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C3.1 SCOPE OF WORKS

SCOPE

The Scope of Work is set out in two portions:

- PORTION 1** covers a general description of the project, the facilities available and the requirements to be met.
- PORTION 2** covers variations and additions to the SABS 1200 Standard Specifications and Particular Specifications which are applicable to the Contract.
- STATUS** Should any requirements of the Project Specification conflict with any requirements of the Standard Specifications, the requirements of the Project Specifications shall prevail.

PORTION 1

PS 1 GENERAL DESCRIPTION

The project involves the Construction of Mkuze Rail Siding Transloading Facility, which includes: Roadworks and Stormwater, Earthworks, Concrete works, Building renovations, Hilo-Unloader Installation and Electrical Works.

PS 2 DESCRIPTION OF SITE AND ACCESS

Mkuze Rail Siding Transloading Facility is situated in Northern KwaZulu Natal, accessed via Fish Eagle Road, in Mkuze, opposite the Ghost Mountain Inn. It is currently an unfenced site with a sugar cane loading facility. The site co-ordinates are S 27°36'55.80" and E 32° 1'58.13"

PS 3 NATURE OF GROUND AND SUBSOIL CONDITIONS

It shall be the Contractor's responsibility in terms of the conditions of contract to have inspected the site and satisfied himself, by his own independent enquiries and observations, as to the nature of ground and subsoil conditions.

No claims for additional payment or an extension of time will be considered on account of the existing site conditions and nature of the ground and subsoil.

Tenderers will be permitted to make any trial pits or boreholes to carry out any sub-surface investigations of the area they require for the purpose of ascertaining the character and nature of the ground and subsoil, at their own expense and with prior written approval obtained from the Engineer before any such work is undertaken.

Refer to site information for available Geotechnical information.

PS 4 DETAILS OF CONTRACT

The Works to be executed under this contract comprises the following works:

- Site Clearance
- Roadworks: Gravel Roads, Concrete ramps and aprons, Weighbridges, Staging Area, Crane Offloading Area, Stormwater.
- Building: Refurbishment of existing building complete, with Water, Sewer, and electrical installations
- Assembly and Installation of Hilo Unloader (free issue), including supply installation and alignment of motors.
- Electrical Works: Distribution and Supply, High Mast Lighting, MCC Panel and Diesel Generator.

PS 5 CONSTRUCTION PROGRAMME AND PENALTY

The Contractor shall submit a programme for construction of the works to the Engineer within seven (7) days after delivery of the Letter of Acceptance and before he starts work on site, clearly indicating how he intends meeting the required Practical Completion date for all sections of the Works, taking due account of the agreed Practical Completion date. The Contractor will not be allowed to commence construction prior to the submission and approval of his programme as described above. No additional payments or extensions of time will be awarded to the Contractor, should he fail to meet the above requirement.

Should the Contractor fall behind programme with the Works, the Engineer shall have the right to request a revised programme from the Contractor which clearly indicates how the Contractor intends to meet the final completion dates and/or to insist on whatever additional plant, labour and materials are required to bring the contract back on programme. No extra payments to the Contractor will be allowed in such cases.

The Contract Completion Period is indicated in the Contract Data in Section C1.2. The penalty for late completion shall be as indicated in the Contract Data. The full penalty shall be applied should the Contractor fail to meet the completion period.

The Contractor will be required to submit a realistic construction and labour resource programme and proposed cashflow.

PS 6 SETTING OUT

The Contractor shall establish his own controls and set out the works as indicated on the drawings in sufficient detail to accurately locate all portions of the work and to construct the works within the level of tolerances specified.

No separate payment will be made for survey, establishing and setting out and the costs of such work will be deemed to be included in the tendered rates for the appropriate works.

PS 7 SITE FACILITIES AVAILABLE

PS 7.1 Source of Water Supply

The Contractor shall make his own arrangements for the supply of water for construction purposes and for his workforce. The Contractor shall bear the cost of all water and the supply thereof to the required site(s).

PS 7.2 Source of Power Supply

The Contractor shall be responsible for making his own arrangements with, and pay all the requisite connection and consumption charges to the relevant authority for whatever temporary power supplies he may require for use on the sites and his tender will be held to include for all such costs and charges.

PS 7.3 Site Camp and Site Area

The Contractor will be permitted to locate his offices, storage facilities, latrines, etc. in positions onsite, as approved by Employer's Agent.

The entire site shall be adequately fenced off with a standard galvanised steel mesh fence.

PS 8 SITE FACILITIES REQUIRED

PS 8.1 Contractor's Site Camp

The Contractor shall provide on the camp site, all his office accommodation and all associated facilities required for the adequate supervision, control and execution of the works.

The area occupied shall be neatly fenced off to denote its limit. The Contractor shall be responsible for the proper upkeep and control of the area for the duration of the contract and all structures and buildings shall be kept in good repair.

The Contractor must not cut down or damage any trees or make any excavation without the written permission of the Engineer and the Contractor will be required to restore the site to its original condition on completion of the works.

PS 8.2 Engineer's Office

A desk for the Engineer in the Contractors office is required under this Contract with WIFI and Telephone.

PS 8.3 Laboratory Facilities

No testing laboratory is required on-site by the Engineer.

PS 8.4 Sanitary Facilities

The Contractor shall provide screened latrines as necessary for his employees, including for local labour, the siting of which shall be to the satisfaction of the Engineer. They shall be constructed and maintained by the Contractor to the satisfaction of the Engineer and in accordance with the requirements of Government, Provincial and/or Local Authority. All applicable fees and charges due under any health by law or any or all of the above authorities shall be paid by the Contractor.

Chemical toilets, or where possible, flush units shall be used and these shall be kept in a thoroughly clean and sanitary condition. Chemical toilets shall be serviced at least twice a month.

All these facilities shall be provided before the commencement of construction and the Contractor shall strictly enforce their use.

A toilet facility for the sole use by the Engineer shall be provided by the Contractor.

PS 8.5 Refuse Containers and Disposal

Adequate containers for collection of refuse shall be provided by the Contractor. All containers shall have lids. Arrangements for refuse disposal shall be made with the relevant authority.

PS 8.6 Parking Facilities

These will not be required. However, an area adjacent to the Engineer's office to accommodate at least two vehicles shall be levelled, cleaned and maintained by the Contractor for the sole use of the Engineer.

PS 8.7 Housing Facilities

The Contractor will not be required to provide housing facilities for the Engineer's staff.

PS 9 PROTECTION OF EXISTING SERVICES

PS 9.1 Care, Damage and Protection

The Contractor shall so carry out all his operations as not to encroach on, or interfere with, trespass on, or damage adjoining lands, buildings, properties, road structures, Pipelines, places and things, in the vicinity of the Works and so as not to interfere in any way at any time with the smooth and continuous operation of the existing facilities.

PS 9.2 Location of Services

The Contractor shall take all the necessary steps to ascertain the location of existing services before commencing any section of the works and shall exercise the greatest care when working in the vicinity of such services. No more than three weeks and not less than one week before commencing his operations in any particular area, the Contractor shall obtain from the relevant authority the latest available drawings showing the location of services already installed.

The Contractor shall take all the necessary steps to protect any existing works against damage which may arise as a result of his operations on Site. The Contractor shall bear the cost of the repair of damage to any service the possible existence of which could reasonably have been ascertained by him in good time.

Where the Contractor is responsible for the cost of repairs carried out by a Service Authority, the Contractor will be billed directly by the Service Authority concerned.

A provisional allowance has been made in the Bill of Quantities for hand excavation to locate existing services, where ordered by the Engineer.

PS 9.3 Relocation of Existing Services

The Contractor may be required to arrange for the relocation of certain services and pay the required charges and fees. An allowance for this work has been made in the Bill of Quantities.

PS 10 SECURITY OF CONTRACTOR'S SITE

The provision of security for the Contractor's Site Establishment and for the entire length of the contract shall be his own responsibility and no claims for additional security measures taken during the currency of the contract will be considered.

PS 11 SPOIL MATERIAL

No indiscriminate spoiling of material will be allowed. All surplus or unsuitable material shall be spoiled by the Contractor to a licensed dumping site, at the Contractor's cost, and weighbills shall be provided to the Engineer.

The site of the works shall be kept in a clean and orderly condition to the satisfaction of the Engineer. Shuttering, propping, scaffolding, etc. after striking is to be removed immediately to the Contractor's workshop or store yards, or to its next place of use. Waste material, empty cement pockets, pipes, manhole rings, etc. are not to be left lying at the site of operation.

PS 12 DESIGNATED BORROW

No designated borrow pits have been identified for this Contract. The Contractor will be required to make his own arrangements with commercial sources for material required and include for this in tendered rates.

PS 13 LENGTH OF TRENCHES

Unless otherwise permitted in writing by the Engineer, not more than 50m of trench in total within the project area shall be opened in advance of pipe laying operations.

No trench may be left open over the Christmas shut-down period or any long holiday period (e.g. public holiday, etc.) prior to the Christmas shut down. The cost of backfilling any trenches before the shut-down period and the re-opening thereof after the shut-down period shall be for the Contractors account.

PS 14 TESTING OF PIPES

The Contractor must commence with testing the Pipelines immediately after the pipe has been installed at each individual site.

Unless otherwise permitted in writing by the Engineer, not more than 200m of Pipelines shall be installed in total, within the project area, in advance of the pipe testing operations.

PS 15 ACCOMMODATION FOR WORKERS

Workers who are not recruited locally must be provided with housing in accordance with any prevailing applicable legislation.

Accommodation on site will not be permitted.

PS 16 COURTESY

In all dealings with the public, the Contractor shall bear in mind their right to enjoy the use of public and private facilities, and the Employer's desire to interfere as little as possible with this right.

The Contractor is requested to deal with all contact with the public with deliberate courtesy and understanding. Any conflicts or disputes with the public shall be referred to the Engineer.

PS 17 FINISHING, TIDYING AND PERIOD OF MAINTENANCE

Progressive and systematic finishing and tidying must form an essential part of this Contract. On no account must spoil, rubble, materials, equipment or unfinished operations be allowed to accumulate in such a manner as to unnecessarily impede the activities of others, and in the event of this occurring, the Employer shall have the right to withhold payment for as long as may be necessary in respect of the relevant works in the area(s) concerned without thereby prejudicing the rights of others to institute claims against the Contractor on the grounds of unnecessary obstruction.

All finishing and tidying shall be carried out to the best advantage of the project as a whole and in the closest co-operation with the Contractors.

PS 18 FACILITIES FOR OTHER CONTRACTORS

The Contractor must note that other Contractors may be working on or adjacent to the site of the Works during the duration of the Contract.

The Contractor must allow for other Contractors, which may involve, inter alia, the adaption of his programme to fit in with work to be done by the other Contractors.

PS 19 DEALING WITH WATER

The Contractor shall be responsible for dealing with all water during construction from whatever source, and the cost of all dewatering unless otherwise itemised in the Bill of Quantities shall be deemed to be included in the tender rates.

PS 20 WORKING SPACE

Working space will generally be 1m on either side of the Pipeline trench and 1m around the base of all work.

This area is to include for access along the Pipeline, for excavated material, and for the placing of topsoil separately from other material.

It must be noted that services such as telephone and power poles, stay poles and stay wires and fences may be located within close proximity of the Pipeline centreline. Some existing building structures may also be located in close proximity of the Pipeline route.

The Contractor will be required to take due care for the protection of and will be liable for damage to, or physical loss of, property adjacent to the site.

PS 21 EXCAVATION OF TRENCHES

Trenches for Pipelines and cables shall be excavated by hand, where applicable and within regulations. Machine excavation will only be permitted where instructed by the Engineer, where substantial quantities of hard material is encountered.

All requirements of the OHS Act shall be complied with, with respect to shoring for both excavation methods.

PS 22 **ADVERSE WEATHER CONDITIONS**

Critical Path Method

In terms of GCC 2015, Clause 5.12.2.2, extension of time will be considered for **abnormal rainfall**. The numbers of days per month on which work is expected not to be possible as a result of **normal rainfall**, and for which the Contractor shall make provision in his/her tendered rates, prices and programme, are listed in Table PS-23.1 below. Only the number of days lost as a result of adverse weather conditions, exceeding the number of days listed in Table PS-23.1, will qualify for consideration of extension of time.

TABLE PS-17.1: EXPECTED NUMBER OF WORKING DAYS LOST PER MONTH DUE TO NORMAL RAINFALL

| MONTH | Expected number of working days lost as result of normal rainfall |
|-----------|---|
| JANUARY | *2 |
| FEBRUARY | 3 |
| MARCH | 1 |
| APRIL | 1 |
| MAY | 0 |
| JUNE | 0 |
| JULY | 0 |
| AUGUST | 0 |
| SEPTEMBER | 1 |
| OCTOBER | 2 |
| NOVEMBER | 2 |
| DECEMBER | *2 |
| TOTAL | 14 days |

Note: Rainfall records above relate to Weather Bureau № 375124 – uBombo.

(* The number of working days lost for December and January allows for the builders' holidays from 18 December 2021 to 11 January 2022.)

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

- if no work was possible on the relevant working day on any item which is on the critical path according to the latest approved construction programme; or
- if less than 30% of the work force and plant on site could work during that specific working day.

Extension of time as a result of abnormal rainfall and adverse weather conditions shall be calculated monthly being equal to the number of working days certified by the Engineer's Representative as lost due to rainfall and adverse weather conditions, less the number of days allowed for as in Table PS-23.1, which could result in a negative figure for certain months. The total extension of time as a result of abnormal climatic conditions for which the Contractor may apply, shall be the cumulative algebraic sum of the monthly extensions. Should the sum thus obtained be negative, the extension of time shall be taken as nil.

The Contractor shall provide a rain gauge installation and ensure that it is tamper-proof. Costs thereof shall be deemed to be included in tendered rates.

PS 23 LOCAL LABOUR AND SUB-CONTRACTORS

It is not the intention of this Contract that use of the local labour is priority.

PS 24 CONTRACTOR'S SITE AGENT

The Contractor shall appoint a suitably qualified and competent Site Agent who shall be on the site on a full-time basis and at all times when work is being performed, for the full duration of the contract.

PS 25 SITE MEETINGS

The Engineer shall arrange monthly site meetings between the Representatives of the Engineer, the Employer and the Contractor, together with any other interested or affected party who the Engineer may require to be in attendance.

The Site Agent shall be present at all meetings and shall be fully empowered to make decisions at all levels pertaining to the Contract.

The Site Agent shall prepare and submit reports on progress, programme and cash flows at each and every site meeting.

PS 26 DAILY SITE DIARY

The Contractor is required to keep a site diary on site, for the purposes of keeping daily records in respect of site conditions, work performed on the site and all significant events.

PS 27 DRAWINGS

PS 27.1 Drawings Prepared by Employer

The drawings listed in Section C5 – List of Drawings are prepared and issued by the Employer for tendering purposes. They are issued separately to this document and must be regarded as provisional and preliminary for Tenderers to generally assess the scope of work. The characters in the "Rev No." column indicate the revision status of these drawings.

At commencement of the contract, the Engineer shall deliver to the Contractor copies of the drawings for construction purposes and any instructions required for the commencement of the works. Further drawings may be issued after Contract Commencement. From time to time thereafter during the progress of the works, the Engineer will issue further drawings as may be necessary for adequate construction, completion and defects correction of the works. The work shall be carried out in accordance with the latest available revision of the drawings.

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

PS 27.2 Drawings to be Prepared by Contractor

The Contractor is required to prepare as-built drawings under this contract.

