

E215 METERING AND INDICATION EQUIPMENT

1. General

1.1 All meters and indicating instruments shall be of the flush mounted type. Meters not designed for flush mounting, shall be mounted on suitable brackets inside the equipment panel for relay panels, control panels and distribution boards. A suitable door with a glass-covered window shall then be provided in front of the meter.

1.2 Metering and indicating instruments shall be mounted at between 1,2m and 2m above floor level, except where the dimensions, type and mounting position of the panel make this impossible.

1.3 All meters shall be protected with suitable fuses.

2. Ammeters

2.1 Ammeters shall be of the flush mounted, 96mm square, quadratic scale type unless otherwise approved by the Engineer.
2.2 Ammeters shall comply with the relevant codes and specifications.
2.3 All ammeters shall be of the combined instantaneous and 15 minute integrating time lag thermal demand type unless otherwise specified in the project specification. The instantaneous movement shall be of the moving iron type to Accuracy Class 2,5 of BS 89. The accuracy of the thermal demand movement shall be within 3%.

2.4 The ammeter full scale reading shall correspond with the rated primary current of the associated current transformer with an extended scale to at least 120 % of the full scale value.

2.5 The scale plates of ammeters shall be marked with a red line at the full load current of transformers and motors, and at the associated current transformer primary rating in all other cases.

2.6 Ammeter movements shall be suitable for use in either 1 A or 5 A current transformer secondary circuits as specified*** in the project specification.

2.7 Ammeters shall be fitted with zero adjustment screws.

2.8 Each ammeter shall be clearly marked with the appropriate colour of the phase to which it is connected.

2.9 Where ammeters are to be used with dual ratio current transformers, loose scale plates shall be supplied for each ratio. The ratio shall be indicated on the scale plate.

2.10 Ammeters shall be mounted in a horizontal line on cabinets and cubicles.

3. Voltmeters

3.1 Voltmeters shall be of the suppressed zero, 96 mm square, quadratic scale, flush mounted type, unless otherwise specified.

3.2 Voltage transformers will not be used on 400/231V systems. On all higher voltage systems, the voltmeters shall be supplied from voltage transformers with 110V secondary windings.

3.3 Voltmeters shall comply with the relevant codes and specifications, and shall be of Accuracy Class 2,5.

3.4 Voltmeter scales shall extend to at least 115% of the nominal system voltage. The nominal system voltage shall be clearly marked with a red line on the scale plate.

3.5 All voltmeters shall be fitted with zero adjustment screws.
3.6 All voltmeters shall be equipped with a voltage selector switch. This selector switch shall be suitable for phase to phase selection on high voltage three-wire systems and for both phase to phase and phase to neutral selection on low voltage four-wire systems. The selection switch shall be mounted directly underneath the voltmeter.

4. kWh, kW Maximum Demand, kVA Maximum Demand And Combined kWh / kVA Maximum Demand Meters

4.1 Three and single phase kWh meters, up to 80 A shall be directly-operated types and those above 80 A shall be operated through current transformers.

4.2 kW and kVA Maximum demand meters and combined kVA/kWh meters shall be operated through current transformers.

4.3 All the above types of meters shall be of the directly-operated voltage type for voltages up to 400/230 V unless otherwise specified. Meters to be used on higher voltage systems shall be operated through voltage transformers with 110 V secondary windings.

4.4 kWh-Meters shall have cyclometer dials and shall be direct reading without the use of a multiplication factor. kWh-Meters or combined kWh/kVA maximum demand meters can, however, be of the non-direct reading type, but in this case, only one multiplication factor shall be used to obtain both the kWh and kVA readings.

4.5 Any multiplication factor applicable to any meter shall be clearly indicated on the meter, or on a label adjacent to the meter, in unit form and not as a combination of several factors. The manner in which this factor is calculated shall however also be displayed indicating the CT and VT ratios used.

4.6 All meters shall be fitted with security seal fitting facilities.

4.7 Maximum demand indicators shall be resettable from the front without the removal of any covers being necessary, and shall have security seal facilities.

4.8 The integrating period on all maximum demand meters shall be 30 minutes, unless otherwise specified.

4.9 Combined kVA maximum demand and kWh meters shall be the relevant codes and specifications suitable for the type of system in which it is to be used.

4.10 Meters shall comply with the the relevant codes and specifications. with Class 2,0 accuracy, unless otherwise specified.

5. Power Factor Indicators

5.1 Power factor meters shall comply with the relevant codes and specifications.

5.2 The meter shall be suitable for use on 3 phase, 3 or 4 wire system. Unbalanced conditions shall be allowed for.

5.3 Where power factor indication is specified in the project specification, only one meter shall be provided on each circuit where indication is required. The meter shall be installed on the Yellow phase circuit.

5.4 The meter shall be suitable for operation with the current and voltage transformers specified.

5.5 The scales of power factor indicators shall be calibrated at least from 0,6 leading to 0,6 lagging, or a wider range.

5.6 Power factor indicators shall be of the 96 mm square, or larger, flush mounted type.

E216 EARTHING

1. General

Bond and earth the services installation and extraneous conductive parts. The design and installation of an earth electrode shall be in accordance with the relevant codes and specifications. The services installation shall be bonded by means of earth conductors to the earth electrode via the earth bar.

2. Earth Electrode

2.1 Array of Earth Rods

Earth rods shall be at least 16mm diameter and at least 1,5m long and shall be of solid copper. Install each earth rod in a pre-drilled 50mm diameter hole. Fill with mud slurry after installation.

An array of earth rods shall be interconnected with 70mm² bare, stranded copper conductors buried 700mm underground. The earth rods shall be spaced at least 1,5m apart and not less than the depth of the rods below final ground level.

Unless otherwise noted, the array of earth rods shall consist of five rods, four in the form of a 3m square with a fifth in the centre. The interconnections shall form the sides of the square and shall form a cross thus connecting the centre earth rod.

2.2 Trench Earths

Trench earths shall comprise 70mm² bare, stranded copper conductors buried underground at a depth of a least 700mm below finished ground level.

Unless otherwise noted the trench earth shall comprise conductors extending 50m in four directions at right angles to each other, and connected at the centre.

2.3 Earth Mat

An earth mat shall comprise 70mm² bare, stranded copper conductors buried underground at a depth of at least 700mm below finished ground level in the form of a flat spiral of 24 turns spaced 25mm from each other thus approximate a circle of 1,75m diameter.

3. Earth Bar

3.1 Provide an earth bar in each LV switchroom for the bonding of the earth electrode, main distribution board earth bar, water mains, any Supplier's earth terminal, any transformer's neutral terminal and tank earth terminal and any HV switchgear frame.

The earth bar shall comprise a 50mm x 6,3mm copper section 500mm long with pre-drilled 10mm holes for connection bolts. Mount the earth bar in the cable trench on spacers away from the wall.

Connect the earth conductors to the earth bar by means of soldered or crimped lugs and 10mm diameter cadmium-plated steel bolts.

3.2 The earth conductors to the earth bar from the main distribution board, earth electrode, water mains, and transformer tank shall comprise 70mm² bare stranded copper conductor. The earth conductor to any transformer's neutral terminal shall comprise a 70mm² PVC-insulated copper conductor.

4. Earth Continuity

4.1 Provide earth continuity conductors to earth outlet and each metallic appliance and luminaire.

4.2 The earth continuity conductors shall be separate bare or green PVC-insulated copper conductors when associated with wiring in wireways.

4.3 2,5mm² Earth continuity conductors shall be green/yellow PVC-insulated.

4.4 With a multi-core cable circuit, the earth continuity conductor may be a separate core of a multi-core cable identified with green sleeves at each end.

4.5 Where earth continuity conductors are looped between outlets the looped ends shall be twisted and ferruled without breaking the electrical or mechanical continuity of the earth conductor.

5. Bonding

5.1 Bond the water main to the earth bar where non-metallic pipes are used and connect the water meter and valves to the earth bar.

5.2 Bond metallic cold and hot water pipes, waste pipes, sanitary appliances, ventilation pipes and ducts by means of 12mm x 0,8mm solid or perforated copper tape (not wire) clamped by means of brass screws and nuts.

5.3 Bond metallic roofs, gutters and downpipes to earth by means of 12mm x 0,8mm solid or perforated copper tape clamped by means of galvanised bolts and nuts.

5.4 Do not use self-tapping screws for any earthing or bonding functions.

5.5 Complete bonding work before painting.

5.6 Route copper bonding conductors on the outside of the building in securely fixed galvanised pipe from 2 000mm above ground level to 300mm below ground level.

6. Testing

6.1 Measure the resistance between the earth electrode and the mass of the earth by one of the methods described in the relevant codes and specifications.
6.2 Test the earth and bonding continuity in accordance with the Wiring Code.

6.3 Submit all test results to the Engineer in a written report before any permanent paving is provided over the earth electrode.

7. Earthing Of Fences

Earth the fence of outdoor transformer and/or switchgear installations by means of a 70mm² bare, stranded copper conductor 400mm below ground level and 500mm outside the fence around the whole perimeter of the fence. At each corner, bond the perimeter conductor to the fence pole and to a 1,8m earth rod by means of a 70mm² bare, stranded copper conductor.

Bond the perimeter conductor to the main earth bar by means of a 70mm² bare, stranded copper conductor.

E217 WIREWAYS

1. General

Metallic wireways shall be electrically continuous and the maximum resistance between any two parts shall not exceed 1 ohm.

Wireways shall be mechanically continuous providing a degree of protection of at least IP3 X (that is providing protection against the entry of solid objects exceeding 2,5 mm diameter).

Unless otherwise required conduit installations shall provide a degree of protection of IP44, that is dust and splashproof. Exterior conduit installations shall provide a degree of protection of IPW65 (that is dust-tight, and hose and weather proof).

Where cabling is to be installed afterwards by others, provide galvanised steel draw wires in the wireways.

Space metallic wireways at least 160 mm and non-metallic wireways at least 300 mm away from gas, steam, hot water or similar piping. Prevent wireways from contacting piping so as to avoid electrolytic corrosion.

2. Conduit

2.1 General

No conduit shall be smaller than 20 mm diameter.

2.2 Types of Conduit and Applications

2.2.1 Black enamelled Steel Conduit

Black enamelled steel conduit shall comply with the relevant codes and specifications for both screwed metal conduit and plain ended metallic conduit.
Black enamelled steel conduits may generally be used except:-

a) where exposed to the weather

b) where cast into concrete slabs in contact with the soil

c) where exposed to damp or corrosive environments

d) where "U" traps are formed

e) within 50 km of the coast

f) in kitchen and boiler rooms (in which locations galvanised steel shall be installed)

g) in animal houses

h) where protecting underground earthing conductors.

i) in plenums containing humidified air.

2.2.2 Galvanised Steel Conduit

Galvanised steel conduit shall comply with the relevant codes and specifications screwed metal conduit and plain ended metallic conduit and shall be hot dip galvanised to the relevant codes and specifications.

2.2.3 PVC Conduit

PVC conduit shall comply with the relevant codes and specifications and shall be installed strictly in accordance with manufacturer's recommendations. All PVC conduit and associated fittings and accessories shall be of one manufacture.

PVC conduit may only be used strictly in accordance with SABS 0142 and where:-

a) specifically noted or permitted by the Engineer,
b) not exposed to temperatures in excess of 50°,
c) not exposed to mechanical damage, and
d) not used to support any loads.

2.2.4 Flexible Conduit

Flexible conduit shall comply with the relevant codes and specifications and shall be constructed of metal-reinforced self-extinguishing plastic metallic flexible conduit with a sheath of self-extinguishing plastic. The internal diameter shall not be less than 15 mm. Flexible conduit connectors shall securely grip the conduit and be manufactured of zinc, or cadmium Plated steel, or brass.

Where flexible conduit is run in ceiling spaces which form air conditioning plenums, the flexible conduit shall be of galvanised, corrugated steel construction with no PVC components.

Flexible conduit shall terminate on a conduit box unless a draw box exists within 2 metres.

2.3 Installation of Conduit

2.3.1 General

The interior surface of conduits shall have no sharp protrusions. Fit brass bushes to steel conduit ends. Bond metallic conduit installations to earth and ensure earth continuity not exceeding 1 ohm. Fit lock nuts to running joints. Swab conduit cast into concrete to remove all traces of moisture.

Plug open conduit ends and exclude ingress of dirt and moisture.

2.3.2 Concealed Conduit

Unless otherwise specified, conduits shall be concealed by being cast into concrete or built into brick or blockwork as applicable. Chasing may only be carried out with the express permission of the Engineer and builder.

Route conduits in structural concrete as close as possible to the neutral axis and secure the conduits against movement.

2.3.3 Surface mounted Conduit

Where surface mounted conduit is specified, it shall be fixed with spacer bar saddles. The maximum distance between saddles shall not exceed 2 m for steel conduit and 1 m for PVC conduit. A saddle shall be installed within 100 mm of a conduit box.

Remove labels from surface mounted conduit.

2.3.4 Routing of Conduit

Conduit in roof spaces, ceiling voids and exposed areas shall be routed parallel and at right angles to structural elements with no diagonal routing.

Wherever possible, conduits shall be run in straight lines with easy curves and shall be drained. Manufactured bends except for 50 mm diameter conduit, and joints at bends, shall be avoided. The minimum radius of a bend shall be four times the conduit diameter.

2.3.5 Terminations of Conduit

Terminate conduits to luminaires, appliances, conduit boxes and bonding trays as follows:-

a) Concealed Steel Conduit:
i) with two locknuts and a brass bush, or,

ii) with one locknut and a brass bush nut.

b) Surface mounted Steel Conduit:

With a coupling on the outside and a locknut and a brass bush or a brass bush nut on the inside.

c) PVC Conduit:

With a PVC threaded adapter and lock nut with no stress on termination.

2.3.6 Corrosion Protection of Conduit

Paint exposed running threads of black-enamelled steel conduit to be cast or built in with two coats of red lead primer or lap with PVC-insulation tape.

Paint exposed running threads of galvanised steel conduit with two coats of zinc-rich paint.

Provide at least 25 mm of cover to conduits cast into concrete.

Where the paintwork of black-enamelled steel conduit is damaged, prepare the surface and apply two coats of zinc-chromate primer.

Where the galvanising of galvanised steel conduit is damaged, prepare the surface and apply two coats of zinc-rich paint.

2.3.7 Future Extensions

Provide galvanised steel conduit where future extensions are required. In roof spaces, terminate conduit stubs 40 mm above tie beams and where 900 mm clearance exists.

In concrete terminate conduit 150 mm beyond the concrete in the required direction and provide a draw box within 2 metres. Thread conduit ends and screw on a coupling and brass plug.

Where conduits are exposed, prepare the surface and apply two coats of calcium plumbate primer.

3. Conduit Boxes

3.1 General

Conduit boxes and their cover plates shall comply with the relevant codes and specifications as applicable. Strong mounting lugs and sufficient conduit knockouts shall be provided.

Metallic conduit boxes may be malleable iron or pressed steel and shall be galvanised where used with galvanised steel or PVC conduit.

Where conduit boxes are installed on the exterior they shall be galvanised, primed and painted steel, or malleable iron, or of suitable non-metallic construction and shall be dust, hose and weatherproof to IP65.

Where the temperature may exceed 60°C, for instance where incandescent or other luminaires are mounted against an outlet box, ordinary PVC boxes shall not be installed but steel, or heat-resistant non-metallic boxes shall be installed.

3.2 Blank Cover Plates

Fit blank cover plates to draw boxes and unused outlet boxes

The finish of blank cover plates to wall-mounted boxes shall match that of switch and socket outlet plates.

Install cover plates to ceiling-mounted boxes accurately flush with the ceiling and before painting of ceilings.

Install suitable brass cover plates to floor-mounted boxes accurately flush with the floor finish. The brass cover plates shall be sufficiently thick and reinforced to be rigid, shall be secured with countersunk brass screws and shall be sealed with a gasket

Fit non-metallic cover plates with nylon screws to PVC conduit boxes.

Where boxes have been installed with fixing lugs below the finished wall surface fit spacers of coiled steel wire or of pipe as necessary.

3.3 Draw Boxes

Provide draw boxes to facilitate the drawing in of cables and particularly: -

1) after 180° of bends, and

2) after every 15m of straight runs.

Locate draw boxes to avoid spoiling the appearance of the building. The location of draw boxes shall be accepted by the Engineer.

Where several conduits on the same route require draw boxes a single, large draw box shall be provided.

3.4 Expansion Joints

Ascertain the location of structural expansion joints and install conduit expansion joints where conduits have to cross structural expansion joints.

The conduit expansion joints shall be arranged with a draw box as shown on the attached drawing.

Where several conduits on the same route cross a structural expansion joint a single, large draw box shall be provided.

The gap between the inner conduit and outer conduit sleeve shall be sealed with a suitable sealing compound.

3.5 Conduit Boxes related to Architectural Features

Where conduit boxes are to be mounted on wall or ceiling panels, tiled surfaces, panelling or other finishes, ensure that such boxes are installed symmetrically. Measure and co-ordinate such positions on site. It will not be sufficient to scale such positions off the drawings.

Where several outlets are close to each other, space them evenly and align them.

4. Trunking

4.1 General

Metallic trunking shall comply with the relevant codes and specifications.

Steel trunking shall be manufactured of at least 1,6 mm thick steel and galvanised to the relevant codes and specifications as appropriate. Where painting is required, prepare, apply a calcium plumbate primer and apply two coats of high gloss enamel paint, or apply a powder coating. All the painting shall be done in accordance with the relevant codes and specifications.

Where steel trunking is cut to length on site, render the edges smooth, prepare the surface, apply two coats of zinc-rich paint, and if painted, reinstate the paint system.

Light steel trunking may only be installed where specified and shall be manufactured of are least 0,8 mm thick steel epoxy polyester powder coated to the relevant codes and specifications.

Unless otherwise specified, provide bridges of 32 mm dia. conduit for each compartment between trunking routes and between trunking and distribution boards, telephone and communications panels. Aluminium trunking shall be anodised to the relevant codes and specifications.

4.2 Installation

Install trunking complete with end caps, outlets, internal splices, covers, internal partitions, 2 clips, knockouts, adaptors, cable retainers, suspension rods, fixings, brackets, clamps, hangers, nuts, bolts, washers, screws and all other accessories required to complete the installation.

Install cable retainers at spacings of not more than 1 metre.
At changes of direction (elbows, tees, cross-overs, etc.), provide internal splices and exterior covers to present a smooth appearance.

Snap-in covers may be used on trunking up to 70 mm wide. Trunking wider than 70 mm shall be fitted with machine screws secured with retained nuts at sufficient points to prevent distortion of the cover.

Support trunking to prevent deflection beyond 1/180th of the span or beyond 3 mm whichever is the lesser.

Provide partitions to separate different services as required.

4.3 Power Skirting

Power skirting shall have 3 partitioned compartments unless otherwise specified.

Power skirting shall allow access to the telephone compartment without any danger of contact with live parts.

Provide cabling throughout power skirting and with sufficient slack to facilitate the addition and repositioning of outlets.

Powerskirting shall be finished in the scheduled colour.

4.4 Underfloor Ducting

Underfloor ducting shall have 3 partitioned compartments unless otherwise specified.

Outlets shall allow access to the telephone compartment without any danger of contact with live parts.

Samples, shop drawings and complete technical literature with approvals, shall be submitted to the Engineer.

Install the underfloor ducting within an accuracy of ± 12 mm from the positions shown on the drawings. Prepare dimensioned "as-built" drawings of the installation.