PS 28 **CONSTRUCTION AND MANAGEMENT REQUIREMENTS**

PS 28.1 **Applicable SANS 1921 Standards**

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

- SANS 1921-1 General engineering and construction works
- SANS 1921-2 Accommodation of Traffic on Public Roads
- SANS 1921-6 HIV/AIDS Awareness

The associated specification data applicable to these SANS 1921 standards is as follows:

| Standard | Clause | Specification Data |
|--------------------|--------|--|
| SANS 1921-1 | | Essential Data |
| | 4.1.7 | The requirements for drawings, information and calculations for which the Contractor is to be responsible is detailed in the project specifications. |
| | 4.2.1 | The responsibility strategy assigned to the Contractor for the Works is A. |
| | 4.3 | The planning, programme and method statements are to comply with the following: <ul style="list-style-type: none"> 1) The programme shall be prepared in bar (Gantt) chart form, preferably using a project management software tool such as <i>Microsoft Project</i> and shall be issued to the Engineer in both hard copy and electronic format. The programme shall be structured to cover all items of work conceivable including all work to be done by sub-contractors and shall clearly indicate the critical path 2) The programme must clearly show the intermediate milestone dates to be achieved taking the indicative construction sequences into account. 3) Method statements shall be prepared in accordance with the requirements of the project specifications. |
| | 4.17.4 | The requirements for detection apparatus are: Nil Where services are found the Engineer must be notified immediately so that a decision can be made regarding re-alignment, relocation or protection of said services. The Contractor shall on no account effect such adjustments without the prior consent of the Engineer. |
| | 4.17.5 | If unknown services are found undamaged, they shall then be deemed to be known services with the provisions pertaining to known services becoming applicable. |
| | 4.17.6 | Where a service has been located and exposed, the Contractor shall take every care in ensuring that the excavation containing the service is barricaded and protected against collapse and that the service is adequately protected against damage. Should the existing service become damaged by the Contractor or any third party due to negligence on part of the Contractor, then the cost of its repair along with any consequential costs shall be borne by the Contractor. |
| | 4.17.7 | Existing known services or services that have been proved by the Contractor, which are damaged by the Contractor, shall be repaired by the |

| Standard | Clause | Specification Data |
|--------------------|---------|---|
| | | service provider and all costs of the repair shall be borne by the Contractor. |
| | 4.18 | The additional health and safety requirements of the Employer are as specified in the health and safety specification included in the tender document. |
| SANS 1921-1 | | Variations |
| | 4.1.10 | Where reference is made to "SANS 2001", substitute with "SABS 1200" |
| SANS 1921-1 | | Additional Clauses |
| | 4.6 (e) | The Contractor is to ensure that stormwater runoff or any groundwater seepage is controlled by means of temporary earthworks, cofferdams, pumping equipment, well-pointing, de-watering equipment etc. to keep the works free of water |
| | 4.6 (f) | Dealing with all water during construction from whatever source will include for by-pass arrangements for dealing with all possible flows whether or not the existing flow path is being interfered with during installation of the Works. |
| | | |
| | 4.7.4 | <p>No blasting will be permitted within 10 m of any structure, Pipeline or service unless the Contractor can satisfy the Engineer that his proposed blasting methods and controls are such that no damage will be caused to the adjoining structure, Pipeline or service. The Contractor will be required to provide equipment for and take vibro-recordings at no additional cost to the Employer.</p> <p>It shall therefore be a requirement of this project that the Contractor shall arrange for his blasting procedure to be prepared by an approved specialist in explosive techniques, to take into account the proximity of the existing powerline and other works, structures etc. The recommendations by this specialist shall be adhered to at all times.</p> <p>All costs associated with compliance of the above requirements shall be included in the tendered rates.</p> |
| | 4.8.1 | <p>The Contractor shall be responsible for protection from damage to any structures or services that might be affected by the excavations or works.</p> <p>The Contractor shall, before submitting his tender, carefully study the tender drawings and inspect on site the structures to be constructed in close proximity to existing structures and services and make due allowance in his rates for protection of structures and services by use of special construction methods such as close shoring, sheet piling, etc.</p> |
| | 4.8.2 | Notwithstanding whatsoever special construction methods, equipment or materials are used by the Contractor to protect the structure or service from damage, all work will be measured for payment on the assumption that normal excavation had been carried out and the Contractor shall therefore make allowance for the additional costs in his tendered rates. |

| Standard | Clause | Specification Data |
|----------|--------|--|
| | 4.9.5 | It will be necessary for the Contractor to liaise closely with the Employer and the Engineer's Representative regarding any disruption of the water supply as a result of his construction activities. |
| | 4.9.6 | The provision of security for the Contractor's site establishment, plant and personnel at all times is sole responsibility of the Contractor and no claims for payment for additional security measures taken during the contract will be entertained. |
| | 4.17.8 | The Contractor shall so carry out all his operations as not to encroach on, or interfere with, trespass on, or damage adjoining land, buildings, properties, road structures, Pipelines, places and things, in the vicinity of the Works and outside of the site boundary. |

PS 28.2 Quality Assurance (QA) *(Read with SANS 1921 – 1: 2004 clause 4.4)*

The Contractor will be solely responsible for the production of work that complies with the Specifications to the satisfaction of the Engineer. To this end it will be the full responsibility of the Contractor to institute an appropriate Quality Assurance (QA) system on site. The Engineer and Employer will audit the Contractor's quality assurance (QA) system on a regular basis to verify that adequate independent checks and tests are being carried out and to ensure that the Contractor's own control is sufficient to identify any possible quality problems which could cause a delay or failure.

The Contractor may only procure goods and/or services from vendors that have received the prior approval of the Employer. In this regard the Employer has a list of approved suppliers and, in the event of the Contractor wishing to procure an item(s) from a vendor that is not on that list, the prospective vendor will be required to make application in writing to the Employer.

Attention is drawn to the need to allow at least one month for the Employer to carry out a vendor assessment and that there is no guarantee that the Employer will approve any particular vendor.

The Contractor shall ensure that efficient supervisory staff, the required transport, instruments, equipment and tools are available to control the quality of his/her own workmanship in accordance with his/her QA-system. His/her attention is drawn to the fact that it is not the duty of the Engineer or the Engineer's Representative to act as foreman or surveyor.

PS 28.3 Testing *(Read with SANS 1921 – 1: 2004 Clause 4.11)*

PS 28.3.1 Process control

The Contractor shall arrange for all tests required for process control to be done by an independent laboratory acceptable to and approved by the Engineer.

The Contractor must employ the services of an independent commercial laboratory. The Contractor must submit the results of tests carried out on materials and workmanship when submitting work for acceptance by the Engineer. The costs for these tests shall be deemed to be included in the relevant rates and no additional payment will be made for testing as required.

PS 28.3.2 Acceptance control

The process control test results submitted by the Contractor for approval of materials and workmanship may be used by the Engineer for acceptance control. However, before accepting any work, the Engineer may have further control tests carried out by a laboratory of his/her choice. The cost of such additional tests will be covered by a provisional sum provided in the schedule of quantities, but tests that failed to confirm compliance with the specifications, will be for the account of the Contractor.

PS 28.4 **Survey beacons** *(Read with SANS 1921 - 1: 2004 Clause 4.15)*

The Contractor shall take special precautions to protect all permanent survey beacons or pegs such as bench-marks, stand boundary pegs and trigonometrical beacons, regardless whether such beacons or pegs were placed before or during the execution of the Contract. If any such beacons or pegs have been disturbed by the Contractor or his/her employees, the Contractor shall have them replaced by a registered land surveyor at his/her own cost.

PS 28.5 **Management of the environment** *(Read with SANS 1921 – 1:2004 Clause 4.19 and the Environment Particular Specification)*

The Contractor shall pay special attention to the following:

(a) Clearing of vegetation

The Contractor will not destroy, remove or clear trees, timber or shrub to any extent greater than that approved. The Contractor will not carry out any activity outside the areas defined for clearing unless otherwise approved by the Environmental Control Officer.

(b) Soil Erosion

The quality of topsoil in stockpiles will be maintained by measures including contamination from other materials, minimizing stockpiling periods and prevention of soil erosion by surface runoff or wind. Monitoring for erosion and soil erosion risk will be undertaken regularly to ensure that any erosion that occurs is mitigated as soon as possible.

(c) Risk of faunal injury and death

The trenches will be kept open for the minimum period necessary to undertake the works. Temporary fencing or barriers will be placed along the trenches in areas that are likely to be used as corridors i.e. linkages between bushes where possible along the corridor.

(d) Pollution Prevention

With particular regard to Sanitation, Solid Waste Facilities, Fuels, Hazardous Substances and other Liquid Pollutants as elaborated in the Particular Specification for Environmental Management.

(e) Rehabilitation

The Contractor is to ensure that the site and its surrounds is rehabilitated to the condition in which it was prior to commencement of construction activities.

PS 28.6 Overhaul

There is no allowance for overhaul in the Bill of Quantities and this is to be allowed for in the Tendered Rates.

PS 29 OCCUPATIONAL HEALTH AND SAFETY *(Read with SANS 1921 - 1: 2004 Clause 4.14 and the Particular Safety Specification)*

PS 29.1 General statement

It is a requirement of this contract that the Contractor shall provide a safe and healthy working environment and to direct all his/her activities in such a manner that his/her employees and any other persons, who may be directly affected by his/her activities, are not exposed to hazards to their health and safety. To this end the Contractor shall assume full responsibility to conform to all the provisions of the Occupational Health and Safety Act No 85 and Amendment Act No 181 of 1993, and the OHS Act 1993 Construction Regulations 2014 issued on 07 March 2014 by the Department of Labour.

For the purpose of this contract the Contractor is required to confirm his/her status as Mandatory and employer in his/her own right for the execution of the contract by entering into an agreement with the Employer in terms of the Occupational Health and Safety Act by executing the Agreement Form included in Section C1: Forms of Security.

PS 29.2 Health and Safety Specifications and Plans to be submitted at tender stage

(a) Employer's Health and Safety Specification

The Employer's Particular Health and Safety Specification will be included in the tender documents as part of the Project Specifications.

(b) Tenderer's Health and Safety Plan

The successful Tenderer shall, on receipt of notification that he/she has been awarded the contract, submit without delay his/her own documented Health and Safety Plan for the execution of the work under the contract. His/her Health and Safety Plan must at least cover the following:

- (i) a proper risk assessment of the works, risk items, work methods and procedures in terms of Regulations 7 to 28;
- (ii) pro-active identification of potential hazards and unsafe working conditions;
- (iii) provision of a safe working environment and equipment;
- (iv) statements of methods to ensure the health and safety of subcontractors, employees and visitors to the site, including safety training in hazards and risk areas (*Regulation 5*);
- (v) monitoring health and safety on the site of works on a regular basis, and keeping of records and registers as provided for in the Construction Regulations;
- (vi) details of the Construction Supervisor, the Construction Safety Officers and other competent persons he/she intends to appoint for the construction works in terms of Regulation 6 and other applicable regulations; and
- (vii) details of methods to ensure that his/her Health and Safety Plan is carried out effectively in accordance with the Construction Regulations 2014.

The Contractor's Health and Safety Plan will be subject to approval by the Employer, or amendment if necessary, before commencement of construction work. The Contractor will not be allowed to commence work, or his/her work will be suspended if he/she had already commenced work, before he/she has obtained the Employer's written approval of his/her Health and Safety Plan.

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

PS 29.3 Cost of compliance with the OHSA Construction Regulations

The rates and prices tendered by the Contractor shall be deemed to include all costs for conforming to the requirements of the Act, the Construction Regulations and the Employer's Health and Safety Specification as applicable to this contract. Should the Contractor fail to comply with the provisions of the Construction Regulations, he/she will be liable for penalties as provided in the Construction Regulations and in the Employer's Health and Safety Specification.

Items that may qualify for remuneration will be specified in the Safety Specifications included or in the Project specifications.

PS 30 APPLICABLE STANDARDISED SPECIFICATIONS

| | |
|-------------|------------------------------|
| SABS 1200A | General |
| SABS 1200C | Site Clearance |
| SABS 1200D | Earthworks |
| SABS 1200DB | Earthworks (Pipe Trenches) |
| SABS 1200DM | Earthworks (Roads, Subgrade) |
| SABS 1200G | Concrete (Structural) |
| SABS 1200L | Medium Pressure Pipelines |
| SABS 1200LB | Bedding (Pipes) |
| SABS 1200LD | Sewers |
| SABS 1200ME | Subbase |
| SABS 1200MF | Base |
| SABS 1200MH | Asphalt Base and Surfacing |
| SABS 1200MK | Kerbing and Channelling |

Particular Specifications

| | |
|------|---|
| PE | Health and Safety Specification |
| PZ | Environmental Management Specification |
| PC | Topsoiling and Grassing |
| PE | Health & Safety Specification |
| PZ | Environmental Management Specification |
| PC | Topsoiling and Grassing |
| C1P | MCC Panel (10969-001-2040-R-0005) |
| C1DG | Diesel Generator (10969-001-2040-R-0004) |
| C1Hi | Hilo Installation (10969-001-2040-R-0006) |
| C1GE | Gen Electrical Installation (10969-001-2040-R-0003) |

| | |
|-------|---|
| C1W | Weighbridge (10969-001-2040-R-0001) |
| C1P | MCC Panel (10969-001-2040-R-0005) |
| C1DG | Diesel Generator (10969-001-2040-R-0004) |
| C1Hi | Hilo Installation (10969-001-2040-R-0006) |
| C1GE | Gen Electrical Installation (10969-001-2040-R-0003) |
| C1SPL | Small Power & Lighting (10969-001-2040-R-0007) |
| C1ST | Building, Hilo-Unloader, Spiller Wall and Hardstand |

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSA GENERAL

PSA 1 CONTRACTOR'S OFFICES, STORES AND SERVICES (SUBCLAUSE 4.2)

The location of the Contractor's offices, stores, and services on site shall be subject to approval by the Employer, and off-site subject to approval from both the Employer and the land owner.

The Contractor shall obtain all the necessary permits and approval for the housing of labour and make all the necessary arrangements for services, latrine facilities etc., all at his cost. Where the Employer is to make any services or facilities available to the Contractor, details and cost implications are given in Portion 1 of the Project Specification.

PSA 2 ACCESS TO WORKS (SUBCLAUSE 5.8)

Notwithstanding subclause 5.8 the Contractor shall, where practicable, maintain free access for other parties to make use of the site, and in this regard he may be called upon to carry out special works as itemised in the Bill of Quantities or under day works. Other parties may include employees of the local authority, other contractors, members of the public who require access to adjoining properties and employees of various departments such as Telkom.

Road crossings and access to erven must be provided by the Contractor at all times. The Contractor shall, at his own expense, provide suitable crossings for residents and other Contractors requiring access to the Site. Such temporary service trench crossings shall be in the form of portable bridges, temporary backfill or other approved means and shall be capable of permitting the safe passage of vehicles of mass not exceeding 3 tons. The Contractor shall also be responsible for maintaining such crossings and for removing them when they are no longer required.

If as a result of restricted road reserve widths and the nature of the works, the construction of by-passes is not feasible, construction shall be carried out under traffic in order to provide access to the erven and properties.

The Contractor may, with the approval of the Engineer, arrange with the occupiers of the affected erven and properties to temporarily close off a portion of a street, road, foot-path or entrance, provided that the Contractor shall give due notice to the occupiers of the intended closure and its probable duration and shall as punctually as possible re-open the route at the prescribed time. Where possible the road shall be made safe and re-opened to traffic overnight. Any such closure shall be an arrangement between the Contractor and the occupiers and shall not absolve the Contractor from his obligations under the Contract to provide access at all times. Barricades, traffic signs and drums shall be provided by the Contractor to suit the specific conditions.

If the Contractor intends to close off a bus route the relevant authorities shall be notified 24 hours prior to the work. If the Contractor intends to close off a taxi route, he shall advise and liaise with local taxi association in this regard. All roads may only be closed between the hours of 08:30 – 15:30.

Items have been included in the Preliminary and General Section of the Bill of Quantities for the provision of access to properties.

Payment shall be a lump sum for providing access to all erven and properties, which lump sum shall be full compensation for providing access to erven and properties at all times and shall include for any additional costs due to construction under traffic, for making arrangements with the occupiers of erven and properties to temporarily close off routes and for taking the necessary precautions to provide for the safe and easy passage of traffic through the areas under construction.

PSA 3 DEALING WITH TRAFFIC

In order to ensure the safety of pedestrians, motorists and workmen where works are to be carried out on public road areas, the Contractor shall comply with the procedures as set out in the latest draft of Road Signs Note No. 13 "Roadworks", as published by the CSRA – CUTA Road Traffic Signs Sub Committee. In particular, the contents of Appendix 4: "Urban Road Sign Sequence" shall be adhered to.

PSA 4 NON-STANDARD ITEMS

A number of Non-Standard Payment Items are included in the Bill of Quantities in respect of items of work not described within the standardised, Project or Particular Specifications.

Measurement and payment of such items shall be in terms of this Clause.

The unit of measurement for each individual non-standard item shall be as indicated for that item within the Bill of Quantities.

The tendered rates and prices for each particular item shall, unless otherwise stated in the "Short Description" of the item, include for everything necessary to construct the particular item complete in all respects and in accordance with the description thereof as set out in the column headed "Short Description" in the Bill of Quantities.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSAB ENGINEER'S OFFICE

PSAB 1 NAMEBOARDS (SUBCLAUSE 3.1)

Notwithstanding subclause 3.1 the Contractor shall supply and erect specified nameboards, within two weeks of commencement of the Works.

Standard details of the nameboard shall be as shown on the Engineer's drawings included in this document.

The Contractor shall consult with the Engineer as to the exact wording, font and colours to be used on the nameboard.

PSAB 2 OFFICE BUILDING (SUBCLAUSE 3.2)

The Contractor is to supply and install an accurate rain gauge of modern design and all other necessary equipment within the site camp area, in a position to be confirmed by the Engineer on site in order to accurately measure rainfall. This area shall be fenced off from the rest of the site camp area and shall have a single pedestrian gate with lock. Only the Engineer's Representative will have access to the key and will be allowed access to the rain gauge. Rainfall records read at this rain gauge will be kept by the Engineer's Representative. The Engineer's Representative shall use these rainfall records in order to confirm days on which rainfall results in a stoppage of work, critical to the completion of the whole of the Works as described under clause PS 23. The contractor's tendered rates shall be deemed to include for the supply and installation of the rain gauge, other related equipment, fencing, gate, lock, key etc.

PSAB 3 SURVEY EQUIPMENT AND MATERIALS

The Contractor shall provide one survey assistant for full time use by the Engineer for the duration of the Contract. The survey assistant shall have a minimum S2 tertiary qualification in civil engineering and shall be identified by the Engineer for employment by the Contractor. The survey assistant will assist the Engineer's Representative with survey work, measurement, recording of construction record information and other work as directed by the Engineer.

The remuneration of the other (S2/S3 minimum) survey assistant is to be as indicated under time-related P&G costs. In addition to remuneration, the Contractor is to allow for the cost of accommodation for the S2/S3 survey assistant as indicated under time-related P&G costs. Accommodation is to be approved by the Engineer.

The Contractor shall provide the following survey equipment on the site from the commencement to completion of the works for the sole use of the Engineer:

- (i) One (1) accurate approved automatic level of modern manufacture together with tripod;
- (ii) One (1) metric 5m levelling staff of approved design;
- (iii) One (1) steel tapes of length 30m;
- (iv) One (1) 5m steel pocket tapes.
- (v) One (1) Dynamic Cone Penetrometers (DCP)

The Contractor shall keep the equipment continuously insured against any loss, damage or breakage, and he shall indemnify the Engineer and the Employer against any claims in this regard. Upon completion of the whole of the works, the ownership of the equipment shall revert to the Contractor. Should any or all of the above not be provided by the Contractor, the Engineer shall at his sole discretion, determine the cost of such items and deduct said cost from the Contractor's Payment Certificate.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSC SITE CLEARANCE

PSC 1 INDIVIDUAL TREES (SUBCLAUSE 5.2.3.2)

A penalty of R1000,00 per tree will apply to trees indicated and marked by the Engineer as trees to be preserved and which are subsequently damaged or removed unnecessarily by the Contractor.

PSC 2 FENCING

Where fencing has to be removed in order to facilitate pipelaying operations the Contractor shall notify the affected property owner and photograph the fence in advance of the dismantling of the fence. All dismantled fencing materials shall be stockpiled neatly in a secure place and shall be safeguarded until the fence can be re-erected again.

The fence shall be re-erected where possible with the original fencing materials. Where this would give rise to a fence in a worse condition than it was before it was dismantled, the Contractor shall erect a new fence to an equivalent or better standard than the previous fence.

Where an uplifted fence interferes with the security of what it controls, a temporary farm gate shall be installed and operated to the satisfaction of the Engineer or his representative. The temporary farm gate shall comprise of locally obtained wooden droppers and wire. This temporary farm gate will be included in the cost of removing and replacing the fence.

The Contractor is to ensure that the gate is closed and animals (dogs, goats) cannot pass through the temporary works at all times.

PROJECT SPECIFICATION

PSD PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS EARTHWORKS

PSD 1 CLASSES OF EXCAVATION (SUBCLAUSE 3.1.2)

The following definitions shall apply to the wording 'efficiently removed' and 'efficiently loaded'.

a) Soft Excavation

- 1.i) For soft excavation 'efficiently removed' without prior ripping by a bulldozer as described in subclause 3.1.2a)1.i, shall mean the removal of more than 150m³ of insitu material per hour.
- 1.ii) For soft excavation 'efficiently removed' without prior ripping by a bulldozer of mass (including mass of ripper if fitted) of approximately 35t and a flywheel power of approximately 220kw shall mean the removal to stockpile of more than 250m³ of insitu material per hour.
2. For soft excavation, in restricted excavation, 'efficiently removed' without the assistance of pneumatic tools by a back-acting excavator as described in subclause 3.1.2 a)2, shall mean the removal of more than 0,035m³ per millimeter of tined-bucket width per hour of continuous, unrestricted operation.

b) Intermediate Excavation

1. For intermediate excavation, 'efficiently removed' by a bulldozer as described in subclause 3.1.2 b)1, shall mean the ripping only (stockpiling not included) of more than 250m³ of insitu material per hour.
2. For intermediate excavation, in restricted excavation, 'efficiently removed' by a back-acting excavator as described in subclause 3.1.2 a)2 shall mean the removal of more than 0,007m³, but less than 0,035m³, per millimetre of tined-bucket width per hour of continuous, unrestricted operation.

Excavation in material that, in the opinion of the Engineer, requires a back-acting excavator of flywheel power exceeding 0,10kw per millimetre of tined-bucket width or the assistance of pneumatic tools prior to removal in order to achieve a removal rate of at least 0,035m³ per millimetre of tined-bucket width per hour of continuous, unrestricted operation will also be classified as intermediate excavation.

c) Hard Rock Excavation

1. Hard rock excavation, other than in restricted excavation, shall be excavation (excluding boulder excavation) in material that does not meet the ripping rate specified in b)1 above.

2. Hard rock excavation, in restricted excavation or for small works, shall be excavation (excluding boulder excavation) in material that does not meet the removal rate of 0,007m³ specified in b)2 above without blasting or without wedging and splitting prior to removal.

With regard to plant specified in subclause 3.1.2 but not referred to above, and other plant (see subclause 4.1), the Engineer will decide on site as to the classification of materials based on its removability as described in subclause 3.1.1.

PSD 2 SELECTION (SUBCLAUSE 3.3.1)

The Engineer shall direct, if the nature of the excavated material so requires, that certain portions of the excavated material be placed only in specific sections of the embankments. The Contractor will receive no additional payment for such selection.

PSD 3 EXPLOSIVES (SUBCLAUSE 5.1.1.3)

Notwithstanding subclause 5.1.1.3, the Engineer shall be notified at least 24 hours beforehand of the Contractor's intention to use explosives on site.

It shall be incumbent on the Contractor to make himself aware of restrictions to blasting imposed by oil Pipeline, electric transmission and other similar authorities. Where the presence and location of the oil Pipeline or electric transmission lines etc. are known or are shown on the Engineer's drawings at tender stage the Contractor must make allowance in his rates and programmes for restrictions and delays which may result from restrictions imposed by the authorities.

PSD 4 NEGLIGENCE (SUBCLAUSE 5.1.2.5)

The Contractor shall be liable for all damages to services caused as a result of the Contractor's negligence.

PSD 5 EXCAVATION (SUBCLAUSE 5.2.2.)

After site preparation as described in subclause 5.2.1 and before placing any fill material, the Engineer's approval of the suitability of the in-situ material shall be obtained. Where excavated material, which is designated as suitable fill material, becomes contaminated or is mishandled or misplaced by the Contractor he shall remove the contaminated material and/or replace the shortfall with suitable material at his own expense.

PSD 6 BORROW PITS (SUBCLAUSES 5.2.2.2 AND 5.2.3)

Unless offsite borrow pits are shown on the Engineer's drawings or are designated by the Engineer at tender stage, the Contractor shall make his own arrangements for the importation of material of a specified quality, when and if required, from borrow pits outside the Contract Site. (See Clause PSD 10).

PSD 7 DISPOSAL (SUBCLAUSE 5.2.2.3)

Where material is carried to spoil or to fill low areas, filling shall be done, unless otherwise specified, generally in accordance with subclause 5.2.3.1 except that compaction requirements will be relaxed. In such cases each layer of material deposited shall be compacted by spreading with earthmoving equipment and by

routing construction traffic such that the whole of each layer is traversed by heavy equipment.

PSD 8 PLACING AND COMPACTING – EMBANKMENTS (SUBCLAUSE 5.2.3.1)

Notwithstanding subclause 5.2.3.1, for cohesive soils the upper 600mm of all fills shall be compacted to a minimum of 93% MAASHTO density.

PSD 9 ROCK FILLS (SUBCLAUSE 5.2.3.1)

Rock excavated from cut shall be used in the portion of the fill that is more than 1m below finished level. The rock material shall be deposited in layers of thickness at least sufficient to accommodate most of the rock material, provided that the thickness of the uncompacted layer does not exceed 750mm. The rock fill shall be spread and sorted by a bulldozer of adequate size to obtain layers of uniform thickness. Oversize material (i.e. any rock having a maximum dimension exceeding 600mm) shall be either broken down to size or, where by the nature of the material this is impracticable, dozed to the outside of the embankment and removed as spoil.

After the material has been spread, the interstices shall be filled with small rock or fine grained material and if, after the addition of such material, the stone layer is still too rough to roll, sufficient fine-grained material shall be added to blind the surface, or the unevennesses shall be broken down by knapping. The layer shall then be watered and given six passes of a 6t vibrating roller or four passes of a 10t vibrating roller. If the 'lock' or the void in the finished layer is not to the satisfaction of the Engineer, he may order spot dumping and hand distribution of suitable fine material, and the application of further water between passes and such additional rolling as he may consider necessary for a dense stable embankment fill to be obtained.

The upper portion of the fill within 1m of finished level shall be constructed in layers of thickness not exceeding 300mm before compaction. The layers shall be formed with material containing no lumps, stones, or clods that, after being broken down and compacted, have any dimension greater than 150mm.

PSD 10 TAKING AND TESTING OF SAMPLES (SUBCLAUSE 7.2 AND CLAUSE 8)

10.1 Tests to the Contractor's Account

Unless a soils testing laboratory has been appointed by the Employer at pre-tender stage, the Contractor shall make arrangements with such a laboratory to undertake the following tests and to pass the test result to the Engineer. The cost of such tests shall be included in the rates tendered for the appropriate item in the Schedule of Quantities.

- a) Material imported from outside the contract site as a working surface, for subgrade improvement, or for fill material.

One CBR and indicator test per 500m³ of compacted material brought on site. (Beach or river sand will normally be exempted from this requirement). A sample and one CBR and indicator test of the material proposed for importation shall be submitted to the Engineer for approval prior to the commencement of importation.

b) Fill material in place

One density and moisture content per 200m³ of compacted fill.

c) Compacted subgrade or finished level

One density and moisture content per 500m² of compacted surface area.

Should any of the above density tests fail to comply with the specified requirements, the Contractor shall at his own expense remedy the failure and submit a new test to the Engineer.

10.2 Tests to the Employer's Account

Where CBR indicator tests and the like are required on material from within the Contract Site the Contractor shall also make arrangements with a soils testing laboratory to undertake these tests, the costs of which will be met by the Employer. Payment for such tests will be per sample tested and reported to the Engineer.

**PSD 11 MATERIAL OR COMPACTION STANDARD NOT TO SPECIFICATION
(SUBCLAUSE 7.3)**

The Engineer shall have free access to the site and will undertake inspections of the work in progress to ascertain compliance with the specifications. The Contractor shall be prepared at any time to demonstrate such compliance and will be required to establish conformity to line, level, cross-section and tolerance by the use of straight-edge, tape, level, etc.

The Engineer may also require additional tests to those specified in Clause PSD 10 above. Where such additional tests prove compliance with the specification, the costs will be met by the Employer. Where such tests fail, the costs to remedy the failure and the costs of the tests shall be met by the Contractor.

PSD 12 CLASSES OF EXCAVATION (SUBCLAUSES 8.3.2 AND 8.3.3)

Where Intermediate excavation is not scheduled as an extra-over item the Contractor shall allow in his unit rate for excavation to excavate in material classified as Soft and/or Intermediate Excavation.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSDB EARTHWORKS (PIPE TRENCHES)

PSDB 1 CLASSES OF EXCAVATION (SUBCLAUSE 3.1)

With reference to subclause 3.1 of SABS 1200DA the following definitions shall apply to the wording 'efficiently removed' and 'efficiently loaded'.

PSDB 1.1 Soft Excavation

For Soft Excavation 'efficiently removed' by a back-acting excavator of flywheel power approximately 0,10 kW per millimetre of tined-bucket width without the assistance of pneumatic tools such as paving breakers shall mean the removal of more than 0,035m³ per millimetre of tined-bucket width per hour of continuous, unrestricted operation.

For Soft Excavation 'efficiently loaded' without prior ripping or stockpiling by rubber tyred front-end loader of approximately 15t mass and a flywheel power of approximately 100 kW shall mean a loading rate of more than 40m³ of insitu material per hour.

Should excavation be undertaken by hand, soft excavation shall be excavation in material that can be removed by hand using a pick and shovel operation.

PSDB 1.2 Intermediate Excavation

For intermediate excavation 'efficiently removed' by a back-acting excavator as defined in a) above shall mean the removal of more than 0,007m³, but less than 0,035m³, per millimetre of tined-bucket width per hour of continuous, unrestricted operation.

Excavation in material that, in the opinion of the Engineer, requires a back-acting excavator of flywheel power exceeding 0,10 kW per millimetre of tined-bucket width or the assistance of pneumatic tools prior to removal in order to achieve a removal rate of at least 0,035m³ per millimetre of tined-bucket width per hour of continuous, unrestricted operation will also be classified as intermediate excavation.

Should excavation be undertaken by hand, intermediate excavation shall be excavation in material that can only be removed by hand with the assistance of pneumatic tools. Classification of material as intermediate will only be considered where in the opinion of the Engineer, the material cannot be removed without the use of pneumatic tools. The method of excavation selected will not determine the classification.

PSDB 1.3 Hard Rock Excavation

Excavation in material that does not meet the removal rates specified in b) above without blasting or without wedging and splitting prior to removal will be classified as hard rock excavation.

PSDB 2 BACKFILL MATERIALS (SUBCLAUSE 3.5)

In areas subject to loads from road or rail traffic Selected Fill Material shall be used for the main fill.

PSDB 3 PRECAUTIONS RELATING TO EXPLOSIVES (SUBCLAUSE 5.1)

With reference to subclause 5.1.1.3 of SABS 1200D or subclause 5.1.1.3 of SABS 1200DA, the Engineer shall be notified at least 24 hours beforehand of the Contractor's intention to use explosives on site.

It shall be incumbent on the Contractor to make himself aware of restrictions to blasting imposed by oil Pipeline, electric transmission and other similar authorities. Where the presence and location of the oil Pipeline or electric transmission lines etc. are known and are shown on the Engineer's drawings at tender stage the Contractor must make allowance in his rates and programmes for restrictions and delays which may result from restrictions imposed by the authorities.

**PSDB 4 SITE CLEARANCE AND REINSTATEMENT IN DEVELOPED AREAS
(SUBCLAUSES 5.3 AND 5.9)**

The Contractor shall employ due care in the protection of all existing improvements when carrying out excavations in developed areas and shall confine his works to the smallest practical area so as to minimise damage. He shall also remove and set aside for future replacement, plants or improvements that lend themselves to reinstatement.

Before commencing excavation in a developed area, the Contractor shall, to the satisfaction of the Engineer, prepare a written record of the location and extent of existing plants and improvements within and adjacent to the anticipated construction area. The Engineer's drawings may form a part of this record where they show sufficient detail.

Where, in the opinion of the Engineer, the Contractor has proceeded with due care, replacement or repair of damaged or removed improvements shall be at the Employer's expense. Where, in the opinion of the Engineer, the Contractor has caused unnecessary destruction or damage, replacement or repair of improvements shall be to the Engineer's approval and at the Contractor's own expense.

Work shall at all times be carried out with a minimum of disruption to residents, and the Contractor shall give advance notice of his intention to enter upon a property or the impending closure of roads, or driveways.

PSDB 5 MINIMUM BASE WIDTHS SPECIFIED (SUB-CLAUSE 5.2)

The minimum base widths shall be determined in accordance with Clause 5.2 and will be regarded as the minimum base widths specified except for all pipes with a nominal diameter of 110mm or less laid at a depth of less than or equal to 1,0m, where the minimum base width and maximum pay width shall be 450mm. In addition, for pipes with a nominal diameter of 110mm or less laid at a depth greater than 1,0m and for

all pipes with a nominal diameter greater than 110mm and up to 200mm, laid at a depth of less than or equal to 1,5m the minimum base width and maximum pay width shall be 600mm.

PSDB 6 TRENCH BOTTOM (SUBCLAUSE 5.5)

Where the bottom of the trench has been loosened during excavation, it shall be compacted at OMC to 93% MAASHTO density prior to pipelaying and bedding. Where the bottom of the trench has been excavated to a depth greater than that specified or ordered the Contractor shall at his own expense replace the excess material so removed with fine granular material compacted to 95% MAASHTO density or with 10 MPa concrete, as directed by the Engineer.

PSDB 7 BACKFILLING (SUBCLAUSE 5.6.6)

The Contractor shall meet all costs of operations ordered by the Engineer to remedy defects in the trench caused by lengthy exposure.

**PSDB 8 BACKFILLING IN AREAS SUBJECT TO TRAFFIC LOADS
(SUBCLAUSE 5.6.2)**

In areas subject to road or rail traffic loads, trenches shall be backfilled to top of subgrade level using Selected Fill Material.

PSDB 9 DISPOSAL OF EXCAVATED MATERIAL (SUBCLAUSES 5.6.3 AND 5.6.4)

In developed areas all surplus material shall be removed to designated sites and evenly spread to the Engineer's satisfaction.

PSDB 10 AREAS SUBJECT TO TRAFFIC LOADS (SUBCLAUSE 5.7.2)

Unless otherwise specified only road or rail crossings, i.e. trenches under road hardening or rail ballast will be considered as 'areas subject to traffic loads'.

PSDB 11 TESTING (CLAUSE 7 AND 8)

Further to Sub-Clause 7.1, Contractor's advised that when required by the Engineer, density testing will be undertaken by an independent soil testing Laboratory, and the results reported directly to the Engineer.

Add the following Sub-Clauses:

7.2 Other Tests on Materials from within the Site

In addition to the provisions made for density testing in Clause 7.1 above, the Engineer may call for any other tests such as CBR, indicator tests, etc. to be carried out on any material from within the site to determine the suitability of such material for use in any section of the Works.

The Contractor shall supply the samples required for such tests and shall include for the provision of such samples in his rates. The costs of the successful tests will be borne by the Employer.