Install the underfloor ducting complete with elbows, tees, cross-overs, outlets, outlet pedestals, end caps, adapters, fixings, and all other accessories required to complete the installation.
Provide cabling throughout underfloor ducting and with sufficient slack to facilitate the addition and repositioning of outlets.

The installation shall provide a degree of protection of IP 67 (that is dust and watertight) to IEC Publication 162 and be watertight to 12 mm water gauge.

5. Building Elements as Wireways

With the express approval of the Engineer, suitable building elements, such as hollow mullions may be used as wireways provided that:-

a) the wiring is not exposed,
b) metallic building elements are bonded to earth,
c) the building elements are non-inflammable or self-extinguishing, and
d) rewireability is facilitated.

E218 CIRCUITRY

1. Minimum Sizes

The following minimum wiring and cable sizes apply, unless otherwise specified:-

(i) PVC-insulated wiring and cabling for single-phase power and lighting - 2,5mm²
(ii) PVC-insulated wiring and cabling for signal, control, alarm and communication - 1,5mm²
(iii) PVC/PVC/SWA/PVC cabling for three-phase circuits - 1,5mm²

2. Neutral Conductor

A neutral conductor, equal in size to the phase conductors shall be run to each three-phase outlet and appliance unless otherwise specified.

3. Segregation of Circuits

Separate wireways, or separate compartments of multi-compartment wireways shall be provided for the following circuits:-

1) normal power and lighting circuits
2) emergency power and lighting circuits
3) standby power and lighting circuits
4) low voltage (50 V to 1 000 V) control, instrument, signal and alarm circuits
5) extra low voltage (up to 50 V) control, instrument, signal, alarm, fire detection, intercommunication circuits

4. Identification Colours

The following colours shall be used to identify wiring and cable cores:-

-	red phase of three-phase circuits	-	red
-	white phase of three-phase circuits	-	white
-	blue phase of three-phase circuits	-	blue
-	live of single-phase circuits	-	red
-	neutral	-	black
-	earth	-	green/yellow
-	alarm circuits	-	orange
-	AC control circuits	-	red
-	DC control circuits	-	blue
-	instrument circuits	-	grey

Where the colour of conductor insulation is unobtainable, fit correctly coloured sleeves to each end of the conductor.

Three-phase circuits shall be terminated with the red phase on the left, white phase central and blue phase on the right viewed from the front of the switchgear.

E219 WIRING IN WIREWAYS

Unless otherwise specified, wiring shall comprise copper conductor PVC-insulated cable complying with the relevant codes and specifications bearing the SABS mark and rated for 660V general service.

PVC-insulated cable may only be used where the ambient temperature does not exceed 50°C. Use heat-resisting cable complying with SABS 529:1977 where:-

1) temperatures exceed 50°C
2) directly terminated to a water heater, or any other appliance or luminaire which operates at temperatures in excess of 50°C.

Take care not to apply excessive tension to wiring when drawing in and not to cut or abrade cabling.

Where wiring is installed in trunking, ensure it is located in its appropriate compartment to prevent cross-overs. Strap cables together in groups of not more than ten at spacings not exceeding 1000mm by means of suitable strapping.

No joints may be made in PVC/insulated cable except at the distribution board, outlet, appliance or luminaire. Any joints specified or permitted by the Engineer shall comprise sufficiently rated brass terminals in porcelain-insulated shrouds.

Install wiring in wireways after the completion of wireway installation and plaster work but before painting has commenced.

Not more than two circuits of a similar nature will be allowed in one conduit unless otherwise specified.

The wiring of circuits shall be arranged in the loop-in system and not more than four cable ends may be terminated at a termination point.

Cutting away of cable strands or insulation is not allowed.

Where installed in vertical wireways, support the weight of the wiring by means of clamps at spacings not greater than 5m. In conduit such clamps shall be located in conduit boxes.

Where wireways pass through a fire wall, provide a fire barrier.

E220 CABLE TRAYS AND LADDERS

1. General

Steel cable trays and ladders shall be galvanised.

Where painting is required, apply a calcium plumbate primer and apply two coats of high gloss enamel paint to SANS 630, or apply an epoxy-polyester powder coating to SANS 1274.

Cable trays and ladders and their accessories shall be pre-manufactured. On site fabrication will not be allowed without the express permission of the Engineer. Where standard lengths are cut on site, render smooth the cut edges, prepare the surface, apply two coats of zinc-rich paint and if painted, reinstate the paint system.

2. Installation

Install cable trays and ladders complete with cross-overs, tees, reducers, bends, elbows, cornices, splices, traying arms, fixings, brackets, "unistruts", clamps, hangers, nuts, bolts, washers, screws and all other accessories required to complete the installation.

Support cable trays and ladders to prevent sagging beyond 1/180th of the span or 3mm whichever is the lesser. Each length shall be supported in at least two places along the length. The diameter of expanding bolts, studs, etc., and nuts, bolts and patent fixings, etc., securing the trays and ladders shall not be less than 10mm.

3. Heavy Duty Cable Ladders

Cable ladders unless otherwise specified, shall be heavy duty manufactured of sheet steel at least 2,0mm thick with shoulders at least 76mm high. Cable ladders and accessories shall be hot-dip galvanised to SANS 121.

Rungs shall be spaced at intervals not greater than 300mm. Bends, tees, elbows, cross-overs and reducers shall have minimum radii of 450mm.

Support cable ladders on traying arms of length to suit ladder width and fitted with end caps.

Cable ladder lengths over 3m shall be supported in at least three places along the length.

Bolts, nuts and washers securing splice pieces shall be at least 6mm diameter.

Where cable ladders ramp slightly so that a bend is not required provide hinged splice pieces hinging on 8mm nuts, bolts and washers and with radiused corners.

4. Light Duty Cable Ladders

Light duty cable ladders may only be installed where specified or where expressly permitted by the Engineer. These cable ladders shall be manufactured of sheet steel with shoulders comprising 41,3mm x 10mm x 1,6mm pressed steel channels. Cable ladders and accessories shall be hot dip galvanised to SANS 121. Rungs shall be spaced at intervals not greater than 300mm. Bends, tees, elbows, cross-overs and reducers shall have minimum radii of 300mm. Support cable ladders on traying arms of length to suit ladder width and fitted with end caps. Cable ladder lengths over 3m shall be supported in at least 3 places along the length. Changes of direction shall be undertaken with manufactured elbows hinged horizontal splices or hinged vertical splices. Bolts, nuts and washers securing splices shall be at least 10mm diameter.

The hinge pin of the hinged horizontal splice shall be at least 8mm diameter.

Hinged horizontal or vertical splices may be used for elbows and bends up to 45°. Manufactured elbows and bends shall be used for elbows and bends over 45°.

5. Heavy Duty Cable Trays

Cable trays, unless otherwise specified, shall be heavy duty manufactured from perforated sheet steel at least 2,5mm thick with shoulders at least 76mm high. Heavy duty cable tray and accessories shall be hot-dip galvanised to SANS 121.

Provide cornices at changes of direction to allow minimum bending radii of cables.

Support heavy duty cable trays on traying arms of length to suit tray width and fitted with end caps.

6. Light Duty Cable Tray

Light duty cable trays may only be installed where specified or where expressly permitted by the Engineer and shall be manufactured from perforated sheet steel at least 1,2mm thick with shoulders at least 19mm high. Light duty cable trays and accessories shall be galvanised to SABS 121.

Provide cornices at changes of direction to allow minimum bending radii of cables.

Support light duty cable trays on traying arms of length to suit tray width.

E221 ACCESSORIES: LIGHT SWITCHES AND SOCKET OUTLETS

1. Light Switches

1.1 General

Wall switches shall comply with SABS 163 and bear the SABS mark and shall be of the tumbler-operated microgap type. Submit samples to the Engineer for approval.

Wall switches shall be rated for 250V 16A. Install wall switches with the centre 1 350mm above finished floor level

Switch boxes and cover plates shall comply with SABS 1085 and SABS 1084.

Multiple switches may be allowed only if the switches control the same circuit. Switches controlling separate circuits on different phases shall be installed in separate boxes.

Switch toggles or rockers shall operate in a vertical direction.

Where indicating lights are specified, they shall form an integral part of the switch and shall have neon lamps or light-emitting diodes.

Light switches shall be finished as scheduled.

Metallic switch plates shall be secured with two chromium plated countersunk screws. Non-metallic switch plates shall be secured with two nylon countersunk screws.

1.2 Flush Wall Switches

Where conduit is routed flush, install flush wall switches built into conduit boxes.

1.3 Surface-mounted Flush-Pattern Switches

Where flush-pattern switches are to be mounted on the surface they shall be mounted in 100mm x 50mm or 100mm x 100mm by 35mm deep extension boxes.

1.4 Industrial Surface-mounted Switches

The box and cover plate shall be constructed of steel fitting together to make a dustproof assembly, IP44 to IEC Publication 162. The switch toggle or rocker shall be shrouded where it protrudes through the cover plate.

Where required, dustproof industrial surface-mounted switches shall incorporate hinged and sprung dust-proof flaps over the switches.

1.5 Hose-proof Switches

Switches designated hose-proof, weather-proof or waterproof shall be of non-metallic construction and hose-proof to IPW65 of IEC Publication 162. Operation may be rotary, or rocker through a membrane.

1.6 Ceiling Switches

Ceiling switches shall be rated for 250V 10A amp shall be installed on a round conduit box. The base shall be bakelite and the cover of bakelite with a brass screw ring insert.

Provide a 1,25m length of nylon cord.

2. Socket Outlets

2.1 General

Socket outlets shall comply with SABS 164:1953 and bear the SABS mark or with SABS 1239:1979 and IEC 309 as applicable. All socket outlets shall be earth leakage protected. Submit samples to the Engineer for approval.

Unless otherwise specified, socket outlets shall be rated for 250V (phase to neutral) 16A, shall be switched and have safety shutters on the phase and neutral contact tubes.

Where indicating lights are specified they shall form an integral part of the socket outlet and shall have neon lamps or light-emitting diodes.

Install socket outlets with the centres at the following heights above finished floor level unless otherwise noted:-

(a) generally unless otherwise specified : 300mm
(b) hospitals, clinics etc. : 450mm
(c) kitchens, laboratories, industrial areas, plant rooms and over work tops : 1 200mm

Socket outlets shall be finished as scheduled.

Metallic socket outlet plates shall be secured with two countersunk chromium-plated screws. Non-metallic plates shall be secured with two countersunk nylon screws.

2.2 Flush Single-phase Socket Outlets (16 A)

Flush single phase socket outlets shall be rated for 250V 16A and incorporate three contact tubes. They shall be mounted in 100mm x 100mm conduit boxes.

2.3 Surface-mounted Flush-pattern Single-phase Socket Outlets
Where flush-pattern single-phase socket outlets are to be mounted on the surface they shall be mounted in 100mm x 50mm or 100mm x 100mm extension boxes.

2.4 Industrial Surface-mounted Single-phase Socket Outlets

The box and cover plate shall be constructed of steel fitting together to make a dust-proof assembly, IP44 to IEC Publication 162. The switch toggle or rocker shall be shrouded where it protrudes through the cover plate.

Where required, dust-proof industrial surface-mounted socket outlets shall incorporate hinged and sprung dust proof flaps over the switches and contact tubes.

2.5 Moulded Case Circuit Breaker Single-phase Socket Outlets

These socket outlets shall comprise a miniature moulded case circuit breaker and a 250V, 16A 3-contact tube socket outlet mounted in a standard 100mm x 100mm box. The miniature MCCB shall be Heinemann AM1-21, or approved alternative and shall be rated at 10A unless otherwise noted. The assembly shall be Hain catalogue reference SGNY-lO or approved alternative.

2.6 Hose-proof Socket Outlets

Socket outlets designated hose-proof, weather-proof or water-proof shall be hose-proof to IPW65 of IEC Publication 162 when the plug is removed and with the plug inserted.

2.7 Three-phase Socket Outlets

Three-phase socket outlets shall be of the CEE 17, 380V, 6h pattern with 5 contact tubes for three-phases, neutral and earth. Each outlet shall incorporate a switch which can only operate with the plug inserted. Unless otherwise specified, the outlets shall be rated at 16A.

2.8 Stove Connectors

Stove connectors shall be rated for 433/250V, 15A with four contact tubes for three-phases and neutral. Earth continuity shall be provided through the metallic casing of the socket outlet to the metallic casing of the plug by means of a screwing ring.

Stove connectors shall comply with the Appendix referred to in Regulation 707 (13) of the Standard Regulations for the Wiring of Premises.

2.9 5A Single-phase Socket Outlets

5A single-phase socket outlets shall be unswitched, rated for 250V, and have 3 contact tubes with shuttered live and neutral tubes. The socket outlets may be mounted in pre-punched trunking, 63mm dia., 100mm x 50mm or 100mm x 100mm conduit boxes.

2.10 Shaver Socket Outlets

Shaver socket outlets shall comply with BS 3052 and shall incorporate a double-wound isolating transformer rated at least 20VA and providing 115V and 230V.

The socket contacts shall be suitable for 115V North American pattern plug tops and 230V European pattern plug tops. Insertion of a plug top shall switch on the transformer primary and removal of the plug top shall switch it off.

Overload protection shall be included.

2.11 13A Single-phase Socket Outlets

13A single-phase socket outlets shall comply with SABS 1363.

3. Isolators (Switch Disconnectors) For Building Services Applications

Isolators shall comprise air-break switch disconnectors complying with SABS 152-1977, be double-pole for single-phase circuits and triple-pole for three-phase circuits, and be rated for 433/250V.

The current rating shall be 63A unless otherwise specified.

Isolators for single-phase appliances with loads less than 2,5kVA may have current ratings of 13A.

Where the final connection from the isolator comprises a flexible cord, the isolator assembly shall incorporate an indicating light, a grommet and cord grip or a compression gland, and a fuse rated to protect the cord.

Metallic cover plates shall be secured with two countersunk chromium-plated screws and non-metallic cover plates with two countersunk nylon screws.

The isolators shall be finished as scheduled.

Where indicating lights are specified they shall form an integral part of the isolator assembly and shall have neon lamps or light-emitting diodes.

Isolators up to 63A current rating shall be installed in 100mm x 100mm conduit boxes.

E222 LUMINAIRES

1. General

Provide all luminaires listed in the Schedule and shown on the Drawings including procurement, delivery, acceptance, storage, installation, aiming, adjustment, testing and commissioning.

Luminaires shall be installed complete with mounting accessories, brackets, poles, stirrups, baseplates etc.

Excavate, backfill and consolidate as necessary for luminaires.

Luminaires shall include lamps, indicator lamps, control gear, power factor correction equipment, electro-magnetic interference suppression equipment and all other accessories necessary to render the luminaires fully operative.

Luminaires shall not emit electro-magnetic or radio/television interference in excess of the limitations stipulated by the Department of Posts and Telecommunications.

Luminaires shall have internal wiring of copper conductors of not less than 0,5mm², with suitable heat-resistant wiring to SABS 529. PVC insulated wire shall not enter luminaires with polycarbonate components. A terminal block shall be fitted to each luminaire. Luminaires shall each have an earth terminal and shall be bonded to earth.

Each luminaire shall be labelled next to the lampholder and on the control gear with the following information:-

a) voltage rating;
b) lamp type
c) lamp wattage (for incandescent lamps, the maximum wattage).

Control gear shall be power factor corrected to at least 0,9 lagging, shall have a circuit efficiency of not less than 0,85 and shall be silent in operation.

Capacitors shall comply with SABS 1250:1979.

On request of the Engineer, submit luminaire details (including photometric data, and noise level reports) prepared by an accredited laboratory.

On request of the Engineer, remove any luminaire from site and submit luminaire to tests required by Engineer.

Luminaires shall be designed and installed to avoid excessive temperatures. Components and materials shall be so selected that they are not adversely affected by the operating temperature.

The harmonic distortion of a lamp circuit shall not exceed 30%.

2. Installation

2.1 Refer to Section: "Fixing of Materials" of this Specification.

2.2 Install luminaires in accordance with the manufacturer's recommendations.

2.3 Mount luminaires after the first coat of paint has been applied. Await final coat of paint, before completing installation of luminaires.

2.4 Fix luminaires equal to or narrower than 225mm at the centre and two outer positions. Fix luminaires wider than 225mm at the centre and at the four corners.

2.5 Where luminaires butt, fix them together with brass bushes and lock nuts.
2.6 Screw conduits directly to exterior luminaires and to luminaires with a degree of protection in excess of IP44. Provide gasketting and sealants between luminaires and surface to which they are mounted. For wall-mounted luminaires, the conduit shall enter the luminaire at a slight downward angle to the horizontal.
2.7 Where luminaires are mounted on, or in, ceilings made of panels, mount the luminaires symmetrically. Where the mass of the luminaires exceeds the load carrying capability of the ceiling systems, install suitable hangers.

Connections to luminaires mounted on or in ceilings shall comprise metallic conduit, flexible conduit (without a PVC sheath), or silicone rubber flexible cord. Co-ordinate such connections with the Contractors installing the ceiling, air conditioning and other services.

3. Exterior Luminaires

Exterior luminaires shall have a degree of protection of at least IPW65 of IEC-162. Lenses shall be resistant to degradation and discolouration from ultra-violet radiation. Materials shall be corrosion-resistant and selected to avoid electrolytic corrosion. Luminaires constructed of sheet steel or sheet aluminium are not acceptable.

The bodies shall be painted cast-iron; painted, or anodised (Class C), die-cast LM6 aluminium; glass-reinforced polyester; or polycarbonate.

Gaskets shall be silicone rubber or neoprene.

Lenses shall be polycarbonate or heat-resistant glass. Lens, or lens-frame, securing screws shall be stainless steel.

Floodlight luminaires shall incorporate calibrated horizontal and vertical angle scales.

4. Sheet Metal Work and Painting

4.1 Sheet metal work shall be constructed from cold-rolled, rust-proofed sheet steel not less than 0,8mm thick suitably reinforced and braced for rigidity.

4.2 Degrease, de-rust and then phosphate with a light-weight hot phosphating solution in accordance with Section 2.4 of SABS 064:1960.

4.3 Prime with an epoxy zinc-chromate primer. Lightly sand and paint with two or more coats of white acrylic baking enamel and then bake to comply with Type 1 SABS 663:1959.

4.4 An approved epoxy-polyester baked powder coating process SABS 1274:1979 may be substituted for the painting specified above in clause 20.4.3.

4.5 Paint finish shall be smooth, glossy and free from imperfections.

5. Emergency and Standby Luminaires

5.1 Emergency Fluorescent Luminaires (with integral battery)

Each emergency fluorescent luminaire with integral battery shall incorporate a mains-failure relay, battery charger, nickel cadmium battery, and inverter which shall provide emergency lighting by means of one lamp operating at 100% light output for at least one hour. The battery charger shall fully recharge the batteries within 24 hours.

5.2 Mercury Vapour Luminaires on Emergency and Standby Circuits

Each mercury vapour luminaire on an emergency or standby circuit shall incorporate a mains failure relay, change-over switchgear, a photo switch and quartz halogen lamp. The quartz halogen lamp shall operate on mains failure until the mercury vapour lamp has run up when the photoswitch shall extinguish the quartz-halogen lamp.

5.3 High-pressure Sodium Luminaires on Emergency and Standby Circuits

Each high-pressure sodium luminaire on an emergency or standby circuit shall have a lamp with a run up time of not less than 20 seconds.