7.3 Tests on Materials Imported from Outside the Site

Wherever material is to be imported from outside the site for use in any portion of the works, the Contractor shall make arrangements with a soils testing laboratory for tests to be carried out to indicate the suitability of such material for use in the relevant portion of the Works.

The results of such tests shall be reported directly to the Engineer. The costs of such tests shall be included in the rates tendered in the Bill of Quantities for the provision of such materials.

PSDB 12 **REINSTATEMENT OF SURFACES** (CLAUSE 5.9 AND SUB-CLAUSE 8.3.6.1)

Road surfaces shall be reinstated as specified in clause 5.9 or as otherwise specified on drawing No. 1331/012 with measurement and payment in accordance with Clause 8.3.6.1, subject to the width of reinstatement for payment purposes being (D + 300mm), where "D" is the outside diameter of the pipe or sleeve used for the road crossing.

PSDB 13 **TRENCH EXCAVATION** (SUBCLAUSES 8.1.2, 8.2 AND 8.3.2)

The length of trench used for computation will be the total through length of the Pipeline as defined in subclause 8.2.2 and will be measured in lineal metres.

The depth of trench shall be as defined in subclause 8.1.2(c) from the surface of the ground along the centerline of the trench to the bottom of the specified layer, except that the surface of the ground shall be taken as the bottom of the layer of topsoil removed, where removal of topsoil has been specified.

Where the Contractor has excavated to a depth greater than that necessary for the specified bedding thickness below the bottom of pipe, no additional payment will be made for the additional trench excavation and bedding material.

PSDB 14 **HAND EXCAVATIONS TO PROVE EXISTING SERVICES**

The Contractor will be required to prove existing services in the vicinity of the Works by careful hand excavation. These services include Telkom, Electrical, Sewers and existing Water Mains, some of which may be shown on the drawings, and others of which no record exists.

Contractors must note that services are very often buried at very shallow depths and must therefore exercise extreme caution during the entire operation of proving services.

Services must be successfully proved prior to work commencing in an area. The use of cable detectors may be needed.

An item is provided in the Bill of Quantities for hand excavation to prove services and measurement will be based on the volume of material excavated. Rate to include for backfilling, compaction and disposing of surplus material.

PSDB 15 OVERFILL TRENCHES

All trenches shall be overfilled and compacted to specification to allow for settlement and for erosion protection. The compacted overfill shall be to a vertical height of 100mm. The overfill shall be included in the backfill rates.

PSDB 16 STEEP SLOPE EROSION PROTECTION

Where directed by the Engineer, the Contractor shall use sandbags or berms keyed into the trench, at intervals to be confirmed by the Engineer, as detailed on the Engineer's drawings, to prevent backfill from eroding on steep slopes.

Measurement shall be per m² of sand bags placed and will include for the sand bags, sand and labour required to key in the sand bags as well as the extra excavation that is required.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSDM **EARTHWORKS (ROADS, SUBGRADE)**

PSDM 1 **CLASSIFICATION OF MATERIALS FOR EXCAVATION PURPOSES** (SUBCLAUSE 3.1)

With reference to subclause 3.1 of SABS 1200D and subclause 3.1 of SABS 1200DA the following definitions shall apply to the wording 'efficiently removed' and 'efficiently loaded'.

a) Soft Excavation

- 1.i) For soft excavation 'efficiently removed' without prior ripping by a bulldozer of mass (including mass of ripper if fitted) of approximately 22t and flywheel power of approximately 145kW shall mean the removal of more than 150m³ of insitu material per hour.
- 1.ii) For soft excavation 'efficiently removed' without prior ripping by a bulldozer of mass (including mass of ripper if fitted) of approximately 35t and a flywheel power of approximately 220kW shall mean the removal to stockpile of more than 250m³ of insitu material per hour.
- 1.iii) For soft excavation 'efficiently loaded' without prior ripping or stockpiling by rubber tyred front-end loader of approximately 15t mass and a flywheel power of approximately 100kW shall mean a loading rate of not less than 40m³ of insitu material per hour.
2. For soft excavation, in restricted excavation or for small works, 'efficiently removed' by a back-acting excavator of flywheel power approximately 0,10kW per millimetre of tined-bucket width without the assistance of pneumatic tools such as paving breakers shall mean the removal of more than 0,035m³ per millimetre of tined-bucket width per hour of continuous, unrestricted operation.

b) Intermediate Excavation

1. For intermediate excavation, 'efficiently removed' by a bulldozer as specified in a) 1.ii) above, shall mean the ripping only (stockpiling not included) of more than 250m³ of insitu material per hour.
2. For intermediate excavation, in restricted excavation or for small works, 'efficiently removed' by a back-acting excavator as specified in a)2. above, shall mean the removal of more than 0,007m³, but less than 0,035m³, per millimetre of tined-bucket width per hour of continuous, unrestricted operation.

Excavation in material that, in the opinion of the Engineer, requires a back-acting excavator of flywheel power exceeding 0,10kW per millimetre of tined-bucket width or the assistance of pneumatic tools prior to removal in order to achieve a removal rate of at least 0,035m³ per millimetre of tined-bucket width per hour of continuous, unrestricted operation will also be classified as intermediate excavation.

c) **Hard Rock Excavation**

1. Hard rock excavation, other than in restricted excavation, shall be excavation (excluding boulder excavation) in material that does not meet the ripping rate specified in b)1 above.
2. Hard rock excavation, in restricted excavation or for small works, shall be excavation (excluding boulder excavation) in material that does not meet the removal rate of 0,007m³ specified in b)2 above without blasting or without wedging and splitting prior to removal.

With regard to plant specified in subclause 3.1.2 of SABS 1200D, but not referred to above, and other plant, the Engineer will decide on site as to the classification of material based on its removability as described in subclause 3.1.1 of SABS 1200D.

PSDM 2 **SELECTION (SUBCLAUSE 3.3 AND CLAUSE 8)**

The Contractor will receive no additional payment for the selection of material.

PSDM 3 **PRECAUTIONS RELATING TO EXPLOSIVES (SUBCLAUSE 5.1.1)**

With reference to subclause 5.1.1.3 of SABS 1200D or subclause 5.1.1.3 of SABS 1200DA, the Engineer shall be notified at least 24 hours beforehand of the Contractor's intention to use explosives on site.

It shall be incumbent on the Contractor to make himself aware of restrictions to blasting imposed by oil Pipeline, electric transmission and other similar authorities. Where the presence and location of the oil Pipeline or electric transmission lines etc. are known or are shown on the Engineer's drawings at tender stage the Contractor must make allowance in his rates and programmes for restrictions and delays which may result from restrictions imposed by the authorities.

PSDM 4 **CROSSINGS BY SERVICES (SUBCLAUSE 5.2)**

Construction of the selected layer and road hardening operations shall not commence until all underground services within the road hardening area have been completed and approved.

PSDM 5 **STRIPPING OF SITE (SUBCLAUSE 5.2.1)**

After site preparation, i.e. before placing any fill material, the Engineer's approval of the suitability of the insitu material shall be obtained.

PSDM 6 **CUT TO FILL-EARTHWORKS BALANCE (SUBCLAUSE 5.2.2.3c)**

For roads such as township roads where road verges are generally higher than the road hardening, the Contractor shall carefully select the exact finished earthworks level such that the material from the box cut will provide the quantity needed to complete the verges. No additional payment will be made to remove excess material or to import additional material should an imbalance be found when finishing roadworks to the specified cross-sections and gradients.

PSDM 7 BORROW PITS (SUBCLAUSE 5.2.2.3d)

Notwithstanding subclause 5.2.2.3d, the Contractor shall make his own arrangements for the importation of material of a specified quality from borrow pits outside the Contract Site (see clause PSDM 12).

PSDM 8 TREATMENT OF ROAD-BED (SUBCLAUSE 5.2.3.3a)

Notwithstanding subclause 5.2.3.3a the Engineer will inspect the road-bed (subgrade) upon completion of earthworks and if the road-bed is indicated by the soil survey or deemed by the Engineer to be unsuitable or unstable, soil shall be removed to a depth determined by the Engineer and replaced with approved material.

PSDM 9 PREPARATION FOR FILLS (SUBCLAUSE 5.2.4.1)

All fills exceeding 5 metres in height and fills of lesser height where excessive seepage occurs shall be provided with a blanket of approved granular material under the toe of the fill. The depth and extent of the blanket will be determined on site by the Engineer.

PSDM 10 COMPACTION (SUBCLAUSE 5.2.4.2f)

For material other than sand and rockfill the upper 600mm of all road fills shall be compacted to a minimum of 93% MAASHTO density.

PSDM 11 TOPSOILING (SUBCLAUSE 5.2.4.3e)

Irrespective of the height of an embankment topsoiling of the side slopes shall take place immediately after, but not before, construction of the embankment has been completed.

PSDM 12 TESTING (SUBCLAUSES 7.2 AND 8.3)

12.1 Tests to the Contractor's Account

The Contractor shall make arrangements with a soils testing laboratory to undertake the following tests and to pass the test results to the Engineer. The costs of such tests shall be included in the rates tendered for the appropriate item in the Bill of Quantities.

- a) Material imported from outside the Contract Site as a working surface, for subgrade improvement or for fill material.

One CBR and indicator test per 500m³ of compacted material brought on site. (Beach or river sand will normally be exempted from this requirement). A sample and one CBR and indicator test of the material proposed for importation shall be submitted to the Engineer for approval prior to the commencement of importation.

- b) Fill material in place

One density and moisture content per 200m³ of compacted fill.

- c) Compacted Road-bed (Subgrade)

One density and moisture content per 500m² of compacted surface area.

d) Compacted selected layer or gravel surface layer

One density and moisture content per 500m² of each compacted selected layer and/or gravel surface area, whichever is applicable.

Should any of the above density tests fail to comply with the specified requirements, the Contractor shall at his own expense remedy the failure and submit a new test to the Engineer.

12.2 Tests to the Employer's Account

If required and upon completion of rough earthworks, but before trimming and compaction of the road-bed (subgrade), the Contractor shall make arrangements with a soils testing laboratory to take soil samples from along the centre-line of the roads where directed by the Engineer, but nominally at intervals of 200 metres and at obvious changes of soil type. The soil samples shall be taken from a depth not exceeding 1 metre below the finished road level and CBR and indicator test values from each soil sample shall be reported to the Engineer.

Where soil types and CBR test results vary significantly within the job site, bottled samples of each type listing the CBR, optimum moisture and maximum dry density shall be made available on site to assist in visual identification of the various soil types.

Results of the soil survey will be used to determine the final road hardening specification and should there be delay in receipt of the results by the Engineer, no compensation for delays to the Contractor will be considered.

Additional tests may also be required by the Engineer on borrow pits or on excavated material to assist in the design.

The costs of the CBR and Indicator Tests referred to above will be met by the Employer and payment for such tests will be per sample tested and reported to the Engineer.

PSDM 13 ROUTINE INSPECTIONS AND TESTING (SUBCLAUSE 7.3)

The Engineer shall have free access to the site and will undertake inspections of the work in progress to ascertain compliance with the specifications. The Contractor shall be prepared at any time to demonstrate such compliance and will be required to establish conformity to line, level, cross-section and tolerance by the use of straight-edge, tape, level, etc.

Notwithstanding subclause 7.3.1 the Engineer may require additional tests to those specified in clause PSDM 12 above. Where such additional tests prove compliance with the specification, the costs will be met by the Employer. Where such tests fail, the costs to remedy the failure and the costs of the tests shall be met by the Contractor.

The permissible deviation from specified MAASHTO densities when materials are tested at OMC shall be -0% with no top limit.

PSDM 14 VOLUME MEASURED AS EXCAVATION (SUBCLAUSE 8.2.1)

Earthworks will be measured by volume once only as EXCAVATION from cut or borrow to fill, stockpile or waste, whichever is applicable.

PSDM 15 CLASSES OF EXCAVATION (SUBCLAUSES 8.3.6, 8.3.7 AND 8.3.9)

Where Intermediate Excavation is not scheduled as an extra-over item the Contractor shall allow in his unit rate for excavation to excavate in material classified as Soft and/or Intermediate Excavation.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSG CONCRETE (STRUCTURAL)

PSG 1 INTERPRETATIONS (Clause 2)

Add the following:

SABS 1491 Part I: Ground Granulated Blastfurnance Slag (GGBS)
SABS 1491 Part II: Pulverised Fly Ash (PFA)
SABS 1491 Part III: Condensed Silica Fume (CSF)

PSG 2 MATERIALS (Sub-Clause 3.2.1)

Delete the paragraph and replace with the following:

Ground granulated blastfurnace slag (GGBS) used on the Works shall be from a source to be approved by the Engineer and shall comply with the requirements of SABS 1491 Part 1, as amended

Pulverised Fly Ash (PFA) used on the Works shall be from a source to be approved by the Engineer and shall comply with the requirements of SABS 1491 Part II, as amended.

Condensed Silica Fume (CSF) used on the Works shall be from a source to be approved by the Engineer and shall comply with the requirements of SABS 1491 Part III, as amended.

Unless otherwise specified no other cement other than cement types CEM I, CEM II/A-S, CEM II/B-S, CEM II/A-V or W, CEM II/B-V or W, and CEM II/A-M shall be used without written consent of the Engineer first being obtained.

PSG 3 COVER (Sub-Clause 5.1.3)

The reinforcement shall be fixed with the minimum cover as specified on the drawings, or as indicated in the following table:

| Type of Construction | Min. Cover, mm |
|--|-------------------------|
| 1. <u>Slabs and Walls</u> | |
| a) Plastered and unplastered internal work | The greater of 20 or d |
| b) Exposed to water pressure | 50 |
| c) External walls | 30 |
| d) Exposed to backfill or corrosive atmosphere | 40 |
| 2. <u>Columns</u> | The greater of 40 or d |
| 3. <u>Beams</u> | |
| a) End cover beyond hooks | The greater of 25 or 2d |
| b) All other surfaces | The greater of 25 or d |

| Type of Construction | Min. Cover, mm |
|---|----------------|
| 4. <u>Piles</u> | |
| a) Precast piles and or faces poured against formwork | 40 |
| b) On unformed faces poured against ground | 75 |
| 5. <u>All structures in sea water or in marine atmosphere</u> | 50 |
| 6. <u>Structures in contact with backfilling or corrosive atmosphere</u> | 50 |
| 7. <u>Footings</u> | |
| a) Members cast on a blinding layer | 50 |
| b) Members cast in contact with the ground | 75 |

In the case of walls and roof slabs, the minimum specified cover shall be attained by one of the following methods, or as approved by the Engineer.

- i) by using "cover blocks" manufactured from dense, strong cement/sand formed in a block with wire ties, cured under water for a minimum period of 7 days.
- ii) by the use of plastic spacers, set in an orientation so that no pockets of air can be trapped beneath them during vibration of the concrete.

PSG 4 FIXING (Sub-Clause 5.1.2)

The welding and the use of heat in cutting high tensile deformed bars (Y bars) shall not be permitted without the approval of the Engineer.

PSG 5 FORMWORK (Clause 5.2)

PSG 5.1 Design of Forms

- i) Forms shall conform accurately to the shape, lines, levels and dimensions of the concrete as shown on the drawings.
- ii) The design of the formwork and supports shall be the responsibility of the Contractor and shall be designed and detailed by a registered professional engineer, if required by the special conditions of contract, and submitted for approval by the Engineer.
- iii) Forms shall be so designed as to support their self mass, the load exerted by the wet concrete and by the vibration, construction or other loads to which they may be subjected. Where the concrete is to be prestressed, the formwork shall be constructed in such a manner that the elastic compressive shortening of the concrete during the tensioning of the tendons is not unduly hindered. The maximum deflection of any formwork component shall in no case exceed 1/360th of its span. Form soffits shall be built to a camber corresponding to their probable deflection under load so that the finished concrete shall conform accurately with the lines and dimensions shown on the drawings.
- iv) The inner faces of forms shall be such as will impact the specified finish to the concrete. Solid steel forms may be used for precast beams and circular columns. Elsewhere, except where otherwise specified or the written consent of the

Engineer has been obtained, only wrought timber or approved shuttering boards shall be used for forms in contact with exposed concrete faces.

- v) All timber shall be free from holes, loose knots, cracks, splits, warps or other defects likely to affect the strength or appearance of the finished structures.
- vi) Wedges and clamps shall be used in preference to nails for securing the form components and wire ties or tie bolts in reinforced concrete must be capable of complete removal after use, except as otherwise specified.
- vii) In the cases where the accommodation of traffic during the construction period is required, false work shall be designed to span underlying road systems with a minimum headroom of 5,0m unless otherwise specified.

PSG 5.2 **Cleaning Before Concreting**

All dirt, sawdust, chips and other foreign matter shall be removed from between the forms before any concrete is deposited

PSG 5.3 **Classification of Finishes** (Sub-Clause 5.2.1)

Notwithstanding Sub-Clause 5.2.1 finishes shall be classified as rough or smooth, as follows:

- (a) A rough finish shall be obtained from formwork constructed of sawn timber, plywood, steel panels or other approved materials arranged without particular regard to pattern or the smoothness of the concrete surface.
- (b) A smooth finish shall be obtained from formwork constructed of planed timber, plywood, good quality steel panels or other approved materials all with close fitting square edges arranged in neat uniform patterns and imparting a smooth uniform surface to the concrete. The surface classification is Class 2 – Rubbed Finish.