5.4 Exit Signs

Each exit sign with integral battery shall incorporate two fluorescent lamps each with its own separate control gear, mains failure relay, battery charger, nickel cadmium battery and inverter which shall provide emergency lighting by means of one lamp operating at 100% light output for at least one hour. The battery charger shall fully recharge the batteries within 24 hours.

Exit sign lettering shall be at least 150mm high.

Exit signs shall comply with BS 5266 and BS 2560. Surface-mounted exit signs shall incorporate an aperture of at least 200mm x 50mm with prismatic diffuser to provide downward light.

6. Fluorescent Luminaires

6.1 General

Interior fluorescent luminaires shall comply with SABS 1119:1976.

6.2 Construction

Provide three 20mm diameter knockouts in the backplate, one in the centre and one at each end. Each knockout shall have accompanying slots for screws to fit a standard round conduit box and arranged so that the luminaire can be turned through an angle of 90°C. The backplate shall extend the entire length of the luminaire. Luminaires shall be so constructed that it is possible to reach the control gear without disconnecting any wiring and without removing the luminaire from its installed position.

6.3 Channel Luminaires

Fluorescent channel luminaires shall consist of a ventilated rectangular wiring channel.

6.4 Lenses. Diffusers and Louvres

Lenses, diffusers and louvres shall be sufficiently strong and rigid to resist distortion and breakage during normal operation and maintenance.

Lenses, diffusers and louvres shall be constructed of:
a) flame-retardant acrylic (methacrylate),
b) flame-retardant, UV and light stabilised polystyrene, or
c) UV and light stabilised polycarbonate.

6.5 Components

Ballasts shall comply with SABS 890:1967. Unless otherwise specified ballasts shall be switch-start. Switch-start ballasts shall be wound length-wise around pre-assembled laminations crimped into a steel channel. No compound shall be required.

Starters shall comply with BS 3772/IEC-55 and be accessible for replacement with the lamps in position.

Lampholders shall be telescopic or hinged sprung-ratchet.

6.6 Lamps

Lamps shall comply with SABS 1041:1975. Lamps shall have an average life of at least 7 500 hours on a 3 hour on/off switching cycle. On request submit to the Engineer the light output of the lamps at 100 hours and 2000 hours. The light output at 2 000 hours shall not be less than 80% of the output at 100 hours.

No lamp flicker of lamps shall be visible under normal operation after initial stabilisation period of 100 hours. Lamp colour shall be SABS colour reference 2 unless otherwise specified. 18W, 36W, and 58W fluorescent lamps (26mm diameter) shall be "colour 84" unless otherwise specified.

7. Incandescent Luminaires

Lampholders shall be porcelain.

Lampholders for lamps of 150W and higher rating shall be Edison Screw (E.S.).

The operating temperature within the luminaires shall be limited to avoid any adverse affects on any components.

8. Gas-Discharge Luminaires
Ballasts shall comply with SABS 1266:1979. Ballasts shall be cast in epoxy-resin and provided with heat sinks, cooling fins, etc., to limit the operating temperature to avoid any adverse affects to any components.

Interior luminaires shall comply with SABS 1278:1980.

Mercury vapour lamps shall be of the colour corrected, high pressure, fluorescent type.

High pressure sodium vapour lamps shall be of the colour enhanced type.

E224 POWER FACTOR CORRECTION EQUIPMENT

1. General

1.1 The power factor correction equipment shall in general comply with all the other clauses in the Standard Specification, where applicable.

1.2 Shunt capacitors shall be used for power factor correction.

1.3 The finish and colour of equipment shall be specified in the project specification.***

1.4 Power factor compensation for the electrical equipment shall be done on a individual, group or central basis as specified in the project specification.***

1.5 The power factor correction equipment shall be suitable for the fault level and voltage of the system as specified in the project specification.***

1.6 All equipment including the capacitors shall be suitable for the ambient temperatures and altitude of the site specified.***

2. Individual Compensation of Low Voltage (up to 1000V) Motors

2.1 Capacitors shall preferably be installed inside the motor control centres.

2.2 Internally fused three phase capacitor units shall be used.

2.3 Where capacitors are connected in small banks they shall be "group fused" with suitably rated fuses. Fuses shall comply with Standard Specification E205, Clause 11.

2.4 No additional protection is needed for individual three phase capacitors where the motors to be compensated has motor protection relays installed.

2.5 The motor protection relay settings shall be adjusted taking the capacitor current into account to ensure that proper protection is given to the motor.

2.6 To provide protection to switchgear and capacitors against inrush currents all the incoming cables to the capacitors shall be coiled close to the capacitors with approximately five turns and 50mm diameter to form an inductor.

2.7 The capacitor current shall not be higher than 90% of the no-load current of the motor to ensure that the self excitation voltage caused by the capacitor is lower than the rated voltage of the motor.

2.8 Labels shall be provided on all panels containing power factor correction capacitors to warn the maintenance personnel about possible static charges on the capacitors which should be discharged before attempting any maintenance work.

3. Individual Compensation of High Voltage (3,3kV And Above) Motors

3.1 Capacitors shall be installed in a free standing cubicle as specified or indicated on drawings***. IP42 enclosure protection is required.

3.2 Suitably rated series reactors shall be mounted on each phase to provide protection to switchgear and capacitors against inrush current surges.

3.3 Internally fused three phase capacitor units shall be used individually or in banks for larger motors.

3.4 High voltage capacitor banks shall be "group fused" with suitably rated BS type fuses mounted in a combined fuse switch. Fuses shall comply with Standard Specification E205, Clause 11.

3.5 A tripping system shall be brought into operation by a blown fuse which shall automatically lock the switch mechanism to prevent closure. The tripping of any single phase shall open all three phases and lock the switch in the open position pending fuse replacement.

3.6 The rating of the fuse switch shall be at least 1,5 times the rated capacitor current.

3.7 The following shall be the maximum kVAr rating per group:

11kV : Maximum 1600kVAr
6,6kV : Maximum 1600KVAr
3,3kV : Maximum 800KVAr

3.8 Fuse trip flag indication on the cubicle and a microswitch for remote indication and alarm purposes shall be provided to indicate fuse blown conditions.

3.9 The capacitor current shall not be higher than 90% of the no-load current of the motor to ensure that the self excitation voltage caused by the capacitor is lower than the rated voltage of the motor.

3.10 The motor protection relay settings shall be adjusted taking the capacitor current into account to ensure that proper protection is given to the motor.

3.11 LED cable alive signal lamps shall be provided on three phases of the incoming high voltage cables to the cubicle.

3.12 Labels shall be provided on all panels containing power factor correction capacitors to warn the maintenance personnel about possible static charges on the capacitors which should be discharged before attempting any maintenance work.

4. Capacitors

4.1 The capacitors shall comply with IEC 60871, Part 1 for Medium Voltage Capacitors and IEC 60831 for Low Voltage Capacitors.

4.2 The capacitors shall be of the self-healing type.

4.3 Low voltage capacitors shall have dry insulation and shall not contain impregnating liquids.

4.4 The medium voltage capacitors shall not be impregnated with poly-chlorinated biphenyls (PCB).

4.5 The casings shall have suitable earthing terminals.

4.6 Capacitors shall be fitted with terminal covers.

4.7 No toxic gases shall be given off on combustion.

4.8 Capacitors shall have a dielectric efficiency of not less than 99% tested at 70°C.

4.9 Capacitance tolerance : +5; -0% per phase.

4.10 Voltage Rating:

- The capacitor shall be rated to operate continuously at 130% of the nominal voltage (IEC rating plus 20% excess).

4.11 Current Rating:

- The capacitors shall be rated to pass continuously 150% of the nominal rated current (IEC rating plus 20% excess).

4.12 Discharging:

Discharging shall be by means of internal resistors or transformers. The discharging period shall be maximum 5 minutes to reach a voltage of 50V.

4.13 Interlocking:

Interlocking shall be provided to prevent closing of the contactor during the capacitor discharging period.

5. Group or Central Compensation

5.1 Group or Central Power Factor Correction shall consist of the number of kVAr steps as specified in the project specification.***

5.2 Power factor correction equipment shall be installed indoors unless otherwise specified.***

- Indoor Enclosure Protection IP44
- Outdoor Enclosure Protection IP55

5.3 The control of power factor correction equipment shall be such that no leading power factor can occur.

5.4 Where power factor correction is done on a group or central basis the capacitors, control equipment and switchgear shall be housed in a combined free-standing cubicle with suitable lockable doors to gain access to the capacitors.

5.5 The power factor correction equipment shall be complete with all equipment, internal wiring, busbars, labels, current and voltage transformers, etc in accordance with the associated standard specifications.

5.6 All wiring, connections, instruments and other equipment shall be flush mounted inside the cubicle and not on the outside.

5.7 Fuse Arrangements

The following fuse arrangements shall apply:

5.7.1 Capacitor steps shall each be "group fused". The following shall be the maximum step sizes in kVAr rating per group.

11kV : Maximum 1600kVAr
6,6kV : Maximum 1600kVAr
3,3kV : Maximum 800kVAr
400V : Maximum 200kVAr (100 kVAr preferred)

Internally fused three phase capacitor units shall be provided.

5.7.2 Where kVAr steps exceed the kVAr ratings in Clause 5.7.1 two or more groups which are individually "group fused" shall be provided per step

5.7.3 Where kVAr steps exceed the kVAr ratings hereunder externally fused capacitor units shall be provided:

11kV : 4800kVAr
6,6kV : 4800kVAr
3,3kV : 2400kVAr

5.7.4 The "group fuses" shall be rated to protect the capacitors against rupture and will have a rating of approximately twice the capacitor bank current. HRC fuses shall comply with Standard Specification E205.

5.7.5 A tripping system shall be brought into operation by a blown fuse which shall automatically lock the switch mechanism to prevent closure. The tripping of any single phase shall open all three phases and lock the switch in the open position pending fuse replacement.

5.8 Control Switches and Push Buttons:

- Control switches and push buttons shall comply with Standard Specifications E205 and E213.

- An ON/OFF control switch shall be provided.

- An automatic/manual switch shall be provided.

- When in manual mode it shall be possible to control the power factor utilizing push buttons to switch the capacitor steps.

5.9 Indication or Signal Lights:

- Signal lights shall comply with Standard Specification E213.

- Each stage shall have an indicating light to show which stages are energised and which stages are being called on to energise.

- Signal lamps to indicate alarms, main switch-off and power factor out of tolerance.

- A signal lamp shall also be provided indicating protection relay operated.

- LED cable alive indication lamps shall be provided on the three phases of the incoming high voltage cables.

5.10 Meters

- Meters shall comply with Standard Specification E215.

- Each power factor correction equipment cubicle shall be provided with the following:

1) 1 x voltmeter with selector switch.
2) 1 x power factor meter.
3) 1 x kVAr meter.

4) 3 x Ammeters

5.11 Alarms

A visible alarm and buzzer with manual override facilities shall be provided on the cubicle to activate the alarm under the following conditions:

1) Main switch switched off and capacitor step fuse blown (power for alarm taken from incoming side of main switch).

2) Power factor out of tolerance (with suitable time delay to give the system time to react to any changes).

5.12 Counters

Each step shall be provided with a non-resettable counter indicating the number of times which a step operated.

5.13 Rotation of Steps

When kVAr banks of the same size are specified the steps to be switched in first, second, etc. shall be rotated.

5.14 Surge Protection

Surge protection shall be provided at the terminals where the low voltage auxiliary power (231V) enter the PFC cubicle as well as at the power terminals of the PLC or Reactive Power Controller. Surge arresters shall be provided on both the Live and Neutral conductors and shall be properly bonded to the earth conductor.

5.15 Busbar and Busbar Trunking

Busbar and busbar trunking shall comply with Standard Specification E206.

Busbar trunking shall only be used for connecting the power factor correction equipment to the electrical system, if specified in the Project Specification.*** If this is not specified, cables shall be used for the interconnections

5.16 Labels shall be provided on all panels containing power factor correction capacitors to warn the maintenance personnel about possible static charges on the capacitors which should be discharged before attempting any maintenance work.

6. Medium Voltage Power Factor Correction Equipment (above 3,3 kV)

6.1 Each capacitor step shall include the following electrical equipment in accordance with the associated standard specifications (number given in brackets):

- Switch-disconnector (E225)
- HRC fuses BS type
- Current transformers (E207)
- Vacuum or SF6 contactors (E226)
- Earthing Switches (E226)
- Series reactors (E226)
- Voltage transformers (if required) (E227)
- Expulsion fuses if capacitors are externally fused.

- Protection relays

Refer also to the relevant standard specifications as indicated pertaining to abovementioned equipment. Unless otherwise specified the rating of equipment shall be at least 1,5 times the capacitor current rating.

6.2 Contactors

Each step shall be individually controlled by a vacuum or SF6 contactor. The contactors shall be restrike-free when breaking capacitive loads.

6.3 Series Reactors

Suitably rated series reactors shall be mounted on each phase of each step to provide protection to switchgear and capacitors against inrush current surges.

6.4 Protection Relays for Medium Voltage Power Factor Correction Equipment:

6.4.1 Each capacitor step shall be provided with a protection relay with the following features:

- Inverse - Time Harmonic Over-current : Maximum THD voltage: selectable 5% or 10%

- Definite - Time 50 Hz Overvoltage : 112%

- Instantaneous 50 Hz Overcurrent : 1,4 x rated capacitor current

- Earth Fault Current 50 Hz : 6 to 60% of rated capacitor current

- Unbalance Current 50 Hz : 1 to 30% of rated capacitor current

Unless otherwise specified*** the ratings of the relay shall be as follows:

- Auxiliary Power Supply : 230 VAC

- Current Transformer Input : 5A

The relay shall also include the following features:

- Trip Relay : 2 contacts
- Alarm Relay : 1 contact
- Trip Indicators : LEDS for all trip functions

The Contractor shall provide to the Engineer a complete set of calculations and recommended relay settings for each step one month prior to commissioning. The Contractor shall be responsible to set the relays on site and to instruct the personnel of the Employer in respect of the operation of the relay. If the Contractor is not familiar with the relay a representative of the relay manufacturer shall be paid by the Contractor to execute this function.

6.4.2 Where capacitor banks or steps of the double star connections is offered a current transformer shall be connected between the two unearthed neutral star points for detection of unbalance currents. A sensitive current relay connected to the current transformer shall be utilised to trip the contactor.

6.5 Reactive Power Control

- The power factor shall automatically be controlled by means of a programmable logic controller (PLC) and a suitable kVAr transducer connected to the current and voltage transformers. The PLC is to be provided with a programming device.

- Under no circumstances shall the program memory of the PLC be lost due to power outages of extended periods or when the system is disconnected and not operational. The PLC shall be equipped with an EPROM I.C. programmed for the specific application after final commissioning.

- The Power Factor Correction (PFC) steps shall be selected based on programmable set points.

The following time delays shall be applicable before each step is switched

Delay Before Switch-in : System lagging for 30 seconds
Delay Before Switch-out: System leading for 20 seconds

The following current set points shall be applicable :

Switch-in = > 1,2x bank size lagging
Switch-out = > 0,3x bank size leading

- The step switch-in cycle shall take the capacitor discharging time into account when applicable.

- The PLC shall be programmed to provide no-volt or mains failure return control which switch the banks off after a selectable period (0 - 500 ms) after a mains failure occurred.

- Harmonic suppression shall be provided to ensure the PLC is not adversely affected by harmonic currents or voltages.

- Further fail safe operation shall be provided namely that in the event of loss of phase, current transformer failure or control supply (longer than 20 milli-seconds) a control relay shall de-energise all outputs and on restoration set up the sequence from step one after taking a new measurement.

- It shall be possible to set the target power factor and to set an alarm cos ø limit below the set point.

- The PLC software shall be well documented particularly with relation to set points, timers and interlocks.

6.6 Constant Voltage Transformer

- The control circuits of the power factor correction equipment and the supply to the PLC shall be provided with power from a suitably rated constant voltage transformer (CVT) in order to limit malfunctions due to transients and voltage dips on the system. The CVT shall be housed inside the PFC cubicle.

7. Low Voltage Power Factor Correction

7.1 Each capacitor step shall include the following electrical equipment in accordance with the associated standard specifications (number given in brackets):

- Switch-disconnector (E205)

- HRC fuses (E205)
- Current transformers (E207)
- Contactors (E205)
- Harmonic watchdog if specified***.

Refer also the relevant standard specifications as indicated pertaining to abovementioned equipment. Unless otherwise specified the rating of equipment shall be at least 1,5 times the capacitor current rating.

7.2 Protection Relay

A harmonic watchdog relay shall be provided where specified*** with a single channel THD transducer which provide an accurate current loop signal proportional to Total Harmonic Distortion (THD), and with a relay output with adjustable trip level.

- Rated input : 5A
- Rated output : Adjustable 1-50% of rated 50 Hz input
- Current loop output : 4-20 mA = 20% THD of rated 50 Hz input

A suitable harmonic watchdog relay is obtainable from Strike Technologies (Pty) Ltd.

7.3 Reactive Power Control

7.3.1 The power factor shall automatically be controlled by means of Reactive Power Control Relay.

7.3.2 The reactive power controller shall be of the solid state adjustable type suitable for the operating voltage.

7.3.3 The controller shall be flush mounted in the panel.

7.3.4 The regulator shall have no-volt or mains failure return characteristics.

The no-volt or mains failure return control equipment shall also allow the switching off of all banks after a total mains failure occurred, to minimise the total inrush currents to all banks.

7.3.5 Further fail safe operation shall be provided namely that in the event of loss of phase, current transformer failure or control supply (longer than 20 milli-seconds) a control relay shall de-energise all outputs and on restoration set up the sequence from step one after taking a new measurement.

7.3.6 When the measured lagging or leading power factor value exceeds a preset level, a minimum time lag of 20 seconds and maximum of 30 seconds for an on or off switching step shall take place. Switching time from stage to stage shall be independent of the reactive power.

7.3.7 The sensitivity of response shall be continuously adjustable, by current lagging or leading.

7.3.8 Harmonic suppression shall be incorporated as standard to avoid zero crossing error caused by a distorted waveform.

7.3.9 It shall be possible to set the target power factor and to set an alarm cos ø limit below the set point.

7.3.10 The reactive power controller shall also take the discharging time of the capacitors into account when applicable.

7.3.11 To match the controller to various capacitor step sizes and input current transformer ratios it shall be possible to set the activating current by altering the "C/K ratio".

8. Installation and Erection

8.1 The power factor correction equipment shall be properly fixed to the floors or supporting steel work.

8.2 The Contractor shall note sizes and positions of cable trenches and vertical shafts and shall include in his tender all supporting steelwork to straddle trenches and vertical shafts to support power factor correction equipment securely.

8.3 The prices for the erection of power factor correction equipment shall include the making off and terminating of all cables and wires.

8.4 The power factor correction equipment shall be properly earthed to the substation and/or building earthing system.

8.5 When aluminium core cables are used, suitable tinned copper or aluminium lugs with Densal paste shall be used for the terminations.

8.6 The costs for the supply and delivery of the lugs and paste shall form part of the price for the erection of the power factor correction equipment.

9. Routine Tests

Test certificates of capacitors for the following tests shall be submitted to the Engineer:

- Measurement of capacitance.
- Measurement of tangent delta.
- Terminal/Terminal voltage test.
- Terminal/Casing voltage test.