PSG 5.4. **Pipe Box-Outs**

Unless otherwise shown on the drawings, the infill to pipe box-outs shall be constructed as follows:

- 5.4.1. Reinforcement shall be cut at centre of box-out and bent around pipe.
- 5.4.2. Existing concrete shall be scabbled to expose sound concrete and all loose material removed.
- 5.4.3. Concrete surfaces shall be saturated with water for 24 hours, and a cement/sand slush applied prior to concreting the infill.
- 5.4.4. Infill concrete shall be grade 30 MPa with nominal 13 mm stone, have a slump of 100 mm, and be well compacted.

PSG 5.5. **Removal of Formwork** (Sub-Clause 5.2.5)

Add the following:

Removal of forms shall be determined by means of cubes cast with the concrete and cured in accordance with the S.A.B.S. 863. The removal shall be carried out under the

personal supervision of the Foreman only after the permission of the Engineer has been obtained and in such a manner that the concrete is not jarred, vibrated or otherwise damaged.

Where test cubes to determine stripping times are not made, the minimum periods which shall elapse between the time of the placing of the concrete and the time of removal of the forms shall, unless otherwise agreed with the Engineer, be in accordance with the table hereunder, where each day covers a full 24 hour period.

Delete Table 2 and replace with the following:

Minimum Stripping Time in Days

| | CEM I | CEM I | CEM II/A & II/B (Max. 29% Extender) | CEM II A & II/B (Max. 29% Extender) | CEM II/B (30-35% Extender) | CEM II/B (30-35% Extender) |
|---------------------------------------|------------------------------|---------------------------|-------------------------------------|-------------------------------------|------------------------------|----------------------------|
| TYPE OF STRUCTURAL MEMBER OR FORMWORK | Normal weather (Above 15°C)* | Cold weather (Below 5°C)* | Normal weather (Above 15°C)* | Cold weather (Below 5°C)* | Normal weather (Above 15°C)* | Cold weather (Below 5°C)* |
| Beam sides, wall or unloaded cols | 1 | 2 | 2 | 4 | 2 | 6 |
| Slabs, with props left underneath | 4 | 7 | 5 | 8 | 6 | 10 |
| Beam soffits, props left under | 7 | 12 | 8 | 14 | 10 | 17 |
| Removal of slab props | 10 | 17 | 10 | 17 | 12 | 21 |
| Removal of beam props | 14 | 21 | 14 | 21 | 18 | 28 |

* Average daily temperature of the atmosphere adjacent to the concrete as measured by a maximum and minimum thermometer. When the average daily temperature is between 5°C and 15°C the minimum stripping times shall be interpolated from the Table.

The table assumes that the member concerned is not subjected to any heavy construction loads and that the total force to be supported is not more than half the design load. Where heavier loads are to be carried, no stripping of soffits shall be permitted until the concrete has attained its full strength. Any days during which the average temperature was below 2°C shall be completely disregarded.

PSG 6 CONCRETE

PSG 6.1 General (Sub-Clause 5.5.1.1)

Concrete shall comply with the requirements for strength concrete. (See Clause 5.5.1.7)

PSG 6.1.1 The maximum cement content for all grades of concrete shall not exceed 450kg per m³ without the permission of the Engineer.

PSG 6.2 Sample and Trial Concrete Mixes

The concrete mixes for the grade of strength concrete shall be designed by an approved design laboratory. The Contractor at his own cost, shall supply to the laboratory samples of the cement and aggregate he proposes to use for the works. The proposed slumps

and the proportions of the materials to be used for each grade of concrete for each type of construction shall be submitted to the Engineer for his approval. The minimum cement/water ratio shall be supplied together with the use of any admixtures.

No structural concrete shall be placed on the job until the Contractor has satisfied the Engineer as to the suitability of the mixes concerned.

PSG 6.3 **Change of Mix**

If the concrete produced fails to comply with the specification the Contractor shall make adjustments in order to meet the specified requirements.

If during the progress of the work, the Contractor desires to use materials or proportions other than those originally approved, or if in the opinion of the Engineer or his representative, the materials from the sources originally approved change in characteristics, he shall provide evidence satisfactory to the Engineer that the new materials and/or new combination of materials will produce concrete meeting the requirements of the specification and will not bring about unacceptable changes in the appearance or other characteristics of the structure.

When any changes are made in terms of this subclause, they shall be made at the Contractor's expense, and no extra payment will be allowed by reason of such change.

PSG 6.4 **Ready-Mixed Concrete** (Sub-Clause 5.5.3.2)

The Contractor may elect to use ready-mixed concrete subject to the prior approval of the Engineer.

Ready-Mixed concrete shall not be delivered to site before the Contractor has furnished the Engineer with a copy of his letter to the Supplier in which he has included the following:

- i) The compressive strength of concrete at twenty-eight days.
- ii) The nominal maximum size of aggregate.
- iii) The type of cement.
- iv) The required slump at the point of delivery; being the site; and
- v) An instruction to the Supplier to provide details of the admixture proposes to use, if applicable.

The Contractor shall have delivered with each truck load of ready-mixed concrete a delivery note from the Supplier on which the following information is noted:

- i) The compressive strength of the mix.
- ii) The actual concrete mix proportions.
- iii) The slump.
- iv) The time at which water was added to the mix.
- v) The time of arrival of the truck on site.
- vii) The time the concrete discharge is completed, and
- viii) The quantity of concrete supplied.

These delivery notes are to be kept on site, being available for inspection at any time. A maximum delivery period of 90 minutes from the time water is added to the concrete mix to the actual discharge of concrete on site shall be permitted. The discharge period including placing of the concrete shall not exceed 30 minutes.

The use of ready-mixed concrete shall in no way relieve the Contractor of any of his responsibilities for providing concrete complying with the specifications.

PSG 6.5 No-Fines Concrete

PSG 6.5.1 General

Unless otherwise specified, no-fines concrete shall only be used for non-structural work.

PSG 6.5.2 Grading of Aggregate

Aggregates for no-fines concrete shall be graded so that not more than 10 per cent (10%) by mass of aggregate is retained on a sieve having 19mm square openings and not more than 5% by mass passes a sieve having 9,5mm square openings.

PSG 6.5.3 Mix Proportion

No-fines concrete shall be mixed with one part of cement to 9 parts of aggregate. Only sufficient water shall be added to the mix to produce a smooth grout to completely cover each and every particle of aggregate.

Proportions may be varied on site with the approval (or to the direction) of the Engineer to obtain a more satisfactory result. The upper surface of the no-fines is to be finished off with a wood float to provide a smooth working surface while adding just sufficient dry mix cement-sand mortar (1 to 8) to close the upper surface of the voids in order to prevent ingress of foreign matter and concrete from the blinding/floor concrete into the intestacies.

Mixing shall be carried out in a mechanical batching plant and the hopper shall be first be charged with the aggregate to which a small quantity of water has been added to moisten aggregate particles. The cement shall then be added followed by the remainder of the water.

The no-fines concrete shall be placed within 20 minutes of having been mixed and shall be rodded and hand tamped into position. The use of vibrators will not be permitted.

No traffic shall be permitted to traverse the surface of the no-fines concrete during the three days following upon placing and thereafter only over planks or boards placed for that purpose.

PSG 6.6 Pumped Concrete

The use of concrete by pumping shall be agreed with the Engineer. The services of a concrete technologist shall be employed to design concrete mixes for pumping. The design of the concrete shall be such as to minimise shrinkage and creep.

PSG 7 COMPACTION (Sub-Clause 5.5.6)

Add the following:

If required by the Engineer concrete shall be re-worked by re-vibration one to three and a half hours after placing. The time shall be decided by the Engineer, taking cognisance of the mix, the ambient temperature and the workability of the concrete.

PSG 8 CONSTRUCTION JOINTS (Sub Clause 5.5.7)

Add the following:

Waterstops where specified, shall be placed and kept in position as shown on the drawings. Care shall be taken during concreting to ensure that waterstops are not displaced, bent or punctured.

Only construction joints shown on the drawings will be measured and paid for. The Contractor shall allow in his pricing for any additional construction joints that he may wish to provide, subject to the approval of the Engineer.

PSG 9 CURING AND PROTECTION (Sub-Clause 5.5.8)

Add the following:

Notwithstanding the above, it is the Contractor's responsibility to produce concrete of a quality and finish which is suitable for the purpose intended. The above is given as a minimum requirement which the Engineer considers necessary to achieve the desired quality of concrete. Site conditions will more than likely require additional steps to ensure that quality is achieved and the Contractor is to allow for this in his rates.

The minimum curing period for various types of cement shall be as follows:

- | | | |
|----------------------------------|---|---------|
| a) CEM I | - | 7 days |
| b) CEM II (max. 29% Extender) | - | 8 days |
| c) CEM II (max. 30-35% extender) | - | 10 days |

PSG 10 CONSTRUCTION DETAILS

PSG 10.1 Cutting of Holes

The cutting of any holes or chases in the concrete other than those shown on the drawings or otherwise approved by the Engineer shall not be permitted.

PSG 10.2 Fixing Blocks in Concrete

Fixing blocks for the attachment of fixtures may be embedded in concrete provided that the strength and/or other desirable features of the member are not, in the opinion of the Engineer, impaired thereby.

PSG 10.3 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 the concrete and the position of all services to be embedded shall be checked by the Engineer or his representative before concreting commences. The clear space between pipes of any kind embedded in reinforced concrete and the clear space between such pipes and reinforcement shall not at any point be less than 40mm, or 5mm plus the maximum size of coarse aggregate, whichever is the greater.

PSG 11 DEFECTS (Sub-Clause 5.5.14)

Add the following:

PSG 11.1 Patching and Repair

Where defects do not warrant the removal of defective concrete, one or more of the following procedures shall be required by the Engineer:

- a) Where the structural strength might be affected and must be restored, repairs may be effected by the application of either pneumatically- placed mortar or of a mortar made of silica sand and an approved epoxy formulation mixed and applied in accordance with the manufacturer's recommendations.

In addition, if the Engineer deems it necessary, an approved epoxy type resin shall be injected into cracks or honeycombed areas, by means of a suitable gun applied through nipples previously fixed in the concrete at appropriate intervals.

- b) Where there are no fears as to structural strength, all defective material shall be chipped away until a dense uniform surface of concrete exposing solid coarse aggregate is obtained. Feathered edges shall be cut away to form surfaces perpendicular to the concrete face. Seized shutter bolts shall be cut back to at least 35mm into the concrete. All loose material shall be hosed away and the surface of the cavity shall be saturated with water for at least 3 hours, after which a thin layer of neat cement mortar shall be applied to the surface. The cavity shall then be filled with stiff mortar mixed in the same proportions of cement to sand as that used in the original concrete. The mortar shall be thoroughly tamped into place in layers. The use of up to 30% white cement in place of the normal cement may be required to reduce the darker appearance of a patch. An interval of thirty minutes shall then elapse before a final surface tamping is given to the patch, after which the surface shall be treated to resemble the surrounding concrete as closely as possible. Board marks may be reproduced by striking a suitable piece of timber held against the plastic concrete. The patch shall be neat and workmanlike in appearance and after completion it shall be kept wet over a period of at least three days.

PSG 12 TESTS (Clause 7)

Add the following:

PSG 12.1 Other Tests

Slump as per table 3. The slump of a batch of concrete at time of discharge shall be expressed as the average of two tests, one of concrete sampled at the one-quarter point of the batch volume and the other on concrete sampled at the three-quarter point.

For ready mixed concrete, the slump of every truck shall be measured on delivery and shall comply with the requirements.

The concrete shall be considered to comply with the specified slump if –

- a) when the specified slump does not exceed 75mm, the average of the two tests is within 12mm of the specified slump.
- b) when the specified slump exceeds 75mm the average of the two tests is within 25mm of the specified slump.

PSG 12.2 **Cover Tests**

Where the Engineer or his representative has reason to doubt whether the concrete cover over the reinforcement is not in accordance with the requirements of clause PSG3, the cover shall be tested with a covermeter. If necessary, the Engineer or his representative shall then indicate to the Contractor where he must expose the reinforcement to prove the depth of cover.

PSG 13 **CONCRETE SPECIFICATION FOR RESERVOIRS AND LIQUID RETAINING STRUCTURES**

PSG 13.1 This specification covers the construction of water reservoirs and water retaining structures in reinforced concrete and deals with particular items of construction in addition to general items as specified in SABS 1200G, and PSG 1 to 12.

PSG 13.2 **Materials**

PSG13.2.1 Concrete

Concrete for the blinding layer, manhole bases and the surround to pipes shall be grade 15/19.

Concrete for the structure shall be grade 35/19.

Site Batching

For grade 35/19 concrete, cement types CEM I (OPC, Duratech), CEM II /A (Eagle Plus), CEM II/B FA (Structcrete, Durastruct, Surecrete) shall be used. No site blending of cement extenders will be permitted without the permission of the Engineer.

Ready Mixed Concrete

For grade 35/19 concrete, a CEM I or CEM II cement and pulverised fly ash (PFA) may be blended together such that the combined cementitious material comprises a minimum of 65% CEM I or CEM II cement and a maximum of 35% PFA by mass.

Alternatively, for grade 35/19 concrete, a CEM I or CEM II cement and ground granulated blastfurnance slag (GGBS) and/or condensed silica fume (CSF) may be blended together such that the combined cementitious material comprises a minimum of 65% CEM I or CEM II cement and a maximum of 35% GGBS and/or CSF by mass.

The minimum combined cementitious material shall not be less than 375kg and not more than 450kg per cubic metre.

Minimum cement/water ratio shall be 2.0.

13.2.2 Polythene Sheeting

Polythene sheeting, where specified on the drawings, shall be in accordance with SABS 952.

13.2.3 Waterstops

Waterstops, where specified on the drawings, shall be manufactured from virgin polyvinyl chloride (PVC) that complies with the following minimum performance requirements:

| | |
|-----------------------|----------------|
| Tensile strength | 12, 2Mpa (min) |
| Elongation at break | 25% (min) |
| Water soluble content | 0,15% (max) |
| Softness (BS 2571) | 38 to 50 |

Waterstops shall be 150mm wide. The waterstops in the floor joint will be the rearguard type "Expandite Supercast Rearguard R" or similar approved and in the walls will be the dumb-bell type "Expandite Supercast Waterfoil" or similar approved.

13.2.4 Joint Fillers

Joint fillers, where specified on the drawings, shall be of resin bonded cork board having a maximum water absorption of 3% by volume and complying with ASTM D 1752 with regard to recovery, extrusion, expansion and compression.

PSG 14 **CONSTRUCTION**

14.1 **Blinding Concrete**

No blinding concrete shall be placed until the base formation has been inspected and passed by the Engineer's Representative.

All blinding concrete shall be a minimum of 50mm thick and laid true to levels and falls to suit the finished floor. All underdrain work is to be completed in a particular area before blinding is started. A sufficient area of blinding shall be prepared in advance of placing structural concrete to allow a minimum of 7 days curing time of the blinding layer.

14.2 **Structural Concrete**

14.2.1 Wall Footings

The wall footings shall be cast with wall starters to form a horizontal wall construction joint as shown on the drawings. The construction joint between footing bays shall also be as shown on the drawings. At least 3 days shall elapse between pouring adjacent wall footings.

14.2.2 Walls

After the wall footings have attained a minimum strength of 10Mpa, but not later than 7 days, each bay of the wall section shall be cast to full height on the same day and vertical construction joints between bays shall be formed as shown on the drawings. At least 3 days shall elapse between the pouring of adjacent wall panels.

As soon as possible after the removal of the formwork in vertical joints or after the concrete has set in horizontal joints the surface laitance of the concrete shall be removed in order to expose the large aggregate and leave a solid surface.

Openings may be left in the form work on the outside face only for pouring and vibrating of the concrete provided they are closed properly and do not impair the concrete finish.

When concreting walls care shall be taken to ensure that there is no loose matter on the concrete surface and that it is wetted in order to assist the new concrete adhering to the existing concrete.

The Contractor's attention is particularly drawn to the fact that the walls form part of a water retaining structure and that no honeycombing will be tolerated. In order to ensure this, the mix proportions of the first 250mm depth of concrete placed in contact with the horizontal joint may be adjusted, with the approval of the Engineer, by reducing the amount of coarse aggregate. The Engineer's Representative may instruct the use of trunking in placing the concrete to avoid losses of fines due to adherence to reinforcement and formwork. The concrete shall be placed evenly over the surface to be covered without reliance on vibration to transport it horizontally. Special care shall be given in order to ensure full compaction at waterstops.

14.2.3 Floor

The floor shall be cast in panels as detailed on the drawings. Consecutively cast panels shall not adjoin one another. The floor panels shall be cast in a checker board pattern with a minimum of 3 days between the pouring of adjacent panels.

14.2.4 Columns

The column and column head shall be cast in one lift. The base of the column may be cast first provided a centrally placed starter is incorporated.

14.2.5 Alternative Means of Construction

The Contractor may propose alternative means of construction which shall be subject to the approval of the Engineer.

If the Engineer accepts any alternative means of construction it shall in no way result in increased costs. The Contractor shall pay for all additional construction joints.