10. Additional Information Required

In addition to details of normal type and routine tests, as well as any other design and test information, Contractors shall submit the following at tender stage:

- Dielectric type (eg. mixed or all-film)

- Maximum element voltage at rated capacitor voltage.

- Maximum field strength in kV/mm calculated with nominal dielectric thickness (i.e. using weight method in the case of plastic film), referred to the nominal element voltage.

- Number of elements in parallel and in series per unit.

- Ratio of partial discharge inception voltage (PDIV) to rated voltage.

- Guaranteed average power losses in watts/kVAr at 40°C.

- Tank rupture TCC curves if external fuses are offered.

11. Drawings

Drawings shall comply with Standard Specification E200.7.

At tender stage Tenderers shall submit general assembly drawings of equipment offered indicating the dimensions of equipment and the positions of cable terminations.

12. Harmonic Filters

Where harmonics are generated by non-linear loads e.g. uninterruptable power supplies, variable speed drives, soft starters etc, or exist on the system, the project specification*** will state whether the power factor correction shall be provided by detuned or tuned harmonic filters instead of just by plain shunt capacitors.

The requirements for any or all of the following will be specified in the project specification:***

Harmonic studies
Harmonic filter designs
Harmonic filter manufacture and installation.

E227 VOLTAGE TRANSFORMERS: (3,3 kV AND ABOVE)

1. Voltage transformers shall comply with SANS 60044-2 and shall be of the oil-immersed, air-insulated or encapsulated type, except when associated with air break, vacuum or SF6 circuit breaker when the oil-insulated type will not be permitted.

2. The normal ratio and rating shall be as specified in the project specification.***

3. The primary side of all voltage transformers shall be connected to the circuit through current limiting resistances and HRC fuses. It shall not be possible to gain access to these with the voltage transformer in service. The voltage transformers shall be of the plug-in type and shall be so arranged that they can be isolated and removed without affecting the associated circuits. The primary shall be connected to the busbar or cable side of the breaker as indicated on the drawings.***

4. When transformers are withdrawn, the plug connections on the switch panel shall be fully shrouded by means of automatic shutters. The shutters shall have padlocking facilities. It shall also be possible to lock the transformer in the 'service' position.

5. The secondary side of all voltage transformers shall be fused and one phase or the neutral, if it is available, shall be earthed. No fuses shall be fitted in a phase circuit that is connected to earth. On three-phase voltage transformers the neutral shall be brought out, and earthed. Care shall be taken to ensure that only the neutral or a phase, not both, is earthed.

6. Each group of voltage transformers shall be earthed directly to the earth bar by means of isolating links of the type where the link cannot be removed from the terminal. These links shall be readily accessible and safe with the voltage transformer racked out.

7. Voltage transformers shall be able to withstand the same surge voltages as the switchgear to which they are fitted.

8. Sufficient means shall be provided to prevent the paralleling of voltage transformers.

9. The burden of the voltage transformers shall be sufficient to drive all meters, relays, heaters and battery power supplies (if specified)***.

10. Class 1,0 voltage transformers shall be used, unless otherwise specified.

11. If remote metering is specified*** in the project specification then the voltage transformers shall also be wired to an easily accessible terminal block at the back of the appropriate panel.

E228 MEDIUM VOLTAGE PROTECTION AND RELAYS

1. GENERAL

1.1 Each circuit breaker and contactor shall be fitted with protection and auxiliary relays as specified on the drawings or project specification.***

1.2 Where the circuit breaker or contactor is to be equipped for remote indication and control, all the auxiliary relay switches shall be wired to an easily accessible terminal block on the back of each panel.

1.3 All measuring relays shall be supplied with built-in test facilities to enable secondary injection testing and measurement of currents, voltages, time delays and operating characteristics without disturbing any connections and without danger of opening CT circuits on load or causing false tripping. These test facilities shall be to approval. The supply of two test handles/plugs of each size and type shall form part of the contract.

Where the measuring relay does not have built-in test facilities, an equivalent separate front panel mounted test facility shall be provided for each measuring relay (or group of measuring relays where agreed by the Engineer). This protective relay test facility shall not be of the type where connections are made by open or short-circuiting link terminals and making screw clamped connections but of the type where connection of test equipment can be made by plugging in a test plug or handle.

1.4 Combined measuring protective relays shall be equipped with means to indicate whether the operation was due to phase overcurrent, earth fault, high-set instantaneous or inverse time. Where high set relays are provided with or combined with a time delay, the high set current relay operation shall only be indicated when the associated time delay has expired.

1.5 Where the MV bus is specified in the project specification*** to be provided with phase and earth fault busbar protection of the blocking type (whereby the detection by the incoming circuit of a fault condition will cause tripping of the busbar unless a relay on an outgoing circuit has also detected the fault and caused the incoming circuit relay's tripping impulse to be blocked), the overcurrent and earth-fault relays on the incoming and outgoing circuits shall be provided with fast current detector/starting outputs having current setting ranges to match, at least, the setting ranges of the delay overcurrent and earth fault relays.

1.6 Unless otherwise approved, all relays shall be of the flush, panel mounting draw-out type, and shall be clearly labelled to indicate their respective functions and shall be contained in dust-proof cases.

1.7 Relay terminal studs shall not be less than 5mm diameter, or, alternatively, relay connections shall be of an approved plug-in type.

1.8 Relays shall be with self-resetting targets. The targets shall not operate until the relay has closed its tripping contacts and resetting shall be accomplished without opening the case. The targets shall not be tripped by vibration caused by normal or fault operation of the associated circuit breakers.

1.9 Relay contacts shall be capable of repeatedly making and, where the circuit renders it necessary, repeatedly breaking, without deterioration, the maximum current possible in the circuit they control for at least the maximum duration of a fault as is set by the protective devices. Where more than one set of contacts is provided, all contacts shall operate simultaneously. Tripping

contacts shall not close due to vibration engendered by the normal or the fault operation of the associated circuit breakers.

1.10 Unless otherwise specified, the relays shall be fitted with self-resetting contacts. Where hand reset relays are specified, resetting shall be accomplished without opening the case.
All hand reset relays shall be accessible to a person of normal height standing on the floor, unless otherwise approved.

1.11 The number of contacts provided on each relay shall be as specified in the schedule or drawings.*** Unless otherwise specified, contacts shall be available for external use and shall be individually wired. Hand or electrically reset relays shall be provided with an additional contact connected internally to interrupt the operating coil current. Electrical reset relays shall, in addition, if called for the provided with a contact connected internally to interrupt the resetting coil current. Electrical reset relays shall preferably also be fitted with hand resetting features. Make contacts shall be taken to mean contacts which are open when the relay is de-energised or reset. Break contacts shall be taken to mean contacts which are closed when the relay is de-energised or reset.

1.12 All trip relays and master trip relays shall be capacitor discharge proof, i.e. they shall not operate when a capacitor of 10 micro farad charged to 2 x EL dc (i.e. to 220V dc) is discharged through the operating coil.

1.13 Tripping duty contacts shall be capable of making and carrying 30A dc for 200ms in a circuit with a L/R of > 10ms.

Breaking duty contacts shall be capable of breaking the current of the associated controlled device on the specified breaking current in a circuit with a L/R of < 40 ms.

1.14 Where dc auxiliary supply voltages are specified, the supply for the relays comes from batteries. The battery voltage can vary about the nominal value to + 20% and - 20% and relays shall be capable of operating within these two limits. The relays shall also be capable of operating in the ambient temperature range of 0 - 55 degrees Celsius.

Where electronic or static relays are offered, these shall not malfunction if the dc auxiliary supplies are switched on or off or switched repeatedly at a random rate.

1.15 Trip indicators for Buchholz and temperature trip indication shall preferably be of the current operated type and each element shall have a coil with pick-up currents and rating to match the current of the associated tripping circuits, whether relay or breaker, down to 50% or nominal battery voltage.

1.16 Where the circuit breaker is to be equipped for remote indication and control, all the relay auxiliary switches shall be wired to an easily accessible terminal block on the back of each panel.
1.17 Allowance shall be made for additional terminal blocks on every panel for testing purposes if solid state relays are offered. Combined solid state overcurrent and earth fault relays shall be equipped with indicating flags or lamps showing the nature of the fault.

2. ELECTRONIC EQUIPMENT

2.1 When electronic equipment is mounted on racks these shall be the standard 19 inch type, fitted with cubicle surrounds with lockable doors and provided with adequate ventilation.
Electronic schemes shall be supplied with power supplies which shall be capable of operating over the dc voltage and temperature ranges specified above.

Particular attention shall be paid to the accessibility of components for maintenance and testing. All printed circuit cards shall be fully withdrawable and print extenders or adapters shall be provided to facilitate testing.

2.2 Equipment requiring built-in batteries will not be acceptable unless otherwise approved in writing by the Engineer.

2.3 All semi-conductor devices shall be of the silicon type.

2.4 DC/DC converters or approved equivalent means shall be provided to furnish the power supplies required for static relays. These shall provide galvanic isolation and protection against induced voltage surges of longitudinal or transverse mode. They shall operate over the specified + - 20% of nominal voltage and be provided with healthy output indication and remote alarm facilities in the event of supply failure. The converters shall be short circuit proof.

2.5 Static relays shall comply with the test requirements if IEC 255-4 as follows:

Insulation Test Voltage:

2 kV, 50 Hz, 60 sec.

Impulse Test
5 kV, 1,2/50 us, 0,5 joule (according to Appendix E)

High Frequency Disturbance Test:

Common mode 2,5 kV, 1 MHz/Transverse mode 1 kV, 1 MHz (according to Appendix E)

Fast Transient Test:

Fast transient (showering arc) test SEN36. 15.3 with a peak value of 4-8 kV.

2.6 Diodes:

Where blocking diodes are required for the operation of the circuit, these shall be of the silicon avalanche type having a rated PIV of 800 volts minimum. They shall have a continuous current rating to match the maximum current which they will be required to carry in service.

3. INVERSE-TIME AND INSTANTANEOUS OVERCURRENT

3.1 The relays shall be provided with three ac overcurrent elements (51) having at least:

a) Standard inverse time characteristic to BS142.

b) Very inverse time characteristic.

c) Extremely inverse time characteristic.

The current plug setting range shall be 50 - 200% of relay rated current.

The overshoot at 20 x setting shall be less than 40 ms (Standard inverse relay) or 65 ms (very inverse and extremely inverse relays). The resetting current shall be greater than 90% of the setting.

A set of N/O (make) contacts wired out of separate terminals shall be provided.

3.2 The relay shall also be provided with three high set instantaneous overcurrent elements fitted with a set of N/O (make) contacts wired out to separate terminals.

The settings range shall be 400 - 1600% of relay rated current and the transient over reach factor shall be less than 120%.

3.3 Each inverse element and each instantaneous element shall be provided with a hand reset operation indicator.

3.4 The relay current circuit thermal rating shall be at least twice the setting current continuously and 20 x the maximum setting current for 3 seconds.

3.5 All relay tripping contacts shall be capable of making and carrying 30A dc for 200ms in a circuit with L/R > 10ms.

Where the measuring relay contacts are not capable of this duty, separate high speed self-resetting tripping relays shall be provided.

4. INVERSE TIME EARTH FAULT

4.1 The relays shall be provided with three ac over-current elements having at least:

a) Standard inverse time characteristic to BS142.
b) Very inverse time characteristic.
c) Extremely inverse time characteristic.

4.2 The current plug setting range shall be 20 - 80% of relay rated current.

4.3 The overshoot at 20 x setting shall be less than 40ms (Standard curve) or 65ms (extremely inverse curve).

4.4 A hand reset operation indicator and a set of N/O (make) tripping duty contacts wired out to separate terminals shall be provided

4.5 The current circuit thermal rating shall be 20 x the maximum setting for 3 seconds.

5. TRIP SUPERVISION RELAYS

5.1 These shall be suitable for supervising the trip circuit of circuit breakers or latched contactors with the circuit breaker or contactor open or closed. The relays shall be delayed on drop-off by 100 – 400 ms to prevent spurious operation during breaker operation or during clearing of the dc faults.

5.2 Resistors shall be provided to ensure no tripping will occur if the relays are accidentally short circuited.

5.3 The relay burdens shall be kept to a minimum to prevent excessive drain on the tripping and alarm batteries.

5.4 Normally this trip supervision consists of 3 relays A, B and C where relay C is a repeat relay for A and B. Relay C shall be wired to separate terminals so that it can be connected to a supply independent of that for A and B. The operation indicator shall be hand reset.

The relay shall be fitted with two normally open N/O (make) contacts and one normally closed N/C (break) contact, self-reset, and wired to separate terminals.

6. SELF-RESET TRIPPING RELAYS

6.1 These shall be self-reset relays fitted with at least two normally open tripping duty contacts separately wired out, and a hand reset flag indicator. The relay operating time shall be of the order of <10ms at rated voltage.

6.2 The relays shall be capable of operation down to 53% of rated voltage and shall be of the high burden type capable of withstanding the capacitor discharge test.

7. HAND RESET MASTER TRIPPING RELAYS

7.1 These shall be similar to Clause 6 above but the contacts and flag shall be hand reset. The relay shall be fitted with an internal coil cut-off contact and 3 N/O and 1 N/C (external) contacts. All contacts shall be wired to separate terminals.

7.2 The relays shall be provided with an obvious operation indicator or a separate flag indicator.

8. AC UNDERVOLTAGE RELAYS

8.1 These shall be definite time delayed relays having a drop-out of 60 - 90% nominal voltage rating and a pick-up/drop-out ratio not exceeding 105%.

8.2 The time delay shall be adjustable over the range 0,5 - 3 seconds. Two self-reset normally open N/O (make) contacts wired out to separate terminals are required together with a hand reset flag indicator which operates only on expiry of the set time delay. The relay shall preferably operate in the "fail-safe" mode, unless otherwise specified, i.e. loss of ac or auxiliary dc shall result in tripping of the associated breaker or contactor.

9. DEFINITE TIME DELAY RELAYS

9.1 These shall preferably be or the high precision static type with time delay adjustable over the range 0,01 - 9,99 seconds in 0,01 second increments.

9.2 The accuracy at nominal voltage shall be of the order of + - 5% of setting or + - 10ms whichever is the greater, over an ambient temperature range of 10 - 30 degrees Celsius.

9.3 The repeatability shall be within + - 1% or + - 10ms, whichever is the greater, assuming the relay resets completely between successive operations.

9.4 The relays shall be fitted with two self-reset normally open N/O (make) tripping duty contacts and a hand reset flag indicator.

10. INFORMATION WITH THE TENDER

The following information concerning the relays shall be submitted with the tender:

10.1 Complete descriptive information in English or Afrikaans explaining the operation of the relays for internal and external fault and the methods for determining the required settings.

10.2 Circuit diagrams of relays.

10.3 Outline dimensions of relays.

10.4 Schematic diagrams of overall protection schemes.

10.5 Outline dimensions of cubicles.

10.6 Detailed block diagrams for printed circuits in the case of electronic relays.

E229 3,3 kV TO 33 kV SWITCHGEAR (CIRCUIT BREAKERS)

1. GENERAL

1.1 The Contractor shall supply and install high voltage switchgear as specified in the Project Specification and indicated on the drawings.

1.2 Type of Switchgear

Contractors may offer minimum or bulk oil or SF6 or vacuum type circuit breakers unless otherwise specified*** in the Project Specification. All circuit breakers shall be trip-free, horizontal or vertical isolating, horizontal draw out type. Full details of circuit breakers offered shall be submitted with tenders.

1.3 Characteristics of Switchgear

1) Number of poles : 3

2) Type : Indoor

3) Rated voltage : The switchgear shall be suitable for the rated voltage and system conditions as set out in the Project Specification.***

4) Rated impulse withstand : As specified in the Project Specification.***

5) Rated frequency : 50 Hz

6) Fault rating : The fault rating of switchgear shall be one of the following as set out in the Project Specification***: 8 kA, 12,5 kA (or 13,1 kA*) 20 kA (or 18,4 kA*) or 25 kA.

*These ratings are acceptable unless otherwise specified.

7) Duration of short circuit : 3 seconds.

8) Phase rotation : Anti-clockwise, Red-Yellow-Blue-Red, unless otherwise specified.***

1.4 Busbars

Single or double set of busbars shall be used as set out in the Project Specification***. All busbars shall be insulated, including busbar joints and T-off points.

1.5 Auxiliary Switches

1) If the equipment is to be suitable for remote indication, as set out in the project specification***, then auxiliary switches shall be provided to give the status of the circuit breaker, isolator and spring.
For double busbar switchgear, auxiliary switches are required to give the positions of each circuit breaker relative to each set of busbars.

2) Over and above the number of auxiliary switches specified above, provision shall be made for additional auxiliary switches for the interlocking as specified in the Project Specification***.

3) In addition to the number of auxiliary switches specified in (1) and (2) above, two normally open and two normally closed spare auxiliary switches shall be provided for each circuit breaker and isolator.

4) All the auxiliary switches on each panel shall be wired to an easily accessible terminal block at the back of each panel.

1.6 Instrumentation and Lamp Indication (Refer also to Clauses E213 and E215)

1) Metering instruments shall conform to the requirements specified herein. Metering instruments and lamp indication shall be provided as set out in the project specification*** and indicated on the drawings.

2) Where indicating lamps are supplied from the batteries, they shall be separately wired from the mechanism and tripping circuits to an easily accessible terminal block at the back of a panel.

1.7 Oil or SF6

The price for the supply and delivery of switchgear shall include the supply, delivery and filling of suitable and sufficient oil or SF6 gas, where applicable.

Prior to acceptance the Contractor shall prove at his own cost that the switchgear is sufficiently filled and that the oil or SF6 gas complies with the specified standards.

1.8 Cable End Boxes, Clamps and Terminations (Refer to Clause E212)

1) The switchgear riser terminals shall be properly tinned.

1.9 Earthing Arrangement

1) Each circuit breaker and isolator shall be so constructed that it is possible to earth the cables.

2) It shall not be possible to earth the busbars under any circumstances.

3) The complete switchboard shall be provided with a continuous copper earth bar at the back of the panels.

1.10 Labelling (See Clause E214)

1.11 Anti-condensation Heaters

1) 30 W, 230 V Anti-condensation heaters shall be provided and installed in the busbar and current transformer chambers, unless otherwise specified.

2) The heaters shall be controlled from an "ON/OFF" switch installed on one of the panels - preferably the bus-coupler panel.

3) The heaters shall be supplied from the voltage transformer or an external supply if no voltage transformer is specified or the voltage transformer is fully loaded. Where an external supply is to be used, the heaters shall be suitably wired to a terminal block at the back of each panel.

1.12 Panel Wiring and Terminal Blocks (See Clauses E209 and E210)

1) Unless otherwise specified or approved, no fuses shall be installed in any tripping circuits, but holder-mounted links shall be provided instead.

1.13 Cable Trench Checker Plate Supports

When the design of the switchgear is such that the gear has to overhang the cable trench, switchgear manufacturers shall fit suitable, adjustable treated angle iron brackets to the bottom frame at the rear of switchgear to support the checker or asbestos plates of substation cable trenches. Where frame leakage protection is specified these angle irons shall be treated with PVC sheath to isolate the checker plates from the switchgear.

1.14 Tools

1) If the design of switchgear is such that integral earthing of cables is not possible, then suitable earthing equipment shall be provided for each type of circuit breaker and isolator for each substation.

2) Suitable testing prongs and jumpers shall be provided for the switchgear for each substation where the design of switchgear requires such equipment.

3) At least two spring charging handles, operating handles and switchgear door keys (where applicable) shall be provided for each substation.

4) Wall-mounted brackets shall be provided at each substation for carrying the manual operating handles and test jumpers.

5) If special tools are required, a complete set of finished case-hardened spanners and special wrenches to fit every nut and bolt on the equipment supplied, shall be provided under this contract at each substation. Any special tools or keys that may be required for effecting adjustments of parts, as well as all standard earthing and test equipment, shall also be provided at each substation.

6) These tools shall be accommodated in a suitable, neat, properly designed, wall constructed steel equipment board with the tool positions marked at each substation. The board shall be capable of being locked by means of a padlock.

7) A fully detailed list of tools shall be supplied before delivery.

8) The tools shall not be used for the erection of the contract works.

1.15 Spare Fuses
Switchgear shall be provided with spring assisted hand operated and Lamps (See Clauses E205 and E213)

2. CIRCUIT BREAKERS

2.1 Operating Mechanisms

1) 8 kA mechanisms or any other standard mechanisms approved by the Engineer.

2) Other circuit breakers can be provided with spring operated mechanisms with hand or motor spring charging, or solenoid mechanisms as set out in the project specification***.

3) Spring and solenoid operated switchgear shall be provided with electrical control switches on the instrument panels for local closing and tripping if specified in the project specification***. The

control switches shall be spring returned to the neutral position and shall be so designed that after having once been moved to the "close" position, they cannot again be moved to the "close" position, without first having been moved to the "open" position.

An approved method for locking the control switches in the neutral positions shall be provided.

4) If the above-mentioned control switches are not required, then the circuit breakers shall be fitted with an electrical tripping push button mounted on the front of the instrument panel.

5) If motor wound spring mechanisms and/or solenoid mechanisms are offered, then the Contractor shall ensure that suitable batteries with sufficient capacities are provided to supply the motors and/or solenoids respectively.

6) If remote operations of circuit breakers are specified in the project specification***, then each breaker shall be provided with a "LOCAL/REMOTE" selector switch mounted on the instrument panel. In such a case, all the wiring for remote operation shall be wired to an easily accessible terminal block at the back of each breaker.

2.2 Trip Coils

Each circuit breaker shall be provided with trip coils, suitable for the battery trip circuit voltage, to be operated by the relays as specified.

2.3 Current Transformers (See Clause E207)

2.4 Voltage Transformers (See Clause E227)

2.5 Mechanical Interlocks and Safety Shutters

The following minimum interlocks are required:-

1) It shall be impossible to raise, lower or withdraw the circuit breaker unless tripped.

2) It shall be impossible to close the circuit breaker unless it is either fully plugged-in, fully withdrawn or earthed.

3) It shall be impossible to plug in the circuit breaker or to close it unless the tank is properly secured.

4) When the breaker is withdrawn, the cubicle contacts shall automatically be covered by substantial vermin-proof shutters. Shutters shall be provided with means of padlocking in the closed position.

5) In instances where the control and protection circuits are connected by multicore cable and a plug to the circuit breaker mechanism contacts, additional interlocking will be required to prevent the circuit breaker being closed in the operating position without the protection circuits being connected.

6) All safety shutters shall be clearly and indelibly labelled in letters of the largest possible size, indicating the live apparatus screened off by the shutters.

2.6 Relays (See Clause E228)

3. ISOLATORS (See Clause E225)

4. MULTICORE AND AUXILIARY CABLE CONNECTIONS

The following circuits shall be wired to a terminal block at the back of the panels:-

a) DC Tripping and control circuits.

b) DC Standing load circuits.

c) 230 V AC Circuits for heaters, and other 230V equipment to be supplied from an external source.

d) Other circuits for remote control and remote metering as previously specified.

Contractors shall further allow for external wiring to the panels as follows:-

a) DC Tripping and control supply to the battery charger unit.

b) DC Standing load supply to the battery charger unit.
c) 230 V AC Supply from the building distribution board.

d) All Solkor and other pilot wire protection schemes to a pilot cable termination box.

e) All other circuits required for remote control and supervisory functions to a multicore cable termination box, if specified.

f) All cabling shall be correctly rated and properly marked.

5. INSTALLATION AND ERECTION

5.1 Fixing Drawings

The successful Contractor shall submit a manufacturer's detail drawing with dimensions indicating fixing holes and positions of the switchgear, to the Engineer within 10 days after the appointment, to enable the builder to place the unistruts for fixing the switchgear in the correct position.

5.2 Alignment and Fixing of Switchgear

1) The switchgear panels shall be properly aligned, erected, plumbed, bolted together and fixed onto the floor.

2) If the floor is not level, suitable non-perishable packing material shall be used to level the switchboard.

3) Each individual panel shall be levelled before the panels are bolted together.

4) The panels shall be assembled and erected strictly in accordance with the manufacturer's instructions, which shall be issued to the Installation Contractor by the manufacturer.

5) Switchgear trucks shall move freely and shall be properly aligned.

6) If frame leakage protection is specified, the switchgear shall be erected in such a manner that it is fully insulated from the floor and any earth.

5.3 Cabling

1) All paper insulated cables shall be wiped unless the use of heat-shrink type terminations are approved by the Engineer. A stranded copper earth conductor shall be wiped into the cable end wipes.

2) Cross-linked polyethylene cables shall be made off with suitable terminating kits recommended by the cable manufacturer and approved by the Engineer. These cables shall be properly clamped with wooden blocks fixed to the switchgear.

3) Suitable wooden blocks shall be fixed to the wall of the cable duct to support all cables from 95 mm2 and larger.

4) The switchgear and all cable earth conductors shall be correctly earthed to the substation earthing system.

5) Low voltage and pilot cables shall be properly made off by using glands and shall be supported and terminated where required.

6) All entrances to the panel shall be vermin-proofed.

5.4 Tool Boxes and Brackets

All tool boxes and testing equipment brackets shall be properly fitted against substation walls in suitable positions.

5.5 Fuses and Lamps for Commissioning

The Contractor shall not use the spare fuses and lamps for the commissioning of the switchboards.

5.6 Cable Duct Cover Plates

The Installation Contractor shall cut the duct cover plates to the correct size and shape. All cut edges shall be repainted, whereafter the cover plates shall be replaced.

5.7 Earthing

Each installation shall be correctly connected to the substation earth bar by means of a 70 mm2 stranded copper conductor or 30mm x 3mm copper bar, at a minimum of two points.

E231 MEDIUM VOLTAGE (UP TO 33 kV), LOW VOLTAGE AND PILOT CABLES

1. General

1.1 The Contractor shall supply and install cables as specified in the Project Specification*** and indicated on the drawings.

2. Cable Construction

2.1 Medium Voltage Cables

2.1.1 Paper-insulated Cables

1) Heavy duty, mass-impregnated, belted, non-draining, paper-insulated, lead-covered, steel wire armoured, unearthed, stranded 3-core cables, shall be supplied, which shall conform to the latest

issue of SANS 97. If steel tape armouring and/or screened cables are preferred, it will be specified*** in the project specification.

2) Cables shall have an outer serving of PVC, unless otherwise specified.

3) Anti-electrolytic cables, where called for, shall finally be served with PVC. The following information shall be printed on the outer PVC sheath, in the factory, where possible:-

Voltage, e.g. : 11 kV

Size, e.g. : 185 Cu or 185 A1.

Name of Client : If required in Project Specification***

The abovementioned information shall be printed on the cable at reasonable intervals.

4) The cores of cables shall be stranded copper or aluminium conductors as specified or as alternatively offered.

2.1.2 Cross-linked Polyethylene Cables

1) Cross-linked polyethylene (XLPE), 3 core, steel wire armoured or unarmoured cables of an approved manufacture shall be used when specified***, provided that full technical information is submitted with the tender. All XLPE insulated cables offered shall comply with SANS 1339. Cores shall be individually screened.

2) The type of cable required shall be specified in the Project Specification.***

3) The following information shall be printed on the outer PVC sheath, in the factory, where possible:-

Voltage, e.g. : 11 kV
Size, e.g. : 185 Cu or 185 A1.
Name of Client : If required in Project Specification***

The abovementioned information shall be printed on the cable at reasonable intervals

2.2 Low Voltage Cables (1000 V)

2.2.1 Cables

1) All low voltage cables shall be polyvinyl chloride insulated with steel wire armouring or strip aluminium armouring, as specified***, and served overall with a final layer of polyvinyl chloride.

2) Cables shall be round with the number of cores specified and suitable for general service as prescribed in SANS 1507.

3) The cores shall be stranded copper or solid shaped aluminium.

4) The cables with stranded copper cores shall be armoured with single steel wire armouring, unless otherwise specified.

5) The cables with solid aluminium cores shall be armoured with strip aluminium armouring or steel wire armouring as specified.

6) Cables with tinned copper earth continuity conductors as part of the armouring shall only be provided when specified*** in the project specification.

2.3 Pilot Cables

2.3.1 Specification and Core Sizes

Pilot cables shall comply with the applicable SANS.

Pilot cable cores shall be 0,9 mm diameter unless otherwise specified.

2.3.2 Working Conditions

The pilot cables may be installed in the same trenches as low voltage or high voltage power cables at depths varying between 0,8 and 1,5 m. Pilot cables may also be installed directly underneath and parallel with overhead power lines.

Pilot cables shall be used for protection applications, as well as speech and data communications.

2.3.3 Electrical Requirements

1)	Continuous working voltage	:	250 V, 50 Hz between cores
2)	Maximum loop resistance	:	56 ohm/km
3)	Minimum insulation resistance	:	30 000 megaohm/km
4)	Mutual capacitance of pair	:	60 nanofarad/km maximum at 800Hz
5)	Capacitance unbalanced	:	600 pF/km maximum at 800Hz
6)	Overvoltage withstand capabilities	:	5 kV between any two cores; 10 kV between any core and any metal work that may be earthed
7)	General	:	Pilot cables shall be designed to ensure the minimum cross-talk level and maximum immunity against induced effects

2.3.4 Mechanical Requirements

1) Unless otherwise specified, pilot cables for outdoor use shall be petroleum-jelly filled. Contractors may offer cables with a polyethylene/ aluminium laminated sheath as alternative for consideration by the Engineer.

All pilot cables shall in any case be fully waterproof, even when operating for extended periods of time fully submerged in water or waterlogged soil.

2) Cable insulation shall be polyethylene.

3) Bedding layers shall be polyethylene.

4) Galvanized steel wire armouring shall be provided.

5) The outer sheath of the cable shall be PVC and an overall conductive coating of colloidal graphite or other conductive material shall be applied to the serving to facilitate voltage testing to earth.

6) All cores shall be clearly and indelibly identified by means of numbers or a colour code.

7) Contractors may offer alternative cables, but full constructional detail shall be submitted with tenders.

2.3.5 Tests and Inspections

1) All pilot cables offered shall in all respects comply with applicable international and/or Telkom Specifications.

2) Tender prices shall include for the costs of performing the following tests on each drum of cable:-

a) Conductor resistance test

b) Overvoltage tests

c) Capacitive tests

3) The Engineer shall be notified at least two weeks in advance of when such tests are to be performed. The Engineer reserves the right to witness all such tests.

4) Test certificates of all tests shall be submitted to the Engineer prior to or with the delivery of the cables.

2.3.6 Pilot Cable Terminal Boxes

1) The multicore cables shall be connected to the panels and equipment via terminal strips in terminal boxes in all substations when specified in the project specification***.

2) The Contractor shall allow for the supply and installation of centrally situated, wallmounted terminal boxes when applicable.

3) The terminal boxes shall be manufactured from mild steel of minimum thickness of 2 mm. A steel frame shall be used to ensure rigidity where necessary. The terminal boxes shall be fitted with front opening hinged lockable doors.

4) All doors shall be of a neat dustproof fit, and the enclosures shall be completely verminproof.

5) The terminal boxes shall be adequately ventilated for the prevention of condensation.

6) The terminal boxes shall be wall mounted.

7) The terminal strips inside the terminal box shall comply with the standard specification.

8) Terminal blocks shall have separate terminals for incoming and outgoing wires, and not more than two wires shall be connected to any one terminal. Insulating barriers shall be provided between adjacent pairs of terminals. The height of the barriers and the spacing of the terminals shall be such as to give adequate protection while allowing easy access to terminals. The connections shall be suitable for the cables provided.

3. Excavations and Laying of Cables

3.1 General

1) 11 kV Cables, low voltage cables, pilot cables, telecommunication cables and pipes shall be laid in the same trenches, where applicable, and in the positions as shown on the drawings.

The rates for the laying of cables shall include for the laying of cables over or under other services.

2) The spacing between cables shall be exactly as shown on the drawings. The positions of cables shall always be measured from boundary lines of stands, unless otherwise specified.

3) After all cables have been laid and correctly spaced, they shall be inspected and approved by the Engineer before trenches are backfilled. In the event of the Contractor not notifying the Engineer well in advance of an inspection, the Contractor shall then open sections of the trenches for inspection at his own cost.

4) The tender prices for excavations shall include the following:-

a) Excavations of cable trenches.

b) Levelling of the bottom of trenches.

c) Supply and laying of a 75 mm minimum layer of sifted soil.

d) Supplying and covering of the cables with a 75 mm layer of sifted soil after the cables have been laid and spaced and after the inspection and approval by the Engineer.

e) The backfilling and consolidation of trenches with soft soil.

f) The removal of all surplus materials from the sites.

g) Finishing and levelling of sites where excavations were done.

5) Cables shall be drawn off drums in the same direction where more than one drum is involved in a cable laying route. The drums shall be suitably placed along the cable route. All drums shall be rolled as indicated by the arrows marked on the drums.

6) No crossing of cores shall be permitted in cable boxes.

7) The quantities of cable trench excavations as set out in the Schedules of Quantities are estimated quantities. The Contractor will be paid according to the actual quantities as measured on site after the cable trenches have been excavated, measured, the cables laid and the trenches backfilled.

8) All cable trenches and especially road crossings shall be properly consolidated. All road surfaces shall be reinstated to the original condition, unless otherwise specified.

9) The widths of cable trenches which will be used for the purpose of measurements, where applicable, will be determined by the combination of the number of cables and/or pipes as specified in the Project Specification and as shown on the drawings.

3.2 Trench Preparation

Once the trench has been basically excavated, trimmed and levelled, the bed of the trench shall receive the following treatment:-

3.2.1 Trenching in Hand-Pickable Ground

1) The bed of the trench shall be checked for the presence of loose rocks or sharp objects. All loose foreign materials shall be removed, leaving the bed of the trench clear.

2) The cleared bed of the trench shall be lined with a layer of backfill screened through a 4 mm mesh, to a depth of 75 mm.

The bed of the trench shall be levelled in a manner which will prevent the cable riding high at any point along its installation. River sand or mine dump scrap will not be accepted as cable trench bedding.

3.2.2 Trenching in Ground requiring Rock-Breaking or Blasting

Where the cable trench has to be cut through ground requiring compressor drilling, rock breaking and/or blasting, the bottom screened soil backfill shall be laid so that 100 mm of screened backfill covers rocky protrusions. All jagged edges of rock, and foreign materials such as loose rocks and sharp objects shall be removed so as to present no risk of subsequent damage to the cable.

3.2.3 Trench Backfilling

1) Upon completion of the cable laying, the cable shall be covered with a layer of 75 mm of backfill screened through a 4 mm mesh.

2) Subsequent backfilling, above the 75 mm layer mentioned above, shall be screened through a 40 mm mesh.

3) Cable protective slabs (only if specified) shall be placed over a minimum backfill of 75 mm above the cables.

4) Excavated ground backfill shall follow upon Item 2 above, the backfill being consolidated at 300 mm levels. The backfill shall be consolidated to at least the same compaction of the original surrounding soil, but to the satisfaction of the Engineer.

Backfilling and consolidation shall be in accordance with SANS 1200.

5) The backfilled trench shall be domed so as to provide drainage, the dome being 150 mm above the surrounding ground level.

3.3 Road and Railway Crossings

3.3.1 General

The Contractor shall allow in his price for the complete installation of the road and railway crossings as indicated on the drawings.

1) The crossing installations shall be in accordance with the detail drawings included in the contract.

2) All excavations, unless otherwise specified in the tender documents, shall be constructed at right angles to the roads and/or railway servitudes.

3) Rigid PVC or asbestos cement pipes shall be used for the crossings. The pipes shall be properly joined. The open ends of spare pipes shall be sealed with easily removable caps or plugs.

4) All crossings, their construction and implementation, shall be carried out in accordance with the requirements laid down by the Local Authorities, the Provincial Roads Department, and the Department of Transport, the Transnet and others.

5) The rates for the laying of cables shall include the pulling through of cables through sleeve pipes in road crossings.

3.3.2 Road Crossings

1) Excavations across roads shall be carried out with the minimum inconvenience to the public and the authorities.

2) Excavations across main roads where the width of the road between kerbs is 9 meters or more, shall be carried out in half road widths so that the flow of traffic can be maintained.

3) Where tarred road surfaces are cut, such cuts shall be neat and straight and no jagged edges shall be tolerated.

4) Road crossings in townships shall always be opposite a stand boundary peg unless otherwise shown.

5) The excavations shall be of such depth that the dimension from the top of pipe ducts to the road surfaces shall not be less than 1.2 m, or as otherwise specified on detailed drawings.

6) The Contractor shall be responsible for the provision of road warning signs, road barriers, the stringing of danger tapes and the positioning of warning lamps between sunset and sunrise. Flashing type warning lamps shall also be positioned at strategic points in the construction areas to caution motor vehicle traffic.

3.3.3 Cable Pipe Ducts

1) Concrete, asbestos cement, polyethylene or PVC pipes shall be used for cable pipe ducts which shall comply with the relevant SANS specification. Suitable approved joints shall be used for the pipes.

2) The cable pipe ducts shall protrude not less than 750mm and not more than 1 000 mm on either side of the street kerbing.

3) The pipe ducts shall be neatly trimmed at the ends after laying, and a heat-shrinkable duct end cap shall be fitted over each and every open end through which no cable is installed. Where the size of the duct does not permit the fitting of these covers, then the open ends shall be sealed by means of a weak cement mix of 7 sand to 1 cement. Polystyrene plugs of suitable size may also be used.

4) All pipe ducts shall be fitted with galvanized steel draw wires.

5) The ducts shall be laid as shown on the enclosed drawings, the required depths and distances between duct centre lines being shown.

3.3.4 Trench Backfilling and Compaction

1) Only material which is compactable shall be used for the backfilling of road crossing excavations. At the discretion of the Engineer, suitable soil shall be imported for the backfill material. No rocks shall be included in the backfill.

2) The backfilling shall be carried out in 150 mm layers (after compaction), each layer being compacted by means of a compacting machine. Each layer so backfilled shall have a sufficient moisture content to ensure that solid binding of the material is obtained. The backfill shall be compacted to modified AASHTO as specified in SANS 1200.

3) Tar re-instatement shall be carried out within four days of completing the trench backfilling. At this stage, the trench excavation shall be trimmed so as to permit the full thickness of tar re-instatement.

3.3.5 Railway Crossings

1) Crossings of railway tracks shall be carried out in accordance with the latest requirements as set out in the approvals received from the South African Transport Services (Transnet) and the requirements of SANS 15589 for cathodic protection of buried and submerged pipelines.

2) Railway crossings shall comply with the detail drawings issued in regard to main dimensions and installation details.