14.2.6 Grouting in of Pipes and Specials

The Contractor shall be responsible for the casting of plinths and grouting in of pipes and specials and grouting up of base plates etc. for the Electrical/Mechanical Sub-Contractor (where applicable).

The Contractor shall be responsible for accurately setting his pipes and specials etc. and shall also be responsible for maintaining in position those items which have been installed by the Electrical/Mechanical Sub-Contractor (where applicable) until they have been grouted/concreted in.

The sides of all holes shall be thoroughly scabbled and cleaned before the pipes and specials are positioned.

The outside surface of all pipes and specials shall be cleaned before being concreted in.

The formwork shall be designed to ensure that it fits neatly around all embedded parts and forms a flush joint around the sides of the opening.

Special care shall be taken to ensure a water tight joint at the crown of the openings.

All grout used for grouting up base plates etc. shall be of the non-shrink type such as Pro-Struct 531 Five Star Grout, or similar approved. Before grouting up all scabbled surfaces shall be thoroughly soaked with water.

14.2.7 Valve Chambers

The chambers shall be constructed to dimensions shown on the drawings. No underpinning of the structure will be allowed.

14.3 **Joints**

14.3.1 General

Joints in the water retaining section of the structure shall be constructed as shown on the drawings. At each joint the concrete shall be finished to an even line and surface.

Any additional construction joints (to that shown on drawing), required by the Contractor shall be to the approval of the Engineer and shall be to the Contractors expense.

14.3.2 Waterstops

Waterstops, where specified on the drawings, are to be placed in wall and floor construction joints as shown on the drawings and in accordance with the manufacturers specifications.

All intersection points shall be factory made pieces.

All joints in straight lengths and between straight lengths and intersection pieces shall be hot welded in accordance with the manufacturer's instructions. Jointing other than by hot welding will not be permitted.

Waterstops shall be carefully positioned and tied to the reinforcement to prevent displacement. Every precaution shall be taken to ensure maximum compaction around the waterstop. Waterstops in the floor joints, however, shall be held back from their horizontal position until the concrete level is just above the final location of the waterstop. The waterstop shall then be returned to their horizontal positions ensuring that no voids are formed beneath them.

14.3.3 Bandage Sealing System

The internal surface of joints in the floor and walls, where specified on the drawings, shall be sealed with a 100mm wide surface mounted "Hypalon" bandage system having an epoxy fixing system, with all materials and procedures conforming to the "Sikadur-Combiflex" surface sealing system as produced by Sika (Pty) Ltd, or similar approved. The Contractor must ensure that where one Hypalon joint intersects another (at right angles or otherwise) that the two layers of interesting hypalon are not epoxied to each other and thereby restrained from moving, i.e. the Hypalon inside an intersecting joint must not be restrained by the epoxy adhesive and the full intended width should be free to move in the intended directions.

14.3.4 Roof Slab Joint Sealant

The construction joints on the top and sides of the roof slab where specified on the drawings, are to be sealed with a 75mm wide self adhesive aluminium foil strip (Bostik "Ditsit" or similar approved) which shall be installed in accordance with the manufacturers

instructions. The “Ditsit” is to be taken over the edge of the roof slab and down the side of the wall for a distance of 500mm.

The construction joints on the soffit of roof slab are to be sealed with 2 coats of a 75mm wide application of Sika Top-Seal 107 (or similar approved) applied in accordance with the manufacturer’s recommendations. The soffit of the roof slab is to be ground down 1.5 to 2mm with an angle grinder and then wire brushed and sprayed clean with water. The slurry is to be applied to a damp surface.

14.3.5 Ferrule Holes

Ferrule holes to accommodate tie rods for holding together shutters on opposite sides of the water retaining concrete walls are to be formed using smooth PVC ducts through which steel tie rods can be placed for purposes of construction. After the concrete has been placed, the shutters stripped and the tie rods and end cones have been removed, the PVC sleeves shall be drilled out with a suitably sized masonry drill so that the concrete surfaces are roughened. Thereafter the surfaces of the hole and cone area are to be cleared of all dust and loose material and primed with an approved latex compound (“Barralutex” or similar approved) and the holes caulked with a sand/cement/water/latex grout in accordance with the recommendation of the supplier of the latex compound.

PSG 15 **WATERTIGHTNESS TESTING OF CONCRETE STRUCTURES**

PSG15.1 **General**

Backfilling of excavations for tanks and other water retaining structures will only be permitted to commence once initial watertightness tests have been passed.

Any leaks which become evident during initial watertightness testing shall be remedied to the satisfaction of the Engineer and backfilling of the excavations shall only commence on written acceptance of the initial watertightness tests by the Engineer.

PSG 15.2 **Approval of Water Retaining Structures**

Notwithstanding any approval given by the Engineer in respect of construction work, an essential criterion for the acceptance of tanks, sumps and distribution chambers shall be that they pass the appropriate watertightness tests.

The water retaining structures shall be watertight against both, external ground water pressures and internal water pressures.

PSG 15.3 **Watertightness tests for Structures**

Watertightness tests on all structures shall be carried out in accordance with B.S. 8007: 1987 Clause 9.

a) Initial Watertightness Test

All inlets and outlets shall be sealed to the satisfaction of the Engineer. The structure to be tested shall be filled to top water level with clean water at an approximately uniform rate not greater than 2m in 24 hours and shall be left standing for at least seven days to allow the concrete to absorb the water. At the Contractors request the Engineer will then inspect the structure and if he is satisfied that there are no leaks the final test shall be proceeded with.

b) Final Watertightness Test

The structure shall be topped up with water to top water level. The fall in the water level will be measured each day for a period of seven days.

Adjustments will be made to allow for evaporation and rainfall according to the following standards:

i) Evaporation – Adjustment Reduces Fall (where the structure is un-roofed)

Measurements made on 1 February, 6mm per day

Measurements made on 1 July, 2,5mm per day

Measurements made between the above dates: adjustment calculated pro-rata.

ii) Rainfall – Adjustment Increases Fall

If rainfall should occur during a test the Engineer may assess an adjustment or may direct that the test be continued or repeated until a dry 7-day test has been obtained. Such continuation or repetition of the test shall be at the Contractor's expense.

c) Allowable Leakage

After taking into account the losses due to evaporation, the permissible drop in the surface level shall not exceed 1/500th of the average water depth of the structure (in mm) in 7 days.

PSG 15.4 Testing of Roofs for Watertightness

The roofs of liquid-retaining structures should be watertight and should, where practicable, be tested on completion by flooding the roof with water to a minimum depth of 25mm for 24 hours or longer if specified. Where it is impracticable, because of roof falls or otherwise, to contain a 25mm depth of water, the roof should have water applied by a continuous hose or sprinkler system to provide a sheet flow of water over the entire area of the roof for not less than 6 hours. In either case the roof should be considered satisfactory if no leaks or damp patches shown on the soffit. Should the structure not satisfy either of these tests, then after the completion of the remedial work it should be retested in accordance with this clause. The roof insulation and covering should be completed as soon as possible after satisfactory testing.

PSG 15.5 Failure to Pass Test

Should any structure fail to pass any stage of the tests the defects shall be found and repaired and the tests repeated at the Contractor's cost until the structure passes all the tests.

In the event of any leakage becoming apparent during the maintenance period, notwithstanding that a satisfactory test for watertightness may have been carried out on completion of the construction, the Contractor shall remedy the defect without delay to the satisfaction of the Engineer.

PSG 15.6 Measurement and Payment

The unit of measurement shall be by sum for the structure and shall include for all pumping, sealing all inlets, outlets, cleaning after testing, etc. necessary complete the test as specified.

Water will be provided to the Contractor free of charge for the initial filling of the reservoir. Should additional water be required for re-testing as a result of failure of the watertightness testing, this shall be for the Contractors account.

PSG 16 ROOF INSULATION

Stone for the roof insulation shall be placed immediately after testing of the roof.

The stone shall consist of a hard washed stone, 19mm nominal size. It shall be distributed by rubber-tyred wheel barrows and deposited so as to avoid undue load concentrations.

PSG 17 TOLERANCES (Clause 6)

Degree of accuracy for permissible deviation II shall be applicable unless otherwise noted.

PSG 18 STERILISATION OF THE RESERVOIRS

Prior to the initial filling of the reservoir, the Contractor shall broom, clean and hose down the internal floor and wall surfaces with a pressure washer. Water used for cleaning purposes is to be led to waste. The reservoir is to be filled to a depth of 0,25m and the water then scoured to waste.

During the initial filling of the reservoir, the Contractor shall sterilise the reservoir by adding chlorine in the form of granular HTH, under the control of the Engineer. The reservoir is to be filled to a depth of 0,5m adding chlorine continuously to give a concentration of 50 parts per million. No further chlorine is to be added on further filling of the reservoir.

Prior to the reservoir being put into service, the chlorine content of the water shall be tested in order to ensure that it does not exceed 1,0 to 2,0 parts per million.

Should the concentration of chlorine be higher than required, the Engineer may call for additional measures in order to reduce the concentration of chlorine to within acceptable limits.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSGA **CONCRETE (SMALL WORKS)**

PSGA 1 **CEMENT (SUBCLAUSE 3.2.1)**

Unless otherwise specified, no cement other than ordinary Portland cement (CEM 1) or Portland cement 15 (CEM 11/A-S or CEM 11/A-V) shall be used without the written consent of the Engineer.

PSGA 2 **FIXING OF REINFORCEMENT (SUBCLAUSE 5.1.2)**

The welding and the use of heat in cutting high tensile deformed bars (Y bars) shall not be permitted without the approval of the Engineer.

PSGA 3 **CLASSIFICATION OF FINISHES (SUBCLAUSE 5.2.1)**

Notwithstanding subclause 5.2.1 finishes shall be classified as rough or smooth, as follows:

- a) A rough finish shall be obtained from formwork constructed of sawn timber, plywood, steel panels or other approved materials arranged without particular regard to pattern or the smoothness of the concrete surface.
- b) A smooth finish shall be obtained from formwork constructed of planed timber, plywood, good quality steel panels or other approved materials all with close fitting square edges arranged in neat uniform patterns and imparting a smooth uniform surface to the concrete.

PSGA 4 **STRENGTH CONCRETE (SUBCLAUSE 5.4.1.5)**

The Contractor shall at an early stage in the Contract submit to the Engineer for his approval design mixes and the proposed slumps for each grade of concrete in each type of construction.

If design mixes are not submitted the Contractor shall batch each grade of concrete in accordance with the mix proportions given in the table overleaf.

| GRADE OF CONCRETE (Mpa) | MINIMUM CEMENT/ WATER RATIO | HAND PLACED | | | VIBRATED | | |
|-------------------------------|--------------------------------------|--|---------------------------|----------------------------|--|---------------------------|----------------------------|
| | | APPROX. MATERIALS PROPORTION PER m ³ | | | APPROX. MATERIALS PROPORTION PER m ³ | | |
| | | CEMENT (SACKS) | SAND (m ³) | STONE (m ³) | CEMENT (SACKS) | SAND (m ³) | STONE (m ³) |
| 10 | 1,09 | 4,6 | 0,80 | 0,75 | 4,4 | 0,75 | 0,79 |
| 15 | 1,30 | 5,5 | 0,77 | 0,77 | 5,3 | 0,74 | 0,85 |
| 20 | 1,56 | 6,4 | 0,70 | 0,77 | 6,1 | 0,67 | 0,85 |
| 25 | 1,80 | 7,2 | 0,65 | 0,72 | 7,0 | 0,63 | 0,84 |
| 30 | 2,02 | 8,1 | 0,65 | 0,73 | 7,8 | 0,62 | 0,86 |
| 35 | 2,26 | 9,0 | 0,63 | 0,72 | 8,7 | 0,61 | 0,78 |
| 40 | 2,50 | 9,8 | 0,59 | 0,68 | 9,6 | 0,58 | 0,86 |

The table given above lists the minimum cement/water ratio and approximate mix proportions by volume to produce 1m³ of finished concrete of each grade, for both hand-placed (85mm slump) and vibrated (35mm slump) concrete. Proportions have been based on the use of ordinary Portland cement, medium sand and 19mm stone, and an allowance has been made for 5% by mass of water in the sand and a bulking of the sand of 22,5%.

Irrespective of whether the Contractor submits design mixes or adopts the proportions in the table above it shall be incumbent on him to make up trial mixes as soon as he has established site, and to cast a minimum of 6 cubes for testing purposes.

Two cubes shall be crushed at 7 days, 14 days and 28 days.

No structural concrete shall be placed until the Contractor has satisfied the Engineer as to the suitability of the mixes and, particularly in the case of water retaining structures, the Engineer shall have received at least the 7 and 14 day test results.

PSGA 5

READY-MIXED CONCRETE (SUBCLAUSE 5.4.1.6)

The Contractor may elect to use ready-mixed concrete subject to the prior approval of the Engineer.

Ready-mixed concrete shall not be delivered to site before the Contractor has furnished the Engineer with a copy of his letter to the Supplier in which he has included the following :

- i) The compressive strength of concrete at 28 days.
- ii) The nominal maximum size of aggregate.
- iii) The type of cement.
- iv) The required slump at the point of delivery, being the site; and
- v) An instruction to the Supplier to provide details of the admixture he proposes to use, if applicable. The details/information provided shall be in accordance with the requirements of subclause 3.5.1 of SABS 1200G - Concrete (structural).

The Contractor shall have delivered with each truck load of ready-mixed concrete a delivery note from the Supplier on which the following information is noted:

- i) The compressive strength of the mix.
- ii) The slump.
- iii) The date and time at which the mixing of the batch was commenced.
- iv) The time of delivery; and
- v) The quantity of concrete supplied.

These delivery notes are to be kept on site, being available for inspection at any time.

PSGA 6 PLACING - CONSTRUCTION JOINTS (SUBCLAUSES 5.3.5.4 AND 8.5)

Except as allowed in subclause 5.4.5.4, concreting shall be carried out continuously up to the locations where joints are shown on the drawings or up to approved locations.

Only construction joints shown on the drawings will be measured and paid for. The Contractor shall allow in his pricing for any additional construction joints that he may wish to provide, subject to the approval of the Engineer.

PSGA 7 TESTS - FREQUENCY OF SAMPLING (SUBCLAUSE 7.1.2)

The Contractor shall take a set of 3 cubes of nominal size 150mm for every day's pour, every 10m³ of concrete poured or every load of ready-mixed concrete placed, whichever gives the greater number of cubes.

PSGA 8 TESTING (SUBCLAUSE 7.2)

All results of cube tests shall be immediately forwarded to the Engineer.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARD/PARTICULAR SPECIFICATION

PSL MEDIUM-PRESSURE PIPELINES

PSL 1 PVC PIPES AND SPECIALS (SUB-CLAUSE 3.7.1)

Either uPVC or mPVC pipes shall be used as specified on the drawings or Bill of Quantities. PVC pipes shall be in accordance with SABS 966 (1998) Part 1 for uPVC pipe or Part 2 for mPVC pipe, shall bear the SABS mark and be of the class specified. All pipes shall be supplied in 6m lengths with spigot and socket ends and mechanical rubber rings joints. The pipe manufacturer shall be ISO 9001: 2000 accredited and shall belong to SAPPMA.

Unless otherwise specified, all specials shall be manufactured of cast iron conforming in general to SABS 546, be bitumen dipped and shall be rated at not less than the pressure rating of the Pipeline.

Hydrants and scour tees shall have a flanged branch and all other specials shall be socketed to receive PVC pipe with rubber ring joints.

PSL 2 POLYETHYLENE PIPES AND FITTINGS (SUB CLAUSE 3.7.2.)

Polyethylene pipes shall be high density polyethylene (HDPE) of the class specified and shall comply with SABS ISO 4427 : 1996 E, shall bear the SABS mark, and shall be manufactured from PE 80 material which is of the 'pipe grade'. The pipe manufacturer shall belong to SAPPMA and shall be ISO 9001: 2000 accredited.

Pipes fittings for HDPE Pipelines shall be polypropylene compression type fittings rated for a minimum working pressure of 1600kPa, and shall be JASWIC approved. Pipe fittings shall be "Plasson", "Unidelta", "Alprene" or similar approved compression fittings.

PSL 3 POLYPROPYLENE PIPES AND FITTINGS

Polypropylene pipes shall be of the class specified, shall be JASWIC approved, and shall be manufactured to comply with the requirements of SABS 0157 specification. Pipe fittings used for polypropylene pipes shall be brass dezincification resistant compression "Conex" type fittings and shall be JASWIC approved.

Polypropylene pipes shall be "Polycop" or similar approved.

PSL 4 STEEL PIPES AND FITTINGS (SUB-CLAUSE 3.4)

PSL 4.1 Steel Pipes

Steel pipes shall be manufactured to conform to SABS 719/1971 for pipes with nominal bore larger than 150mm diameter and to SABS 62 for pipes with nominal bore up to 150mm diameter and shall bear the SABS mark. Pipes larger than 150mm diameter shall be manufactured from grade 300WA steel and shall have a minimum wall thickness of 4,5mm, unless otherwise specified. Pipes up to 150mm diameter shall be "heavy grade" to SABS 62 unless otherwise specified.

Pipes shall be supplied with plain ends, flanged ends, screwed BSP threaded ends or roll grooved ends for “Klambon” couplings, as specified in the Bill of Quantities and on the drawings.