3) The installation Contractor shall fully familiarise himself with the railway's operational procedure, and the necessary forward planning shall be carried out by him for the safe execution of the work.

3.3.6 Types of Crossings and Duct Sizes

The crossings consist of the following:-

1)	High voltage cable crossings	:	The cables shall be laid in 150 mm dia. pipes. One spare pipe shall be installed for each high voltage cable, unless otherwise specified.
2)	Low voltage cable crossing	:	The main low voltage cables and street-light cables shall be laid in 100 mm dia. pipes. No spare pipes are required for low voltage cables.
3)	Low voltage service connection cable crossings	:	These are crossings between minisubs or cubicles on the one side of the road reserve to low voltage connection boxes or service connection on the opposite side of the road reserve. More than one cable can be laid in the same 100 mm dia. pipes. No spare pipes are required. These pipes shall be installed from the cable reserve on one side of the road reserve to the cable reserve on the opposite side of the road reserve with the ends of the pipe 0,5 m from the stand boundaries.

4) Special crossings : Cable crossings below motor highways and wide railway reserves are special cases and will be specified separately.

3.4 Classification of Excavations

3.4.1 Tenders shall submit rates for excavations in the following soil types

1) Excavations in Soft Materials

Excavations which can, in the opinion of the Engineer, be carried out by pick and shovel or a machine shall be considered as excavations in soft material. The classification definition for "soft excavations" and "intermediate excavations" as set out in SANS 1200, are combined in this specification document as "excavations in soft materials".

2) Hard Rock Excavations

Excavations in formations that require blasting or wedging and splitting, will be classified as hard rock excavations. The rates shall include the removal of rock from site.

3) Boulder Excavations, Class "A"

Excavations in material containing by volume more than 40% boulders ranging in size from 0,03 m3 to 2,0 m3 in a matrix of soft material, will be classified as boulder excavations, Class "A". The rates shall include the removal of rock from site.

4) Boulder Excavations, Class "B"

Excavations in material containing by volume 40% or less boulders ranging in size from 0,03 m3 to 2,0 m3 in a matrix of soft material, will be classified as boulder excavations, Class "B". The rates shall include the removal of rock from site.

3.4.2 The excavations will be measured as set out in SANS 1200. Excavations in soft materials will be measured on a linear basis.

The measurement for the following excavations will be on a volumetric basis and it will be considered as an extra over rate:-

1. Hard rock excavations

2. Boulder excavations, Class "A"

3) Boulder excavations, Class "B"

3.4.3 The Engineer's decision as to the type of excavations excavated shall be final and binding, and the Contractor shall be paid in accordance with the classification by the Engineer.

3.4.4 Jointing Pits

The Contractor shall provide workable jointing pits where cables are to be jointed. The costs of jointing pits are to be included in the normal excavation rates of cable trenches.

3.5 Cable Trench Layout

The standard minimum cable trench depths are as follows unless otherwise specified:-

1)	11 kV Cables only, or 11 kV plus LV cables	:	1,0 m deep
2)	Pipes for cables underneath road surfaces	:	2 m to top of pipe measured from lowest point of final road surface
3)	LV cables and streetlight cables	:	800 mm deep
4)	Cables through premises and property		
	a) 11 kV only, or 11 kV plus LV or LV Main Cables	:	1 000 mm deep plus slabs
	b) Service connection cables	:	800 mm deep without slabs

The widths of cable trenches which will be used for the purpose of measurements, where applicable, are determined by the combination of the number of cables and/or pipes as specified in the Project Specification and as shown on the drawings.

3.6 Cables in Servitudes inside Stands

The Contractor shall conform to the following requirements where cables are laid in servitudes inside stands:-

1) The cable trenches shall be 1,0 m deep or as specified and as close as possible to the stand boundary, but inside the servitude.

2) The cable shall be laid on a 75 mm bedding of sifted soil.

3) The cable shall be covered with a 75 mm layer of sifted soil.

4) Concrete slabs shall be laid above the cable on top of the sifted soil covering mentioned in Item (3) above, for the full length of the stand. PVC marker tape shall be laid on top of the concrete slabs.

5) The trench shall be back-filled and consolidated as previously specified, and the site shall be levelled. All surplus materials shall be removed.

6) The costs of the concrete slabs shall be included in the prices for the laying of cables unless separate pricing is requested.

3.7 Cable Crossings

1) Where power cables cross communication cables and/or pipes and vice versa, the crossings shall be done in accordance with the requirements of Telkom. The power cables shall be laid underneath the communication cables and concrete slabs shall be laid above the power cables to separate the power and telecommunication cables.

2) Where power cables cross each other the cables shall not be laid directly on top of each other but shall be separated with a 100mm layer of sifted soil. Where the cables cross, they shall not be bent with less than the minimum allowable radius.

3) After completion of the work the Contractor shall certify in writing that he complied with all the requirements specified by the authorities.

4. Land Surveyor Pegs

4.1 Stand boundary pegs which were installed by the Land Surveyor shall under no circumstances be removed or shifted.

4.2 Any stand boundary pegs which are found missing by the Contractor during the execution of his contract works, shall immediately be reported to the Engineer. If the Contractor does not report missing stand pegs when cables are laid and the cables are laid in wrong positions, then the Contractor shall re-lay the cables at his own cost.

4.3 The Contractor shall immediately notify the Engineer if any pegs are removed or shifted by the Contractor. In such cases these pegs shall not be reinstated by the Contractor.
4.4 The pegs will be reinstated by a Land Surveyor at the cost of the Contractor.

On completion of the contract the Contractor shall provide a Land Surveyor certificate to the effect that all pegs along the routes where the Contractor had worked are intact. For this reason Contractors are advised to ensure that all pegs are in position when taking over the site unless otherwise approved by the Engineer.

5. Bush Clearing

The absolute minimum number of bushes and trees shall be cleared by the Contractor for the purpose of laying cables.

6. Cable Markers

6.1 Marking Tape

Yellow PVC marking tape, 150 mm wide, with the wording "Buried Electric Cable - Caution" in both English and Afrikaans, printed in red or black, shall be laid approximately 300 mm below ground level above the high voltage cables. One marking tape shall be laid for every two high voltage cables installed.

6.2 Cable Markers

Cable markers shall be installed if specified*** in the Project Specification. Cable markers shall be approved by the Engineer prior to installation.

7. Damages to Fences, Walls, Street Surfaces, Kerb Stones and Properties

7.1 Before the Installation Contractor commences with any excavation work, he shall submit a detailed list of all existing damages to fences, walls, street surfaces, kerb stones, properties, etc. to the Engineer who will inspect and verify the list.

7.2 After the completion of all backfilling and compaction of cable trenches, the Installation Contractor may request an inspection to have all the damages brought about by his operations listed and verified by the Engineer.

7.3 The Installation Contractor shall then at his own, or his insurer's cost, be responsible for all such damages, except for damages so listed previously.

E232 TRIPPING AND EMERGENCY LIGHTING BATTERIES AND TRICKLE CHARGERS

1. General

1.1 The trickle chargers and battery cabinets shall be provided as specified*** and as indicated on the drawings.

1.2 Each set of batteries shall be provided with a separate battery charger.

1.3 The battery bank and charging equipment shall be housed in a floor-standing metal-clad cabinet as one unit if nickel cadmium batteries are used. Lead acid batteries shall, however, be housed in separate free-standing treated hardwood racks.

1.4 The battery charger shall be connected to a terminal block at the back of the switchgear panel by means of PVC cable and shall be supplied from the voltage transformers where no external supply is available.

1.5 No fuses shall be installed in the trip circuits from the batteries to the switchgear panels.

2. Batteries

2.1 Where spring charging motor and solenoid mechanisms are used, 110V battery sets shall be provided for the supply of the mechanisms, as well as for tripping and closing coils. 110V Battery sets shall also be provided for 33kV and higher voltage substations. In all other cases, 32V battery sets shall be provided unless otherwise specified***.

2.2 The battery sets shall be capable of providing the full standing load of all associated equipment during complete failures of the AC supply, for a minimum period of 6 hours, after which period it shall be possible to open and close all circuit breakers once in rapid succession. The battery sets offered shall be fully capable of providing the load requirements of all motors, lamps, relays, coils, etc.

2.3 Lead acid battery sets shall be housed in a hard-wood cabinet, finished in alkaline or acid resistant paint, whichever is applicable. The cells shall be so arranged that the electrolyte is clearly visible and to allow for easy maintenance of the batteries.

2.4 All batteries shall be of the Ni-cad type unless otherwise specified.

2.5 Lead-acid type batteries shall be used for large substations which will be specified in the project specifications*** if required.

2.6 The batteries are to be contained in non-corrodible transparent cases to enable electrolyte levels to be easily checked, with high and low level marks clearly visible.

3. Charging Equipment

3.1 Rectifier

1) The unit shall comprise a double wound transformer with solid state type rectifier.

2) The output voltage variation shall be not more than +1% for variations of +10% of the input voltage at the temperature ranges specified for the site.

3) The charger shall be of the constant voltage control type with a higher (booster) and lower (trickle) rate of charge. The higher rate of charge shall be such as to completely charge a fully discharged battery in a period of 15 hours.

4) The capacity of the charger shall be rated to provide the full standing load plus battery charging current, for the specified ultimate loads.

3.2 Instruments

The following minimum instruments are required:-

1) DC ammeter - charging current
2) DC voltmeter

3.3 Indication Lights

An indication light is required to indicate that the AC supply is switched on.

3.4 Switches and Fuses

The following switches are required:-

1) A main switch to isolate the AC input.
2) Fuses on the DC and AC sides except in the trip circuit.

3.5 Control of the Charge Rate

The following are required to control the rate of charge:-

1) A push button or switch to select the higher rate of charge.

2) A timer to switch over automatically from the higher rate to the lower rate of charge after a period adjustable from 1 to 10 hours.

3.6 Protection and Alarms

1) If a standing load is to be supplied to switchgear and control panels then the following protection systems with alarms shall be provided to trip the standing load supplies:-

(a) AC supply fail relay with time delay
(b) DC under-voltage relay with 90% setting

(c) Tripping indication for the above conditions

2) If supervisory indication is specified for the system then a charger failure alarm relay shall be provided and the auxiliary switches of all the relays including the above-mentioned, shall be wired to an easily accessible terminal block in the charger cabinet.

3) Where a standing load is to be supplied from the battery unit, the standing load supply shall be separated from the tripping and control supply. The standing load supply only shall be automatically disconnected in case of:-

a) Failure of the AC supply

b) The battery voltage falling below 90% of the nominal voltage.

4. Installation

4.1 The units shall be properly bolted on floors where possible.

4.2 The charger shall be connected to the AC supplies.

4.3 The batteries shall be connected to the switchgear or light fittings (stand-by lights) where applicable, by means of suitable PVC cable.

4.4 All battery electrolyte levels shall be checked and corrected if necessary.
4.5 The battery sets shall be fully charged.

4.6 The metal work of all units shall be correctly earthed to the substation earth bar by means of 70 mm² stranded copper conductor or 30 mm x 3 mm copper bar.

E234 VARIABLE SPEED DRIVES (VSDs)

1. General

1.1 The VSD shall comply with Part 4A and Part 4B where applicable with special reference to cubicle construction, wiring of cubicles and accessories.

1.2 The supplier of the VSD shall be responsible to ensure that the variable speed drive system, the motor and feeder transformer are fully compatible as a system. If the motor is supplied under a separate contract it shall be the responsibility of the supplier of the VSD to obtain all the relevant information from the motor Contractor.

1.3 Unless otherwise specified the VSDs shall be suitable for centrifugal pumps with a squared torque characteristic***.

1.4 Where VSDs are offered which operate at other voltages, than the motor or the system, step down or step up transformers shall form part of the offer. The ratings of the transformer shall be compatible with the drive requirements taking harmonics into account.

1.5 Only very high reliability and availability of equipment shall be acceptable. This shall be achieved by state of the art designs, high quality control standards, first class workmanship, best available materials and components, sufficient redundancy and adequate derating factors. Materials shall be capable of withstanding the variations in temperature arising under working conditions without distortion or deterioration.

1.6 Components which are standard for number of product ranges of the manufacturer shall be used.

1.7 The colour of the VSD shall be specified in the project specification***.

1.8 The availability of spares shall be guaranteed for 10 years after the contract is accepted.

2. Pulse Width Modulated Drives (PWM Drives) for Induction Motors

2.1 This specification covers VSDs incorporating a method where a variable frequency and variable voltage shall be applied to a standard squirrel cage induction motor in order to vary the speed of the motor.

2.2 The method of operation shall be as follows : A 380 to 1000V AC/50 Hz supply shall be converted into dc via a transistor controlled converter and a dc capacitor after which the dc current shall be inverted to VAC by means of a thyristor and diode controlled inverter. This ac current shall then be fed the induction motor.

2.3 The rectifier and converter shall be 6 or 12 pulse as specified.***

3. Power Supply Details

The VSD shall be suitable for continuous operation when fed via a step down transformer if specified in the project specification*** from a 3-phase power supply having the following characteristics :

- System voltage : Specified in the project specification***.
- Motor voltage : Specified in the project specification***.
- Voltage fluctuations : +10% to 15%
- Nominal frequency : 50 Hz, ±2½%
- Phase rotation : R-Y-B-R anti clockwise
- System fault level : Specified in the project specification***.

4. Supply Interruptions and Distortions

4.1 The VSD shall be capable of operation without damage and without interruption under the following power supply distortions and interruptions.

- Total interruptions and restoration after 300 milliseconds.
- Loss of one phase and restoration after 300 milliseconds.
- Reduced phase voltage of one or more phases by up to 30 (thirty) per cent below nominal for up to 3 seconds.
- Negative phase sequence voltage of 2½ per cent (continuous).
- Supply voltage total harmonic distortion of 3 (three) per cent with individual voltage harmonic distortion of one per cent.

5. Harmonics

The harmonics generated by the VSD shall be compensated if necessary not to exceed the following levels:

- Any individual harmonic voltage may not exceed 1%.
- The total harmonic voltage may not exceed 3%.
- The current harmonics may not exceed 5% of the current rating of the equipment.

The Contractor shall also carry out a system study to determine filter requirements so as to limit the distortion to the 11 kV system, as measured at the 11 kV system, to the specified levels.

Any equipment which is sensitive to harmonics shall be designed to function under voltage conditions which may have up to 5% total harmonic voltage distortion and up to 2% individual harmonic voltage content.

6. Ratings

6.1 The electronic devices of the variable speed drive shall be continuously rated for a motor shaft output of 15% in excess of the power required by the pump at any speed over the whole speed range. The details of the motor are specified*** in the project specification if not forming part of the contract.

6.2 Each VSD shall be capable of continuous duty at full rating (24 hrs/day, 365 days/annually) under the specified power supply conditions.

7. Speed Range Requirements

The speed of the variable drive shall be continuously variable between the lower and upper speed limits. The lower speed limit of the VSD shall be at least 10 per cent below the minimum and 10 percent above the maximum speed required for the driven pump. The speed range of the VSD are specified*** in the project specification.

The drive system shall also have the facility to inhibit operation at pre-determined speeds to prevent system resonance.

The speed control stability tolerance shall be better than 1,0 per cent of the set point.

8. VSD Electronic Equipment and Components

8.1 The control circuitry shall consist of independent electronic control and protective circuits arranged on separate PCB's. This circuitry shall be isolated from the mains supply by means of isolating constant voltage transformers (CVT's) in order to limit malfunctions due to transients and voltage dips on the system.

8.2 The electronic equipment shall be of modular construction mounted on plug-in boards. Modules shall be easily removable to ensure rapid rectification of faults by module replacement. Such modules shall be suitably coded so as to prevent insertion into wrong sockets.

8.3 The material used for the printed circuit boards shall be of the best quality.

8.4 The connections to the printed circuit boards shall, wherever possible, be made by means of suitable connectors with gold-plated contacts that are designed to be soldered to the tracks of the printed circuit board.

8.5 The printed circuit board assembly shall be protected from deposits of dust and moisture by coating with suitable material (e.g. conformal coating material complying with BS 5917).

8.6 Means shall be provided for mounting the printed circuit board assembly inside the enclosure so as to facilitate easy insertion and withdrawal of the assembly. The assembly shall be mechanically secured so as to prevent vibration.

8.7 The printed circuit board assembly shall be designed with suitable means of self diagnostic indication of faults and indication of status for the purposes of setting up easy service and

maintenance, or shall be provided with easily accessible test points to facilitate diagnostic tests for faults. Suitable test equipment shall form part of the contract.

8.8 The power supply to electronic control equipment shall be provided with an electrostatic screen between the primary and secondary windings. The screen shall be connected directly to earth.

8.9 Electrolytic capacitors used in the dc application of electronic equipment (e.g. filter circuits) shall be of the long-life grade complying with IEC Publication 384-4.

8.10 All semiconductor devices, power transformers, chokes and other components forming necessary parts of the drive equipment shall be suitable for the particular application with respect to their rated voltages, rated currents, temperature rise and service life.

8.11 Solid state electronic components shall be used.

9. Digital Technology

Digital control based on the latest microprocessor technology shall be used. However, standard products and components shall be used and purpose made systems shall not be acceptable.

10. Modbus RTU Interface Protocol

When specified*** in the project specification the VSD shall be equipped with MODBUS RTU interface protocol with facilities to report all fault conditions on a first in first out basis as well as control functions and the parameters during normal running condition. A suitable data storage buffer shall be provided of sufficient capacity to ensure a real time record of the above information and of any other variables the Contractor consider necessary for fault diagnostics.

11. Control Card Monitoring

All control cards shall be provided with suitable monitoring, either by means of on-board identification, or if specified*** via the modbus interface to permit identification of and replacement of faulty control card with a minimum of drive downtime.

12. Hardwire Trip Interlocks

12.1 Protection devices in the VSD shall be hardwired to ensure that an electrical fault within the controller trip the transformer feeder circuit breaker.

12.2 Electrical interlocks shall be provided to trip the VSD in the event the access doors to the power section and the DC sections of the drive being opened.

13. Main Power Equipment

The main power equipment unit shall comprise the following:

13.1 AC power supply incorporating a fused isolating switch. It shall be possible to visually observe the isolator contacts in the open position from the front of the panel.

13.2 The contactor unit.

13.3 Rectifying transistors and inverting thyristors.

13.4 A choke in series with the rectifying transistors (input) shall installed to limit the inrush current.

13.5 By-pass switch if specified*** in the project specification.

13.6 Auxiliary power supply equipment.
13.7 Step down transformers if required.

14. Cubicle Arrangement

14.1 Smaller VSD's shall be mounted into a free-standing MCC panel suitable for floor fixing.

14.2 The Contractor shall confirm within two weeks after appointment that the cubicle as offered by the Contractor can be installed in the MCC room by studying the appropriate construction drawings.

14.3 The VSD equipment e.g. fused isolator, contactor, thyristor stock, control circuitry, etc., shall be housed in separate compartments or cubicles.

14.4 When more than one cubicle/panel is provided, the cubicles shall form a straight line and be of the same height. All cubicles shall be braced and of modular bolted construction to form a rigid assembly. They shall be provided with a substantial channel iron base which shall prevent distortion transportation and installation.

14.5 The equipment shall be arranged so that the various parts of the drive are easily accessible.

14.6 The instrument and control panel shall be flush mounted on the front of the cubicle at a comfortable height from the ground.

14.7 The main isolator handle shall be mounted on the front of the cubicle and shall be door inter-locked.

14.8 IP54 enclosure protection shall be provided unless otherwise specified*** in the project specification.

14.9 The VSD unit shall conform with the rest of the MCC panel e.g. colour shall be matched, labels shall be matched, etc.

14.10 The cable entry shall be below unless otherwise specified***.

15. Ventilation

The temperature in the MCC room may rise to 45°C unless otherwise specified*** and the equipment shall be rated to operate at this temperature.

15.1 The transistors/thyristors shall be forced air cooled by means of fans.

15.2 The fans shall be mounted directly above the transistor/thyristor stacks on top of the cubicle. The fans shall be suitably electrically protected with miniature circuit breakers. Fans shall have an associated air differential pressure gauge to ensure that the drive shall be tripped on cooling system failure. A standby fan shall be provided, operating automatically on failure of the duty fan.

15.3 Replaceable air filters shall be provided at the air-intake of the cubicle.

15.4 The hot air shall be exhausted into the room.

16. Protection

Variable speed A.C. drives shall be provided with the following integral protection features. A separate motor protection relay shall be provided if these features are not part of the VSD protection features. The Contractor shall explain how each requirement is met in his drive and shall supply detailed supporting literature for each item.

16.1 Thermal Overload

The relay shall have current time characteristics matched to the thermal damage curve of the drive motor.

16.2 VSD and Motor Short Circuits and Earth Faults

The drive and the motor shall be fully protected against internal and external short circuits and earth faults on the supply connections, transformers, the DC link, or on the motor. This protection shall preferably be instantaneous in operation and arranged to trip the supply. It shall not operate incorrectly if the drive is able to feed current to a supply side fault unless the condition is sustained for long enough to damage the drive components.

16.3 Negative Sequence Voltages

The motor shall be protected against negative sequence currents resulting from the presence of negative sequence voltages on the supply lines, or produced by unbalanced operation of inverters, etc., protection shall be provided which detects the condition and stops the drive before it or the motor can be damaged. The drive shall be able to operate continuously at the rated output if the negative sequence voltage on the supply does not exceed 2,5%.

16.4 Loss of Supply Voltage

If the positive sequence voltage to the drive should fall below 85% for longer than 1 second, the drive shall be disconnected without any damage to the rectifiers, thyristors, or any other components in the drive liable to adversely affected by a low supply voltage condition.

An under voltage trip which is pre-settable to a minimum of 15% voltage drop shall be provided.

If the voltage drops more than the pre-set voltage above the drive shall trip automatically. In the event of the supply voltage returning to a value which is greater than the pre-set voltage in less than 2 seconds, which is also pre-settable, the drive shall automatically start up. A facility to enable the flying start, shall be provided on the drive.

The variable speed drive system shall be able to tolerate a sudden total loss of power without any damage to the drive. See 4.1

16.5 Overtemperature inside Cubicle

In the case of drives above 100 kW, RTD temperature protection with alarm and trip set points shall be provided in the cubicle and be arranged to stop the drive for high cooling air temperatures. Indication of overtemperature shall be provided on the front of the panel and one spare set of potential free contacts shall be provided for alarm purposes.

16.6 High Supply Voltage

If the supply voltage should rise above 110% for more than the safe withstand time for all components in the drive, it shall be disconnected automatically.

16.7 Electronic Equipment

This shall be provided with all protection equipment necessary to ensure that diode overvoltages, overcurrents, or other transient conditions will not result in component failure. Such protection shall be arranged to disconnect the drive, where necessary for its safety.

16.8 Loss of Phase

Loss of a supply phase shall cause the drive to be disconnected sufficient rapidly to prevent damage.

16.9 Incorrect Phase Rotation

The drive controls shall be capable of detecting this condition and preventing start-up.

16.10 The drive shall also be protected against the following faults:

FAULT

Over voltage in the dc link
Under voltage in the dc link
Overcurrent in the inverter
Motor stalling
Transient surges
dv/dt and di/dt
Overspeed
Open motor circuit
Transistor overcurrents by means of HRC fuses

16.11 Audible and visible indication shall be provided for all trip and alarm functions.

16.12 Indications and Transducers
All protection functions shall be complete with the necessary current and voltage transducers and the condition that originated any drive shutdown shall be indicated clearly on approved operation indicators.

The following are examples of indications to be displayed on the panel door. Contractors shall provide information of fault indications offered applicable to the equipment.

1. Overspeed trip.
2. Instantaneous overcurrent trip.
3. Inverse time overcurrent trip.
4. Converter over temperature trip.
5. Earth fault trip.
6. Converter ventilation fan failure trip.
7. Cooling fan failure.
8. Power supply low voltage trip.
9. Back-up electronic trip.
10. Supply phase-loss and incorrect phase rotation protection trip.
11. Stator winding over temperature alarm/trip.
12. Bearing over temperature alarm/trip.
13. Earth alarm/trip.
14. External fault.
15. Long starting time.
16. Over temperature (Transformer).

17. Surge arrestor (Converter).
18. Surge arrestor (Motor).
19. Underspeed trip.
20. DC current monitor.

16.13 Remote Indication

A potential free contact wired to terminals at the back of the panel shall be provided to indicate a system fault for remote indication.

17. Control Indication and Instrumentation

The following minimum controls and instrumentation shall be provided on the front panel of the electronic compartment:

17.1 Controls

a) Start/Stop push buttons for local operations.

b) Emergency stop push button:

The push button for the emergency stop shall be red, only manually resettable and will prevent the motor from starting from the local or any remote position. (Parallel circuitry to a terminal block to be provided for a similar switch at the motor).

c) Local/Remote switch shall be provided.

d) Test/Off/Normal : This switch shall operate with a key removable only in the normal position. In the test position the complete starting and tripping sequence shall be operational for testing without applying power to the motor.

e) Protection trip reset push buttons.

f) Indication test push button to test lamps.

g) Speed control.

17.2 Signal Lamps and Push Buttons

The following main colour-codes shall be used for signal lamps and push buttons.

a) Signal Lamps

Trip	:	Red
Run, Ready	:	Green
Speed Control Healthy	:	White

b) Push Buttons

Stop Emergency	:	Red
Run	:	Green
Trip Reset	:	Blue
Lamp Test	:	White
Siren Mute	:	Yellow

17.3 Instrumentation

a) LCD Display.

b) Ammeter on all the phases with instantaneous reading and overscale facility.

c) Speed meter.

d) Voltmeter with selector switch for phase to phase and phase to neutral readings.

e) Ammeters for the heater circuits.

f) Non-resettable running hour meter.

17.4 Remote Control and Indications (When specified*** in project specification)

The variable speed drives shall be suitable for future remote control operation and monitoring. All the required functions and signals shall be wired to terminal blocks which are easily accessible. The following functions control signals are considered as a minimum. The design will however be finalised with the successful Contractor:

a) Control functions:

- ON/OFF
- Start to minimum speed
- Speed control (4 - 20 mA signal)
- Stop

b) Indications:

- Machine ready
- Speed indication (4-20 mA)
- Temperature trip
- Common protection trip
- External trip
- Local control
- Cubicle overtemperature
- By-pass closed (if applicable)
- Emergency stop
- Amps (load current)
- Volts

18. Training

The Contractor shall allow for two on site training sessions. The sessions shall last at least one full day and include programming and setting up procedures of the VSDs.

E237 STREET- AND SECURITY LIGHTING

1. General

Street and security lighting shall in general conform to SABS 098, unless otherwise specified.

2. Steel Poles for Streetlighting

2.1 General

All steel streetlighting poles shall be properly treated against corrosion. Painting and/or galvanising shall be carried out in accordance with Specification E202.

2.2 Design

1) All steel poles shall be designed to withstand all static and dynamic loads on the pole, fittings and street lighting brackets with a minimum factor of safety of 2,5 in compliance with the Occupational Health and Safety Act (85/1993).

2) The pole shall be designed to withstand a wind speed of 120km/h (unless otherwise specified in the project specification) at a height of 10m above ground level and exerted on the projected area of the pole, fittings and street lighting brackets.

2.3 Base Plate

1) Each steel pole shall be equipped with a suitable base plate, at least 350mm in diameter or square plates with an equal or larger surface area.

2) The base plates shall be held in position by means of steel hook bolts to be hooked into the steel pole. The plates are not to be welded to the steel pole. The base plate shall have the same finish as the pole.

2.4 Steel Sleeve

1) All steel streetlighting poles shall be provided with a 6 mm thick and 1,0m long steel sheath, if specified*** in the Project Specification.

2) The sleeve shall extend 500mm above and 500mm below ground level after installation.

3) The steel sleeves are to be welded or shrunk onto the poles.

2.5 Protection of Poles against Corrosion

1) Poles shall be completely galvanised and/or painted as specified*** in the Project Specification. Galvanising and painting shall be done in accordance with the Standard Specification E202. The interior of poles to be used at coastal areas, or if specified*** in the Project Specification shall in addition be coated with at least one coat of suitable bituminous paint.

2) The lower 2,0m of the pole including the base plate, shall be painted on the outside with two coats of suitable bituminous paint.

3) After erection on site a final coat of paint shall be applied to the pole if specified*** in the project specification.

2.6 Size of Spigots

Contractors shall ensure that the diameters and lengths of the pole spigots shall suit the types of luminaires offered.

2.7 Cable Entries

1) Each steel pole shall be provided with a suitable cable entry hole. The hole shall be so located that after erection the entry hole shall be approximately 700mm below ground level.

2) The edges of the cable entry hole shall be smooth to prevent damage to cables.

3) The dimensions of the entry hole shall be such that two 25mm², 4-core PVC insulated steel wire armoured cables can be easily installed. The project specification*** will state whether ECC cables shall be used.

2.8 Cable Termination Compartment

1) Each pole shall be provided with a suitable cable termination compartment with a bracket complete with a 5A, 5kA miniature circuit breaker mounted on the bracket. Each luminaire shall be protected by a circuit breaker on double outreach installations.

2) An earthing stud welded to the inside of the pole shall also be provided inside the compartment. The earth conductors of the incoming cable and the earth conductor from the luminaire shall be terminated on the same earthing stud.

3) The cover of the compartment shall be watertight and sealed with a gasket. It shall be retained by a lug and secured by a bolt with a seven sided shrouded head.

4) The compartment shall incorporate a suitable gland plate for the termination of the incoming cables.

2.9 Pole Mounted Protection Boxes

Where steel streetlighting poles are to be used in an overhead reticulation system, the pole shall be provided complete with a pole mounted weatherproof PVC circuit breaker box with tripping lever fitted with a 5A, 5 kA single phase miniature circuit breaker.

3. Wooden Poles for Streetlighting

3.1 Wooden poles shall be suitably treated and shall comply with SABS 753 or 754.

3.2 The dimensions and classes of wooden poles required shall be as specified*** in the Project Specification.

3.3 Wooden poles shall be equipped with either "Pratley" type underground cable T-off boxes or galvanised junction boxes to be mounted above ground level as specified*** in the Project Specification.

3.4 Where underground "Pratley" type boxes are specified*** for use or where poles are to be used in an overhead distribution system, the wooden poles shall be provided with a pole mounted weather-proof circuit breaker box with tripping lever fitted with a 5A, 5kA single phase miniature circuit breaker.

3.5 Where an above ground termination box is specified, Contractors shall allow for the provision of this box in their tender prices. The box shall be galvanised and fitted to the pole with galvanised clamps. The box shall be equipped with a 5A, 5kA miniature-circuit breaker. The lid of the box shall be fixed with countersunk bolts. The box shall be watertight and shall be mounted approximately 500 mm above ground level.

3.6 In the case of 3.4 above galvanised steel pipe shall be provided against the pole to serve as a cable protection sleeve. The diameter of the pipe shall be suitable to allow easy installation of a

25mm², 3-core steel wire armoured PVC insulated cable. The pipe shall be fixed to the pole with suitable clamps at intervals of not more than 500mm. The pipe shall extend 2,0 meter above ground level and 500mm below ground level.

3.7 In the case of 3.5 above where an above ground termination box is called for, a cable sleeve as specified above shall be provided above the box. Two similar galvanised pipes, each suitable for a 25mm², 4-core cable shall be provided below the box. The pipes shall fit over the cable glands complete with neoprene covers suitable for the cable sizes. The pipes shall extend 500mm below ground level.

4. Midhinge Type Masts

4.1 General

1) The masts shall be similar or equal to the scissor type as manufactured by Sectional Poles Africa.

The Engineer shall decide whether any mast offered complies with this requirement.

2) The masts shall comply with the relevant clauses as specified for steel poles, above.

4.2 Construction

1) The lower half of the masts shall be divided into two fully enclosed half sections, which shall form an octagonal section in the operating position with no unsightly steps or protrusions.

2) The pivot shall be located approximately at the mid-point of the mast and shall consist of two full length stainless steel sleeves and not a shaft and hinge plates.

3) The pivoting half of the mast base section shall be securely bolted to the base plate by means of an adequately designed vandal proof securing system. A special socket type spanner shall be provided for this securing system.

4) Street light brackets for mounting of luminaires, shall be provided as specified in the relevant clauses for street poles as specified above.

5) The pivoting half of the base section shall be balanced in such a manner that lowering can easily be done by one person using a nylon or stainless steel rope without additional equipment being required. The lowering of the pivoting section of the masts shall not be by a winch, power tool or bolt type lowering mechanism.

6) A safety chain shall connect the pivoting half with the fixed half to prevent accidental lowering or damage to the trailing cable.
7) A galvanised or stainless steel wire rope shall be affixed to the top and bottom of the masts on the inside to allow the electrical cable to be strapped to it.

8) The fixed part of the mast shall be provided with a cable termination compartment as specified in the relevant clauses for steel poles as specified above.

4.3 Foundation

1) A concrete foundation shall be provided for each mast unless otherwise specified.

2) The foundation designs shall be submitted with the tender/quotation and the successful Contractor shall provide foundation drawings.

3) Adequately designed foundation bolts, made from mild steel, shall be provided with each mast together with templates.

4.4 Corrosion Protection

1) The mast shall be corrosion protected to comply where applicable.

2) All materials used in the pivot construction shall be of AISI grade 316ℓ stainless steel.

3) Steel used for the construction of the masts shall be SAE 950X grade B and shall be a high tensile low carbon type or equivalent.

4.5 Design

1) The design of the mast shall comply with the relevant clauses or specification for steel poles, above.

2) The mast shall be capable of withstanding the loads impacted on it when being lowered.

3) The following design calculations shall be submitted:

a) The mast in wind conditions;
b) The mast during lowering.

5. High Masts

5.1 High masts shall be provided in the positions as indicated on the drawings.

The positions indicated on the drawings are only approximate positions: the Contractor shall ascertain from the Engineer what the final positions are on site and shall peg the positions prior to commencing excavation work for the bases.

5.2 Construction

1) The masts shall be manufactured from mild steel in accordance with SABS 1431, which shall be of a grade suitable for the working loads.

2) A base plate of suitable thickness shall be welded to the bottom end of the mast and shall be suitably pre-drilled for the foundations bolts. Gussets shall be provided between the bolt holes for increased structural strength.

3) All welding shall be subject to SABS inspection and acceptance certificates shall be provided to the Engineer.

4) The selected cross-section and wall thickness of the masts shall be based on working load calculations.

The design shall be approved by a Professional Structural Engineer appointed by the Contractor for this purpose.

5) The masts shall give an overall floodlight mounting height as specified*** in the project specification.

5.3 Working Loads

1) The design of the masts shall comply with the relevant clauses as specified for steel poles, above.

The design shall take into consideration the increase in wind speed with height and a design based on a constant wind loading over the entire length will not be accepted.

2) The Contractor shall ensure that the design is carried out in accordance with:

SABS 0160 - 1980 : Code of Practice for the General Procedure and Loading to be adopted for the Design of Buildings.

SABS 0162 - 1989 : Code of Practice for Structural Steelwork.

3) The Contractor shall, prior to commencing with the construction of the masts, submit to the Engineer his approved design drawings, detailed design calculations and any other substantiating data to prove that the requirements of the specification have been met.

4) In addition to the above, information relating to the following shall be submitted with tenders:

a) Dynamic behaviour of the masts with respect to wind-induced oscillations and resonance.

b) Deflection of masts and resultant stresses and bending moments over the entire length of the structure at maximum wind loading.

5.4 Luminaire Carriage and Raising and Lowering Mechanism

1) The masts shall be fitted with a luminaire carriage suitable for carrying the specified luminaires and which, when raised to the operating position, shall always be correctly aligned. Indication shall be provided to show when the carriage is in its fully raised position.

2) An electrically operated raising and lowering mechanism shall be provided for the luminaire carriage.
Where a separate unit has to be used for the raising and lowering operation, only one unit shall be provided for all the masts.

5.5 Access Opening

An access opening suitably designed to maintain the mast strength shall be provided 600 mm above the base plate and shall be fitted with a hinged weatherproof door. The door shall be fitted with a lock suitable for preventing vandals from gaining access to the electrical equipment housed in the mast.

The electrical equipment for controlling the luminaire shall be readily accessible for operating and maintenance through the access opening.

5.6 Corrosion Protection

1) The mast shall be corrosion protected to comply where applicable with the relevant clauses as specified for steel poles, above.

2) All parts of the mast and the luminaire carriage which are not manufactured from stainless steel shall be hot-dip galvanised to SABS 763-1977 and inspection certificates shall be provided.

5.7 Electrical Control Equipment

1) Each mast shall contain a glass fibre distribution board (DB) mounted inside the mast shaft opposite the access door.

2) Each phase of a multiple phase connection shall be protected by a single phase 5 kA miniature circuit breaker and a lightning arrester. The DB shall further contain the electrical control equipment as shown on the drawings or specified*** in the project specification. A suitable supply connection for the hoist unit shall also be provided.

5.8 Lightning Protection and Earthing

1) Each mast shall be fitted with a lightning spike projecting above the head assembly to protect the luminaires.

2) An earth stud shall be provided near the base and connected to an earth rod and the distribution board earth bar.

5.9 Mast Foundations

1) A reinforced concrete base shall be provided for each mast as generally shown on the drawings.

2) The base shall be designed by a Professional Structural Engineer appointed by the Contractor. The Contractor shall measure the soil bearing pressure at each location prior to the bases being designed.

3) When the bases are cast, test cubes shall be taken and submitted to an approved test laboratory. The results shall be submitted to the Structural Engineer for his approval.

4) After the masts have been installed on their bases a final inspection shall be carried out by a Structural Engineer and the installation shall be approved in writing.

5) After casting of the foundation base, the slab shall be covered with earth which shall be properly compacted. The area around the base shall be brought to the original level and shall be left neat and tidy with no excess soil.

6. Luminaires

6.1 High masts and poles shall be fitted with luminaires as specified*** further herein and in the Project Specification.

6.2 The final adjustment of the luminaires shall be done on site to provide area lighting to the Engineer's satisfaction.

6.3 Luminaires shall consist of a cast aluminium or aluminium alloy or fibreglass reinforced polyester housing, high quality non-deteriorating reflectors and an acrylic lens. The lens material shall not discolour or lose its translucence with time. Polycarbonate is not acceptable. The complete fitting shall be corrosion resistant.

6.4 Where control gear is required for operation, the control gear housing shall form an integral part of the luminaire. Intertap chokes, to enable optimum operation from 200V to 250V, shall be provided if specified*** in the Project Specification.