PSL 4.2 **Steel Pipe Specials and Fittings**

Steel pipe specials shall be fabricated from straight steel pipe as specified in clause PSL 5.1 and shall be manufactured and tested in accordance with BS 534 – Clause 4.

Where specified on the drawings or Bill of Quantities, ANSI B16 even curvature bends, tees and reducers shall be used.

Pipe flanges shall be as specified in PSL 17.

Bolts, nuts and washers shall be as specified in PSL 19.

Couplings for grooved end pipes shall be Klambon SP galvanized steel couplings.

PSL 4.3 **Coatings and Linings**

Before painting all surfaces shall be thoroughly cleaned and rust, grease, dirt and other contaminants or deleterious substances shall be removed. The surfaces shall be shot blast cleaned to SA 2 1.2 finish to Swedish Standard SIS OS/59/00-1967. Surface profile must not exceed 0,1 mm.

After being subjected to surface preparation as specified above, and immediately after preparation the pipes shall be coated internally and externally with “Copon EP2300” or similar approved solvent free epoxy material, shop applied to a minimum aggregate dry film thickness of 300 microns. The thickness of the coating shall be checked with an approved non destructive thickness gauge. The finished coating shall also be checked for blemishes using a Holiday detector as directed by the Engineer.

Reinstatement of damaged coatings and linings is to be carried out using “Copon Hycote 151” or similar approved epoxy material, after preparing the surface as specified above and applying in accordance with the manufacturers recommendations.

In addition to the hot dip galvanising, steel pipe for buried sections of Pipeline shall be supplied with the “TOSA wrap” dual layer pipe coating system comprising of a 800 micron rubber bitumen compound inner layer and a 1200 micron heat shrunk polyolefin outer layer.

Reinstatement of damaged “TOSA wrap” coating system is to be carried out in the field as follows:

- i) For damaged areas 10mm diameter or less:

Remove contaminants from the damaged area and cut away any protrusions. Use a weld stick and seal the damaged area by gently heating the point of the weld stick until it begins to flow. Press the weld stick firmly over the damaged area.

- ii) For damaged area 11mm diameter or larger:

Remove contaminants from the damaged area and cut away any protrusions. Use a 100mm wide EV750 or similar approved tape wrap, and beginning from

100mm before the affected area, spirally wrap the pipe with a 55% overlap. Continue to apply the tape until the repair is 100mm beyond the affected area.

As an alternative to the “TOSA wrap” coating system, where specified, galvanised steel pipe and fittings installed below ground and exposed to the soil will be tape wrapped to the following specification:

- The pipe barrel shall be cleaned to remove dirt, be solvent wiped and then primed, all in accordance with the Manufacturers specifications.
- Denso Ultraflex 750 tape wrap or similar approved shall be applied with a 55% overlap in accordance with the Manufactures specifications.
- Wrapped pipes shall be supported on appropriate dunnage that will not damage the tape wrapping during handling, transportation or storage on site.

Exposed pipes and fittings inside the chambers etc. are to be painted with two coats of approved enamel paint after installation. Exposed Galvanised pipes to be primed with a self etching primer followed by one coat of universal undercoat and 2 coats of approved high gloss enamel paint.

Pipe flanges and bolted couplings buried outside the chambers are to be wrapped using the “Denso Mastic Blanket System” as described in PSL 16.

Alternatively, where specified on the drawings or Bill of Quantities steel pipes and fittings up to 150mm diameter shall be protected by hot dip galvanising (heavy duty). All galvanising shall be done in accordance with SABS EN 10240 and/or SABS 1461 (1999). The minimum amount of zinc deposited shall be 760 g/m². All galvanised surfaces which suffer damage during transport or construction shall be made good using an approved “cold galvanising” process.

PSL 4.4 **Welds**

All welds shall comply with the requirements of API 1104, SABS 455, SABS 62 and SABS 719.

All welds shall be free of all undercuts, sharp protrusions, blow holes and discontinuity. The height of the inner weld reinforcement shall not exceed 1mm.

The Engineer will employ the services of a recognised independent authority to carry out radiographic tests on approximately 10% of all shop and field welds as directed by the Engineer.

PSL 4.5 **Inspection of Manufacture and Quality Control**

The Contractor shall ensure that all materials used and production methods employed comply with the requirements of this Specification.

The Contractor shall maintain accurate and up to date records of all tests and test results as specified and shall make these available to the Engineer.

The Contractor should note that no payment will be certified for material supplied until the test certificates as required under this specification have been provided.

The Employer may appoint an independent body to carry out additional Quality Surveillance at the premises of the pipe supplier. The Contractor shall provide all facilities and shall arrange access to premises at all reasonable times as may be necessary for the independent inspectorate to perform its function.

The Contractors quality control records shall be available for inspection by the independent inspectorate at all reasonable times, and copies of such records shall be made available on request.

Notwithstanding any surveillance carried out by the Employer, the contractor shall retain full responsibility for the quality of pipes supplied and installed under this contract.

All costs relating to the reinstatement and repair of defective coatings and linings and faulty welded joints, including removal and replacement of backfill and making good of lining and coatings etc. shall be borne by the Contractor.

PSL 5 **VALVES (SUB-CLAUSE 3.10)**

(a) **Gate Valves**

Unless otherwise specified, valves shall conform to the requirements of SANS 664 and shall be rated for a working pressure not exceeding 1600KPa or as specified on the drawings or Bill of Quantities. Cast iron valve components shall be made by the "Mechanite" process and the valve trim shall be Type B. The valves shall have non-rising spindles unless otherwise specified, shall be fitted with a cap top for key operation and close in the anti-clockwise direction.

The valves shall be capable of being easily opened by one man against the maximum unbalanced pressure, and the effort required to operate each valve shall not exceed a torque of 180 Nm.

Valves rated up to Class 16 are to be fitted with a means of preventing leakage past the spindle of a type specified in SANS 664, in order to permit the re-packing of the gland while the valve is under pressure.

All valves shall be coated and lined with a fusion bonded epoxy powder coating system.

Unless otherwise indicated, line valves on PVC pipes up to 200mm diameter shall be double socketed. Hydrant and scour isolating valves, valves on PVC Pipelines larger than 200mm diameter and valves on 75mm diameter HDPE Pipelines shall be double flanged, with flanges to SANS 1123. Line valves on steel and ductile iron Pipelines shall be double flanged.

All valves are to be clockwise (right hand) closing. The following valves have been approved by the Employer viz Amri, Vosa, AVK and Ainsworth, and will be accepted by the Employer. Any other valves offered by the Tenderer will be subject to the approval by the Employer and Engineer and any and all costs relating to approval of the valves, including but not limited to Quality Assurance, Quality Control Procedures, conformance with national and / or international codes of practice, visits to manufacturing facilities, etc, will be borne by the Contractor.

(b) **Air Valves**

All air valves shall be of the double purpose type (i.e. air release and vacuum protection) with an anti-shock orifice for surge protection.

Air valves shall be of the "Vent-o-Mat Series RBX" type or similar approved.

Unless otherwise specified, air valves shall be rated for a working pressure of 1600KPa, or as specified on the drawings or Bill of Quantities.

Air valves up to 50mm nominal diameter shall be supplied with screwed BSP threaded inlets. Air valves larger than 50mm nominal diameter shall be supplied with flanged inlets to SANS 1123.

The valve body shall be stainless steel Grade 304. The top and bottom floats, and the anti-shock orifice float shall be high density polyethylene. Washers, nuts, screws, nozzles and the baffle plate shall be stainless steel Grade 304. The top and lower flanges shall be mild steel, fusion bonded epoxy powder coated.

PSL 6 MATERIALS FOR MANHOLE COVERS AND FRAMES
(SUB-CLAUSE 3.11.5.1)

Manhole covers and frames shall be as detailed on the Engineer's drawings or schedules of quantities, and conform with the requirements of SABS 558 where applicable.

PSL 7 MARKER POSTS

Pipeline marker posts shall be as shown on the drawings.

PSL 8 LAYING-GENERAL (SUB-CLAUSE 5.1.1)

Pipes shall be bedded uniformly on selected granular material (see SABS 1200LB and PSLB) and the use of blocks to support the pipes will not be accepted unless both pipes and blocks have been specifically designed for that purpose and recommended by the Manufacturer.

When laying Pipelines around curves, AC pipe joints and PVC pipes may be deflected by an amount not to exceed the manufacturer's recommendations. Where, because of the sharpness of the curve, the above procedure is not practicable, short lengths of pipes, or a series of bends connected by straight pipes shall be employed.

PSL 9 MINIMUM COVER TO PIPES (SUB-CLAUSE 5.1.4.1)

Unless otherwise stated on the layout drawings, the minimum cover depth for Pipelines shall be as follows:

- Provincial Road Crossings – 1.2m
- Provincial Road Reserves – 1.0m
- District Road Crossing – 1.0m
- District Road Reserve – 0.8m
- Agricultural Land – 1.0m
- Minimum Cover elsewhere – 0.6m

PSL 10 CONCRETE ENCASEMENT TO PIPES (SUB-CLAUSE 5.4)

Where concrete encasement is specified, the Contractor shall place the encasement in accordance with details shown on the Engineer's drawings. The rates/prices for encasement shall include for blinding and formwork.

PSL 11 VALVE CHAMBERS AND MANHOLES (SUB-CLAUSE 5.6 AND 5.)

All valve chambers shall be constructed in accordance with the details given on the relevant drawings.

PSL 12 TEST PRESSURE AND TIME OF TEST (SUB-CLAUSE 7.3.1)

Pressure testing for the purpose of acceptance of a section of rising main Pipeline shall be carried out in the presence of the Engineer and shall take place only after the trench has been backfilled to finished level. Should the Contractor elect to leave joints open until after testing in order to satisfy himself that the Pipeline can withstand the test pressure he shall accept full responsibility for deterioration of the trench and consequential damage.

The test pressure for field testing at mid-elevation of the section of Pipeline under test, shall be 1,25 times the Rated Working Pressure for the particular class of pipe being tested.

The test pressure at any elevation along the Pipeline under test shall not be more than 1,5 times nor less than 1,0 times the Rated Working Pressure of the pipe being tested. Note that this latter requirement conforms to the requirements of Sub-Clause 7.3.1.4 for asbestos cement, polyethylene and PVC pipes. Where other pipes are used the Contractor shall obtain a ruling from the Engineer as to the maximum allowable test pressure.

PSL 13 PERMISSIBLE LEAKAGE RATES (SUB-CLAUSE 7.3.3)

Where erf connections or standpipes have been installed and are pressurised during testing of a section of Pipeline the appropriate permissible leakage rates for the type of pipe used shall be increased by 0,075 litres per hour, per connection to main.

PSL 14 MEASUREMENT AND PAYMENT (SUB-CLAUSE 8.2)

Pipelines will be measured per lineal meter along the centerline of the Pipeline and to the centerline of connecting mains.

PSL 15 ANCHOR/THRUST BLOCKS (SUB-CLAUSE 5.5)

If there is any doubt regarding the suitability of the insitu material at any location, the Contractor shall obtain a ruling from the Engineer prior to casting the thrust blocks. Thrust blocks shall be constructed as detailed on Drawing No. 1268/011/041.

PSL 16 SPECIAL WRAPPING IN CORROSIVE SOIL (3.9.6)

All below ground joints with exposed bolted connections that are in contact with the soil shall be wrapped using the "Denso Mastic Blanket System" or similar approved for the protection of flanges and couplings.

The "Denso Mastic Blanket System" comprising Denso Priming Solution, Denso Mastic Blanket, Denso Petrolatum Tape and Denso Layflat Sheeting shall be applied in accordance with the manufacturer's work procedure for the corrosion prevention of below ground fittings.

The rate for the special wrapping shall be included in the rate for supply and installation of the relevant pipe, fitting or coupling.

PSL 17 FLANGES AND ACCESSORIES

Unless otherwise indicated on the drawings or schedules of quantities, the dimensions and drilling of flanges shall be in accordance with the requirements of SABS 1123 Table 1000/3 or 1600/3 as specified. All flanges shall be truly at right angles to the axis of the pipe or fittings and shall be drilled with bolt holes off-centre.

Flanges with multiple table drillings will not be accepted.

Puddle flanges shall be of the same diameter and thickness as the end flanges and shall be undrilled.

Flanged joints shall be supplied complete with a reinforced rubber insertion 3mm thick cut to the full depth of the flange.

PSL 18 FLEXIBLE COUPLINGS

Flexible couplings where scheduled, shall be of the "Viking Johnson" type or similar approved without central registers, unless otherwise specified. Couplings shall be protected by an approved epoxy coating. The plain end of the steel pipe shall be properly prepared before corrosion protection so as to accept the flexible coupling.

The couplings shall be designed to withstand the same pressure as the pipes or fittings which are to be coupled. Couplings shall be supplied complete with bolts, nuts and washers.

PSL 19 BOLTS, NUTS AND WASHERS

Bolts and nuts are to comply with SABS 135 or SABS 136 as applicable. All bolts, nuts and washers shall be electro galvanised mild steel and yellow passivated.

Bolts and nuts shall be fitted with two pressed steel flat washers, under the bolt head and under the nut. Bolt lengths shall be such that when tightened, not less than 3mm or more than 6mm of thread protrudes from the nut.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSLB BEDDING (PIPES)

PSLB 1 SELECTED GRANULAR MATERIAL (SUBCLAUSE 3.1)

The compactibility factor of Selected Granular Material as bedding for concrete pipes shall not exceed 0,55. For all other pipes the compactibility factor shall not exceed 0,4.

PSLB 2 SELECTED FILL MATERIAL (SUBCLAUSE 3.2)

The material should be free from vegetation and from lumps and stones of diameter exceeding 12mm.

PSLB 3 TRENCH BOTTOM (SUBCLAUSE 5.1.1.2)

The trench bottom shall be prepared in accordance with the requirements of subclause 5.5 of SABS 1200DB as amended by clause PSDB 5 of Project Specification PSDB: Earthworks (Pipe Trenches).

PSLB 4 COMPACTING (SUBCLAUSE 5.1.4)

Selected Granular Material shall be compacted to 93% MAASHTO density, in maximum 100mm layers.

PSLB 5 CONSTRUCTION OF BEDDING (SUBCLAUSE 5.2)

Completion of the bedding cradle and placing of the selected fill blanket, and the main fill, shall commence as soon as possible after pipelaying has been completed. The Contractor shall meet all costs of operations ordered by the Engineer to remedy defects in the trench caused by lengthy exposure.

PSLB 6 CONCRETE CASING TO PIPES (SUBCLAUSE 5.4)

Where concrete encasement is specified, the Contractor shall place the encasement in accordance with details shown on the Engineer's drawings. The rates/prices for the encasement shall include for blinding and formwork.

PSLB 7 DENSITY TESTING (SUBCLAUSE 7.1 AND Clause 8)

Measurement and payment for density tests on the bedding cradle and fill blanket, where ordered by the Engineer, will be by number per successful density tests reported to the Engineer.

PSLB 8 DISPOSAL OF DISPLACED MATERIAL (SUBCLAUSE 8.1.5)

In developed areas all displaced material shall be removed to designated sites and evenly spread to the Engineer's satisfaction.

PSLB 9 BEDDING THICKNESS (SUBCLAUSE 3.3, 6.1.2, 5.3 AND 8.1.3)

For HDPE pipes, the minimum thickness of selected granular bedding material above the crown of the pipes shall be 150mm. The minimum thickness of the selected granular bedding material below the invert of the pipes shall be 50mm. The maximum pay width shall not exceed these minimum requirements.

For uPVC, mPVC and steel pipes the minimum thickness of selected granular bedding material above the crown of the pipes shall be 200mm. The minimum thickness of the selected granular bedding material below the invert of the pipes shall be 100mm. The maximum pay wide shall not exceed these minimum requirements.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSLD SEWERS

PSLD 1 uPVC PIPES (SUBCLAUSE 3.1.5)

uPVC pipes and fittings used in the Contract shall be heavy duty solid wall pipe Class 34 unless otherwise specified. Joints for uPVC pipes shall be of the spigot and socket type fitted with non-cellular rubber joint rings.

PSLD 2 CAST IRON PIPES AND FITTINGS (SUBCLAUSE 3.1)

The requirements of Clauses 3.3 and 3.9.1 of SABS 1200L shall apply.

PSLD 3 STEEL PIPES (SUBCLAUSE 3.1)

The requirements of Clauses 3.4 and 3.9.2 of SABS 1200L shall apply.

PSLD 4 FLANGES (SUBCLAUSE 3.1)

Unless otherwise specified on the Engineer's drawings, all flanges and drillings shall be to SABS 1123.

PSLD 5 MATERIALS FOR MANHOLES, CHAMBERS, ETC. (SUBCLAUSE 3.5)

Notwithstanding subclause 3.5 manholes shall be constructed of either brick or precast concrete sections. Details are as shown on the Engineer's drawings. The material for jointing precast concrete sections shall be 'Bitujoint' or a similar approved jointing compound.

PSLD 6 MANHOLE COVERS AND FRAMES (SUBCLAUSE 3.5.8)

Manhole covers and frames in areas not subject to road traffic loads shall be either precast concrete or medium duty cast iron, single seal type, as detailed on the Engineer's drawings.