6.5 The luminaires shall be fully gasketed to eliminate the ingress of dirt and moisture.

6.6 All luminaires offered shall be of high quality and of a type approved by the Engineer.

6.7 Unless otherwise specified the types of luminaires offered shall be in accordance with the types recommended in SABS Code of Practice 098, 1277 and 1279 for the various types of roads and classes of installations.

6.8 The type of lamps is specified*** in the Project Specification and Contractors may offer alternative wattage lamps that will provide the specified lighting levels.

7. Photo-Electric Cells for Streetlights and High Masts (Refer to Clause E205)

Where photo-cells are called for in the Project Specification*** for the control of streetlighting, the photocells shall comply with the following requirements:

7.1 The photocell shall be mounted on the pole nearest to the minisub, substation or low voltage distribution cubicle.

7.2 All photo-electric cells shall be provided with suitable mounting brackets to mount these on the streetlight pole.

7.3 The photo-electric cells shall be so mounted that light of the streetlight fitting shall not interfere with the proper functioning of the photo-cell.

8. Streetlighting Arms

8.1 Streetlight brackets shall be used for the mounting of luminaires on wooden poles and steel poles where the arms do not form an integral part of the pole.

8.2 The brackets shall be galvanised and, if called for, painted as specified in the Standard Specification E202.

8.3 The brackets shall consist of a tubular section with suitable struts and braces to ensure sufficient mechanical strength and rigidity as shown on the drawings.

8.4 The dimensions of the spigot shall be suitable for the type of luminaires offered.

8.5 The bracket shall be fixed to the pole by means of at least two clamps with bolts, nuts and washers. All parts shall be galvanised.

8.6 The tubular section shall be such that the cable entry opening faces downwards to prevent the entry of water into the arm and luminaire.

9. Installation of Streetlighting

9.1 Contractors shall allow in their tender prices for the following:

1) Pole hole and/or foundation excavations.

2) Concrete foundations for midhinge and high masts.

3) Erecting, backfilling and consolidating. This includes the ensuring that poles are plumbed and aligned.

4) Terminating of the underground streetlighting cables where applicable.

5) Connection of the cable earthing conductors to the earthing studs by means of bare copper earth wires and crimped ferrule connections.

6) Mounting of luminaires, brackets, miniature circuit breakers, connection boxes, cable protection sleeves, etc.

7) Supply and installation of internal 3 x 4mm² PVC insulated copper conductors from the connection box to the luminaires on steel poles. On double outreach standards, each luminaire shall be separately wired to its miniature circuit breaker.

8) Supply, installation and termination of 4mm², 3-core PVC insulated cable on wooden poles.

9) Supply, installation and termination of three 4mm² PVC insulated copper conductors from overhead lines to pole mounted miniature circuit breakers and to luminaires.

10) Supply, installation and termination of cable internally installed in high masts.

11) Balancing the load evenly over all three phases.

12) Testing and commissioning of the complete assembly.

9.2 All luminaires shall be installed complete with the types of lamps specified.

9.3 All luminaires, steel brackets and poles shall be properly earthed.

9.4 Where painting of streetlighting poles are called for, a final coat shall be applied after erection.

E241 LOW VOLTAGE ELECTRIC MOTORS

1. GENERAL

1.1 This specification covers low voltage (below 1000 V), 3 phase a.c. squirrel cage induction motors.

1.2 The motors shall be designed, manufactured, tested, delivered, erected and commissioned in accordance with:

SANS 60034 : Rotating Electrical Machines, Parts 1 to 18
SANS 60072 : Dimensions and output series for rotating electrical machines.
SANS 1804 : Induction Motors, Parts 1 to 4

Where reference is made to a code, specification or standard, the reference shall be taken to be the latest edition, including addenda, amendments and revisions thereto.

All deviations from these specifications shall be clearly pointed out at tender stage as deviations not indicated, will not be accepted.

1.3 Motors of the same manufacture shall be used throughout the Contract unless otherwise approved by the Engineer.

1.4 Motors shall be designed for fixed speed or variable speed operation as specified in the Project Specification ***.

2. QUALITY OF MATERIALS

2.1 All materials shall be new, of the best quality and of the class most suitable for the application. All parts shall be capable of withstanding variations of temperature arising under working conditions without distortion, deterioration or setting up of undue stress in any part.

2.2 Quality control shall be in accordance with ISO 9001.

2.3 Mild steel plate for fabricated parts shall be of weldable quality in accordance with SANS 1431. No welding, burning in, filling, plugging up or metal deposition to correct defects in any component will be permitted unless agreed to by the engineer in writing, following an inspection on the defect.

3. INTERCHANGEABILITY

3.1 Motors of the same rating shall be interchangeable without them having to be modified.

3.2 The corresponding parts of motors that are identical, for all practical purposes, shall be interchangeable without them having to be modified. The same requirement applies to spare parts.

4. DRAWINGS AND INFORMATION FOR APPROVAL

The following drawings and information shall be submitted for approval before manufacture commences:

4.1 Dimensioned outline and required foundation drawings of the motors. (Shaft diameter, shaft height and motor mass to be clearly shown).

4.2 Cross-sectional dimensioned drawings of the terminal boxes.

4.3 Detailed drawings of the motor base plate showing full constructional details with dimensions.

5. INSPECTION OF MANUFACTURED EQUIPMENT

5.1 The Engineer, or his appointed representative, reserves the right to inspect the motors or associated parts at any stage of manufacture.

5.2 The Contractor shall ascertain at what stages inspections will be carried out and shall give the Engineer not less than seven days notice of when the inspections may be undertaken.

6. GUARANTEE AND MAINTENANCE

6.1 All motors provided under the Contract shall be fully guaranteed for a period of twelve months from the date of handing over.

6.2 A full maintenance service shall be provided during this period. The Tenderer shall indicate with his tender what duties have been included and the time intervals between services. Should the Tenderer fail to provide this information, the Engineer will lay down the duties as well as time intervals with which the Contractor shall comply.

7. MOTOR RATINGS

7.1 Motors shall have continuous maximum ratings not less than the following :

- 50 kW or under: not less than 25% in excess of the maximum likely to be drawn by the pumps within the operating range.

- Over 50 kW and up to 100 kW: not less than 15% in excess of the maximum likely to be drawn by the pumps within the operating range.

- Over 100 kW: not less than 10% in excess than the maximum likely to be drawn by the pumps within the operating range unless otherwise specified***.

- Where operating at other than continuous running duty is required, (i.e. short time or intermittent periods, as for valve actuators, hoists, etc.), motors shall have appropriate ratings in respect of output, duty and starting class.

7.2 The motor shall develop adequate torque to accelerate the driven equipment to full speed, within an acceptable time, using the starting method specified in the Project Specification ***. For direct-on-line (DOL) starting the motor voltage shall be taken to be 85% of the rated voltage. For other starting methods the motor voltage shall be taken to be the output voltage of the reduced-voltage starter.

7.3 Motors shall be designed to allow 6 starts per hour, of which two shall be consecutive.

7.4 Rated voltage shall be 400 / 525 / 690 V as specified in the Project Specification ***.

7.5 Rated frequency shall be 50 Hz.

7.6 The motors shall be capable of operating with Zone A combined voltage and frequency variations as defined in SANS 60034-1.

7.7 Rated speed shall be nominal 1500 rpm unless otherwise specified in the Project Specification*** and the operating speed range shall be as required by the driven equipment.

7.8 Motors shall be rated for continuous running i.e. Duty S1 to SANS 60034-1 and shall have a service factor of 1.

8. MOUNTING

8.1 The motors shall be mounted to suit the driven equipment. The mounting arrangement shall be as stated in the Project Specification***.

8.2 Motors shall be mounted on common base-plates with the driven equipment. When uncoupled from the load, it shall be possible to lift the motor clear without withdrawing the rotor and with the minimum amount of dismantling. Baseplates shall be provided with the driven equipment unless otherwise stated in the Project Specification***.

8.3 Motor feet shall be fitted with Grade 316 stainless steel jacking screws for both horizontal and vertical adjustment.

8.4 Mounting bolts shall be included in the motor's price, unless otherwise stated in the Project Specification ***.

9. ENCLOSURES AND COOLING

9.1 Motors shall be totally enclosed with a protection rating of IP55 in accordance with SANS 60034-5, unless otherwise stated in the Project Specification***.

9.2 The cooling system shall be in accordance with SANS 60034-6 and the cooling method (IC Code) shall be as specified in the Project Specification ***.

9.3 Ambient and cooling temperatures shall be in accordance with SANS 60034-1, unless otherwise stated in the Project Specification***.

9.4 Noise levels shall not exceed the levels permitted in SANS 60034-9.

10. WINDINGS

10.1 Unless otherwise specified in the Project Specification ***, thermal class and temperature rise of the motor winding insulation system shall be in accordance with SANS 60034-1 (i.e. Class F insulation, but Class B temperature rise).

10.2 With self-ventilated cooling systems, allowance shall be made for the speed dependency of heat transfer.

10.3 Converter-fed motors (variable speed drives) shall be rated to allow for additional harmonic losses in accordance with SANS 60034-17.

10.4 For converter-fed motors (variable speed drives), the motor manufacturer shall check the voltage stress withstand capability of the motor against the converter supplier's specification. To ensure that no service lifetime reduction of the motor insulation occurs, the actual stress due to converter operation shall be lower than the repetitive voltage stress withstand capability of the motor winding insulation system.

10.5 Functional evaluation of the winding insulation systems shall be carried out in accordance with SANS 60034-18 - 31. In the case of converter-fed motors, special attention is required because of the additional stress factors produced, such as increased voltage stress and high frequency repetition rate, additional heating as a result of harmonic losses, and mechanical vibrations.

11. BEARINGS

11.1 Type

Bearings shall be of the rolling- or sliding-element type as appropriate. Vertical shafts shall have approved thrust and guide bearings. Grease-lubricated bearings shall be sealed or regreasable.

Rolling-element bearings shall be loaded conservatively, in order that the grease may be renewed at intervals of not less than 4000 hours and they shall be equipped with grease nipples.

Where bearings are oil-lubricated, they shall be provided with a readily accessible filler and clearly visible oil level indicator. For large motors, forced lubrication may be provided as an alternative and details of the system shall be submitted with the tender.

Sliding-element bearings shall be fitted where rolling-element bearings cannot be fitted because of high speed, torque and/or bearing loads. Motors having sliding-element bearings shall be designed to allow measurement of bearing wear with a minimum of dismantling being necessary.

Sliding-element bearings shall be of the plain journal type, and not of the segmental type, and they shall be automatically lubricated by at least two oil rings or a single disc integrally mounted on the shaft, running in an oil bath of adequate capacity. The oil bath shall be fitted with a drain plug and an external oil level indicating device which is readily accessible or visible.

For sliding-element bearing motors employing forced oil lubrication, full particulars of the proposed lubricating system shall be submitted.

Care shall be taken that bearings are properly sealed in order to prevent ingress of bearing lubricant into windings and cores. For purpose of maintenance, end-shield bearings are preferred. A minimum L10 bearing life of 40 000 hours is required. Unless otherwise approved in writing, motor bearings shall be designed to allow the motor to run indefinitely when uncoupled from the driven machine.

11.2 Insulation

To prevent damage by any shaft currents which may be produced (e.g. on converter-fed motors), the bearings and their lubricating and cooling systems, shall be insulated from the bed-plate or frame. Although both bearings shall be insulated, the drive-end bearing insulation shall be shorted out with a copper earth strap to prevent the build up of static electricity on the rotor.

11.3 Flow Indicator

A flow indicator and/or pressure switch shall be provided on forced-lubricating systems to indicate failure of the system. Adjustable alarm and cut-out contacts shall be provided.

12. TEMPERATURE DETECTORS

12.1 All motors 55 kW and larger but smaller than 150 kW shall be provided with two PTC thermistors per winding suitable for class B temperature rise protection i.e. with reference temperature of 140°C. The three thermistors shall be connected in series via terminal blocks in the terminal box. (1 per winding connected to terminal blocks shall be spare)

12.2 All motors of 150 kW and larger shall be provided with two platinum resistance detectors (RTD's) of type PT 100 ohm per winding and one per bearing. The bearing detectors shall touch the outer bearing race and shall be spring loaded and of the screw type with weatherproof die cast alloy heads. The RTD's shall be of the three wire type with a stainless steel sheath and mineral insulation. When specified in the Project Specification*** the bearing RTD's shall be provided with 2 wire transmitters with a 4 - 20 mA output terminated in a die-cast cap.

12.3 The wires of all detectors must be wired to a terminal strip in a suitable terminal box on the motor.

12.4 When specified in the project specification*** the motor manufacturer shall provide a 1 inch BSP threaded hole in the motor casing to enable the installation of a bearing temperature probe by others.

13. ANTI-CONDENSATION HEATERS IN MOTORS

13.1 Anti-condensation heaters shall be built into the stators of motors and rated for a single-phase power supply of 230 V AC 50 Hz.

13.2 The terminals of the heaters shall be wired to a heater terminal box.

14. TERMINAL BOXES AND TERMINATIONS

14.1 The terminal box for the main supply cable(s) shall be adequately sized for the cables specified in the Project Specification***, and shall have a removable cover and gland plate. The degree of protection shall not be less than IP55.

14.2 Phase segregation shall be provided to prevent flashover, if the air and creepage distances between phases, and phases to earth are not adequate.

14.3 All terminals must be properly and permanently marked for easy identification.

14.4 Terminal boxes shall be on the left hand side if viewed from the drive end, unless other specified in the Project Specification***.

14.5 An explosion-relief diaphragm shall be provided to direct high pressure gases away from personnel who may be near the motor in the event of a terminal box fault.

14.6 Terminal boxes shall be fault-tested for both a through-fault and a short-circuit in the terminal box, based on the maximum fault level at the point of connection.

14.7 The terminal box shall be suitable for the cable termination method specified in the Project Specification***.

15. INFORMATION PLATES FOR MOTORS

15.1 In addition to the information required by SANS 60034-1, the following shall also be marked on the name plates:

15.1.1 Year of manufacture
15.1.2 The order number
15.1.3 Total mass of motor in kg
15.1.4 Diagram indicating the number, type and positions of heaters and temperature detectors if applicable.
15.1.5 Bearing types and sizes
15.1.6 Bearing grease interval or bearing replacement interval where pre-packed bearings are used.

16. COUPLINGS AND DIRECTION OF ROTATION

16.1 Couplings between the motors and the driven equipment will be provided with the driven equipment unless otherwise stated in the Project Specification***.

16.2 The motor's direction of rotation shall be to suit the driven equipment, and the motor terminals shall be marked in accordance with SANS 60034-8.

17. BALANCE AND CRITICAL SPEED

Motors and couplings shall be accurately and efficiently balanced statically, and dynamically, so that there will be no unbalanced end-thrust, when either new or worn, and to eliminate noise and vibration when running.

Where end-thrust arises, adequate long-wearing thrust bearings shall be provided. Dynamic balancing shall be done by the removal of parent metal, in a manner which does not affect the structural strength of the rotating element.

The use of solder, or similar deposits for balancing, will not be accepted. The operating speed of rotating elements shall be below and as far removed as possible from the critical resonant speeds thereof.

The permitted levels of vibration generated within the motors shall not exceed the values given in SANS 60034-14.

Notwithstanding the acceptance of the vibration limits during the works test, the Engineer reserves the right to call for a vibration test on the installed equipment, if he considers it necessary and the Contractor shall be responsible for reducing the vibrations to within the specified limits.

The motors shall have a suitable margin of safety between critical speed and normal running speed. The first critical speed shall be not less than 120 percent of nominal speed.

18. TESTING

Motors shall be tested at the manufacturer's works, with the scope of the tests depending on whether the motors have been built to a new or proven design as set out below.

Four copies of all test certificates shall be submitted to the Engineer no later than when the motors are delivered.

18.1 New Designs (Type Tests)

Any single motor, or the first motor of any batch of identical motors, shall be subjected to the following tests:

(a) Resistance measurement (cold) of all windings and auxiliary devices
(b) Load test
(c) Temperature rise at full load and hot resistance of windings
(d) Speed / torque and speed / current curves
(e) Vibration and noise levels
(f) Verification of dielectric properties
(g) No load test
(h) Locked rotor test
(i) Measurement of starting, pull-up and breakdown torque
(j) Verification of degree of protection
(k) Overspeed test (if application can result in overspeed).

The remaining motors shall be tested as for motors built to a proven design.

18.2 Proven Designs (Routine Tests)

All motors that have been built to a proven design shall be subjected to the following tests:

(a) Resistance measurement (cold) of all windings and auxiliary devices
(b) No load test
(c) Verification of dielectric properties
(d) Insulation resistance test.

Type test certificates shall be provided for the motors that are only subjected to routine tests.

19. INSTALLATION

(a) The motors shall preferably be installed by the motor supplier, and shall be installed strictly in accordance with the supplier's installation instructions.

(b) To allow for interchangeability of motors, the motors shall be installed on 2mm thick corrosion-resistant shims to allow for shaft height variation.

(c) The motor frame shall be insulated from the baseplate if necessary to prevent circulating bearing currents with converter-fed motors. The coupling shall similarly be insulated if required.

(d) The motor shall be aligned to the driven equipment using laser aligning equipment or approved equivalent. Final alignment shall be done before commissioning may start, and shall be witnessed by the Engineer. Alignment shall be within the tolerances specified for the shaft coupling.

20. COMMISSIONING

Once the motor and driven equipment have been aligned successfully, the following minimum commissioning checks shall be carried out.

(a) Ensure that the switchgear controlling the motor, and any associated protection and metering circuits, have been checked fully. It is imperative to ensure that any trip and emergency shutdown circuits are working correctly before the circuits are energized.

(b) The motor windings shall be checked for dryness and also that the insulation resistance and polarization indexes have acceptable values, as recommended by the motor manufacturer.

(c) Check the earth connections to the motor frame and terminal box for tightness.

(d) Check all auxiliary services, such as oil and water for lubrication and cooling to ensure that there is adequate flow and that interlocks and protection circuits are operational.

(e) Check that all hazard warning signs, guards and covers are in position and securely fastened.

(f) Check separately-driven motor cooling fans for correct operation and rotation, and to ensure that interlocks and protection circuits are operational.

(g) Ensure that phase rotation of supply to motor has been checked. If there is any doubt and any risk of damage to the driven equipment, the coupling should be split and the motor run alone.

(h) Check that direction of rotation matches the marking on the motor to ensure correct functioning of shaft-mounted fan.

(i) Check shaft bearing and motor footing insulation if provided.

Should dampness in the windings be detected through the measurement of low insulation resistance (Item b above), then the motor shall be dried out and a withstand voltage test carried out at 80% of the test voltage recommended in SANS 60034-1 for factory testing (i.e. 80% of 2 VR + 1 kV).

It is recommended that the test voltage for measuring insulation resistance be limited to 500 V dc, and the minimum acceptable insulation resistance shall be 1,5MΩ.

The method adopted for drying-out shall be by applying heat, preferably by circulating current through the windings or, alternatively, by means of space heaters located in and around the machine.

Insulation resistance measurements and temperature readings shall be taken regularly every half hour at the start of dry-out until the motor attains an even temperature and thereafter every hour. The characteristic dry-out curve of insulation resistance versus temperature shall be plotted and dry-out may be considered complete when the required polarization index is achieved.

All equipment and the personnel required for the drying out operation, shall be provided by the Contractor. The onus remains on the Contractor to satisfy himself that a motor is dry before it is connected to the supply. Any motor which fails as a result of being commissioned in a damp condition, shall be repaired free of charge by the Contractor.