PSLD 7 MARKER POSTS (SUBCLAUSE 3.6)

Marker posts shall be manufactured from 1,1m long 10mm reinforcing rods bent at 90° for 100mm at one end and painted for 100mm with WHITE road marking paint at the other end.

PSLD 8 LAYING AND BEDDING METHODS (SUBCLAUSE 5.2.3)

Pipelaying shall proceed in an upstream direction and shall commence in any particular section of sewer as soon as possible after the excavation has been completed and the trench bottom inspected and approved by the Engineer. The Contractor shall meet all costs of operations ordered by the Engineer to remedy defects in the trench caused by lengthy exposure.

Unless otherwise specified rigid sewer pipes shall be bedded and backfilled to Class 'B' standard and uPVC pipes to the standard for Flexible Pipes, as detailed on the Engineer's drawings.

Anchor blocks shall be constructed to details shown on the Engineer's drawings and unless otherwise specified, will only be required where the slope of the pipe is 1 in 3 and steeper.

PSLD 9 CONNECTIONS TO MANHOLES (SUBCLAUSE 5.4)

Where asbestos cement pipe is used, pipes joining into the manhole shall have one flexible joint on either side of the manhole at a maximum distance of one metre from the outside face of the manhole. This is not a requirement where flexible pipes are used.

Where the centre line crown level of an incoming pipe is more than 400mm above the crown of the outgoing pipe, it shall be connected to the manhole by means of a ramp connection or a drop connection, details of which are shown on the Engineer's drawings. The incoming sewer shall be continued at a straight grade through the manhole wall to form a rodding arm. Where called for by the Engineer, a plug stopper approved by the Engineer shall be supplied and fitted in the rodding way as close to the junction as possible to prevent overshoot of sewage into the manhole.

PSLD 10 MANHOLES, INSPECTION CHAMBERS, ETC. (SUBCLAUSE 5.6)

Notwithstanding subclause 5.6 manholes shall be constructed as detailed on the Engineer's drawings.

Precast sections shall be placed with the male joint upwards and the pipe sections and cover slabs shall be carefully and firmly bedded on a continuous layer of 'bitujoint' or similar approved jointing material so as to ensure a watertight joint of approximately 5mm all round. (For 1066mm diameter sections approximately 1 joint can be made per litre). Before bedding the precast sections the ends shall be coated with a suitable primer for the type of jointing material to be used. After bedding the joint shall be neatly finished flush with the inner surfaces.

The Contractor's attention is specifically drawn to the effect of constructing manholes where the sewer on the downstream side has a very steep grade. In such cases, it is necessary to construct a base slab at a lower level in relation to the design invert level than would otherwise be the case and involves also additional concrete to benching or brickwork to chamber walls.

Manhole frames shall be set in a full 13mm thick bed of 1:3 cement:sand mortar and 45° fillets, also of 1:3 mortar, shall be constructed to the edge of the frame.

Unless otherwise specified manhole frames and covers within the road formation shall be tilted to conform exactly to the level and fall of the surrounding formation. In other areas the frames and covers shall normally be set horizontal with the top set 50mm above the highest contiguous ground level.

PSLD 11 STEP IRONS (SUBCLAUSE 5.6.3)

Step irons shall not be required, unless particularly specified on the Engineer's drawings.

PSLD 12 CONCRETE CASING TO PIPES (SUBCLAUSE 5.7)

Where concrete encasement is specified, the Contractor shall place the encasement in accordance with details shown on the Engineer's drawings.

PSLD 13 ERF CONNECTIONS (CONNECTING SEWERS) (SUBCLAUSE 5.9.1)

Construction details shall be in accordance with the Engineer's drawings.

PSLD 14 PLACING OF MARKER POSTS (SUBCLAUSE 5.9.2)

A marker post shall be placed at the end of each branch and riser above its centreline at the time of backfilling and while the end of the connection is still exposed. The painted end of the post shall protrude 100mm above ground.

PSLD 15 RECORDING LOCATION OF ERF CONNECTIONS (SUBCLAUSE 5.9.3)

The Contractor will only be required to record the data listed under Subclause 5.9.3 if the 'As Built' location of the connection varies by more than 300mm from the location shown on the Engineer's drawings.

PSLD 16 TESTING - GENERAL (SUBCLAUSE 7.1)

Upon completion of each length of sewer between adjacent manholes, the Contractor shall check and satisfy himself as to the grade, direction, line and appearance of the inner surface of the Pipeline. It is strongly recommended that the Contractor also apply an air or water test on the sewer before proceeding with backfilling.

After completion of backfilling and construction of manholes to finished level, the Engineer will inspect each length of sewer and one of the acceptance tests, as listed under subclause 7.1.6, shall then be carried out in the presence of the Engineer.

PSLD 17 WATERTIGHTNESS OF MANHOLES (SUBCLAUSE 7.2.6)

On completion of any or every manhole, a watertightness test may be called for by the Engineer at the Contractor's expense. This will be carried out by plugging all pipes and filling the manholes with clean water. Should the water level drop noticeably over a two hour period, the Contractor shall carry out at his own expense whatever measures are necessary to waterproof the manhole to the Engineer's satisfaction.

PSLD 18 MEASUREMENT AND PAYMENT OF PIPELINE (SUBCLAUSE 8.2.1)

Pipelines will be measured per horizontal lineal metre from centre to centre of manholes or to the end of any pipe not connected and no deduction will be made for manholes.

PSLD 19 MEASUREMENT AND PAYMENT OF MANHOLES AND INSPECTION CHAMBERS ETC. (SUBCLAUSES 8.2.3, 8.2.4 AND 8.2.5)

The tendered rates for manholes and inspection chambers shall cover the cost of any additional excavation, as specified under subclause 8.2.5, and the cost of construction of the manhole or inspection chamber complete as detailed on the Engineer's drawings including for precast concrete frame and cover.

Extra over payments will be made for the following items complete:

- i) Cast iron frame and cover - by number.
- ii) Downstream pipe at grade steeper than 1 in 4 - by number.
- iii) Ramp or drop connection - by number and difference in invert levels.
- iv) Type B benching - by number.
- v) Extra channelling where more than 2 pipes join a manhole.

Progress payments will be made for completed manholes only.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSME SUBBASE

PSME 1 CLASSES OF EXCAVATION (SUBCLAUSE 3.1.2)

Notwithstanding subclause 3.1.2, the definitions of the wording 'efficiently removed' and 'efficiently loaded' given in clause PSDM 1 of Project Specification, PSDM : Earthworks (roads, subgrade) shall apply to subclauses a)1), b)1) and c)1) of subclause 3.1.2 of SABS 1200D.

PSME 2 RATE OF APPLICATION OF STABILIZING AGENT (SUBCLAUSE 3.3.1 AND 5.5.1)

Where stabilization of the subbase is required the type of stabilizing agent and rate of application shall be as stated in the Bill of Quantities. The rate of application shall be as a percentage, by mass, of the mass of the material to be stabilized measured at maximum dry density.

PSME 3 COMPACTION (SUBCLAUSE 5.4.4.2)

Gravel shoulders and gravel wearing courses shall be compacted to at least 95% MAASHTO density.

PSME 4 PARTIALLY SLAKED OR UNSLAKED LIME (SUBCLAUSE 5.5.4)

When partially slaked or unslaked lime is used, the Contractor shall slake the lime in accordance with the recommendations under subclause 3.2.5.1 or SABS 0120 : Part 2.

PSME 5 MIXING-IN OF STABILIZING AGENT (SUBCLAUSE 5.5.4.1)

Notwithstanding subclause 5.5.4.1 mixing of the material to be stabilized and the stabilizing agent shall continue until the mix is of uniform colour and in the opinion of the Engineer has been thoroughly mixed.

PSME 6 TESTING (SUBCLAUSES 7.2, 7.3.3 AND 8.3)

6.1 Tests to the Contractor's Account

Unless otherwise specified the Contractor shall make arrangements with a soils testing laboratory to undertake the following tests and to pass the test results to the Engineer.

The costs of such tests shall be included in the rates tendered for the appropriate item in the Bill of Quantities.

a) Material imported from outside the Contract Site as subbase, gravel shoulder or gravel wearing course material

One CBR and two indicator tests per 500m³ of compacted material brought on to site. (Beach or river sand will normally be exempted from this requirement). A sample and one CBR and two indicator tests of the material proposed for importation shall be submitted to the Engineer for approval prior to the commencement of importation.

b) Stabilized material in place

One CBR per 5000m² of completed surface area stabilized with a stabilizing agent other than cement.

One UCS per 5000m² of completed surface area stabilized with cement.

c) Compacted subbase, gravel shoulder or gravel wearing course

One density and moisture content per 500m² of compacted subbase, gravel shoulder or gravel wearing course, as applicable.

Should any of the tests referred to in b) and c) above fail to comply with the specified requirements, the Contractor shall at his own expense remedy the failure and submit a new test to the Engineer.

6.2 Tests to the Employer's Account

Where CBR, indicator tests and the like are required on natural material from within the Contract Site the Contractor shall also make arrangements with a soils testing laboratory to undertake these tests, the costs of which will be met by the Employer. Payment for such tests will be per sample tested and reported to the Engineer.

PSME 7 ROUTINE INSPECTIONS AND TESTING (SUBCLAUSE 7.2.2)

The Engineer shall have free access to the site and will undertake inspections of the work in progress to ascertain compliance with the specifications. The Contractor shall be prepared at any time to demonstrate such compliance and will be required to establish conformity to line, level, cross-section and tolerance by the use of straight-edge, tape, level, etc.

Notwithstanding subclause 7.2.2 the Engineer may require additional tests to those specified in clause PSME 6 above. Where such additional tests prove compliance with the specification, the costs will be met by the Employer. Where such tests fail, the costs to remedy the failure and the costs of the tests shall be met by the Contractor.

Permissible deviation from specified MAASHTO densities when materials are tested at OMC shall be -0% with no top limit.

PSME 8 CLASSES OF EXCAVATION (SUBCLAUSE 8.3.4)

Where intermediate excavation is not scheduled as an extra-over item the Contractor shall allow in his unit rate for excavation to excavate in material classified as Soft and/or Intermediate Excavation.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSMF **BASE**

PSMF 1 **CLASSES OF EXCAVATION** (SUBCLAUSE 3.1.2)

Notwithstanding subclause 3.1.2, the definitions of the wording 'efficiently removed' and 'efficiently loaded' given in clause PSDM 1 of Project Specification, PSDM : Earthworks (roads, subgrade) shall apply to subclauses a)1), b)1) and c)1) of subclause 3.1.2 of SABS 1200D.

PSMF 2 **PROPERTIES OF GRADED CRUSHED STONE AND GRADED CRUSHED STONE WITH FINES** (SUBCLAUSES 3.3.2 AND 3.3.3)

In addition to the requirements of subclauses 3.3.2 and 3.3.3 the minimum CBR at 98% MAASHTO density of graded crushed stone and graded crushed stone with fines shall be 80%.

PSMF 3 **PLACING-GENERAL** (SUBCLAUSES 5.4.1 AND 5.6.1)

Notwithstanding subclauses 5.4.1 and 5.6.1 the base shall not be placed until the subgrade or sub-base layer, as applicable, has been inspected and approved by the Engineer.

PSMF 4 **GRADED CRUSHED STONE AND GRADED CRUSHED STONE WITH FINES** (SUBCLAUSE 5.4.3)

Where it is found necessary, after compaction, to add material to the base the full depth of crushed stone shall be scarified before adding the material and thereafter the whole layer shall be mixed and re-compacted in one operation.

PSMF 5 **STABILIZATION** (SUBCLAUSE 5.5)

Where stabilization of the base is required the type of stabilizing agent and rate of application shall be as stated in the Schedule of Quantities. The rate of application shall be as a percentage, by mass, of the mass of the material to be stabilized measured at maximum dry density.

PSMF 6 **TESTING** (SUBCLAUSES 7.2 AND 8.3)

6.1 **Tests to the Contractor's Account**

Unless otherwise specified the Contractor shall make arrangements with a soils testing laboratory to undertake the following tests and to pass the test results to the Engineer. The costs of such tests shall be included in the rates tendered for the appropriate item in the Schedule of Quantities.

- a) Natural gravel, processed gravel and crushed stone imported as base material
One CBR and two indicator tests per 5000m² of compacted material brought on site. A sample of one CBR and one indicator test of the material proposed for importation shall be submitted to the Engineer for approval prior to the commencement of importation.

- b) Stabilized material in place
One CBR per 5000m² of compacted gravel base stabilized with a stabilizing agent other than cement.

One UCS per 5000m² of compacted gravel base stabilized with cement.
- c) Aggregate crushing value (ACV)
One ACV test per 3000m³ of compacted material brought on site. One ACV test result shall be submitted to the Engineer for approval prior to the commencement of importation.
- d) Flakiness
One flakiness index per 3000m³ of compacted material brought onto site. One flakiness index test result shall be submitted to the Engineer for approval prior to the commencement of importation.
- e) Compacted base
One density and moisture content per 500m² of compacted base.

Should any of the tests referred to in b) and e) above fail to comply with the specified requirements, the Contractor shall at his own expense remedy the failure and submit a new test to the Engineer.

6.2 Tests to the Employer's Account

Where CBR, indicator tests and the like are required on natural gravels from within the Contract Site the Contractor shall also make arrangements with a soils testing laboratory to undertake these tests, the costs of which will be met by the Employer. Payment for such tests will be per sample tested and reported to the Engineer.

PSMF 7 ROUTINE INSPECTIONS AND TESTING (SUBCLAUSE 7.3.2)

The Engineer shall have free access to the site and will undertake inspections of the work in progress to ascertain compliance with the specifications. The Contractor shall be prepared at any time to demonstrate such compliance and will be required to establish conformity to line, level, cross-section and tolerance by the use of straight-edge, tape, level, etc.

Notwithstanding subclause 7.3.2 the Engineer may require additional tests to those specified in clause PSMF 6 above. Where such additional tests prove compliance with the specification, the costs will be met by the employer. Where such tests fail, the costs to remedy the failure and the costs of the tests shall be met by the Contractor.

The permissible deviation from specified MAASHTO densities when materials are tested at OMC shall be -0% with no top limit.

PSMF 8 CLASSES OF EXCAVATION (SUBCLAUSE 8.3.4)

Where intermediate excavation is not scheduled as an extra-over item the Contractor shall allow in his unit rate for excavation to excavate in material classified as Soft and/or Intermediate Excavation.

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSMK **KERBING AND CHANNELLING**

PSMK 1 **ASPHALT** (CLAUSE 3)

Extruded asphalt kerbing shall be constructed of hot asphalt and the materials used in the manufacture of the asphalt shall comply with the requirements of clause 3 of SABS 1200MH : Asphalt Base and Surfacing.

Grading of the aggregates shall be given in the table below.

| | | | | | | | | |
|-------------------|-----|--------|--------|-------|-------|-------|------|-------|
| Sieve size mm | 9,5 | 4,75 | 2,36 | 1,18 | 0,60 | 0,30 | 0,15 | 0,075 |
| % passing by mass | 100 | 90+10% | 50+10% | 34+6% | 23+5% | 15+5% | 9+3% | 6+2% |
| | | | - | - | - | - | - | - |

Unless otherwise specified the bituminous binder for the asphalt kerbing shall be bitumen of grade 40/50 pen. Complying with the requirements of SABS 307 and the nominal bituminous binder content shall be 5,7%.

PSMK 2 **EXPANSION JOINT FILLER BOARD** (CLAUSE 3)

The filler board for expansion joints in kerbing shall consist of a 13mm thick bitumen impregnated soft board.

PSMK 3 **EXPANSION JOINT SEALANT** (SUBCLAUSE 3.5)

Notwithstanding subclause 3.5 the sealant for expansion joints in kerbing shall consist of a gun grade joint sealing material such as "Plycol 327" or similar approved and shall be grey in colour.

PSMK 4 **CONCRETE FOR CAST-IN-SITU AND EXTRUDING KERBING AND CHANNELLING** (CLAUSE 3)

The Contractor shall submit his design mix and the proposed slump for the concrete to be extruded at least three weeks before kerbing operations are scheduled to commence.

It shall also be incumbent on the Contractor to make up a trial mix well in advance of the scheduled commencement of kerbing operations, and to cast a minimum of 6 cubes for testing purposes.

Two cubes shall be crushed at 7 days, 14 days and 28 days.

No extruded concrete kerbing and channelling shall be placed until the Contractor has satisfied the Engineer as to the suitability of the mix and the Engineer has received at least the 7 and 14 day test results.

The cost of preparing test specimens and testing the trial mix shall be borne by the Contractor.

PSMK 5 **BEDDING MATERIAL** (SUBCLAUSES 3.9, 5.1 and 5.2)

Notwithstanding subclause 3.9, where specified, concrete shall be used as bedding material for precast concrete kerbing and channelling. The concrete grade and thickness of bedding material shall be as shown on the drawings.

PSMK 6 **EXPANSION JOINTS** (CLAUSE 5)

Expansion joints in all concrete kerbing and channelling shall be provided at 20m intervals and shall be constructed of filler board, as specified in clause PSMK 2, followed by a 10mm deep joint sealant (refer clause PSMK 3) which shall be finished flush with the kerb face.

PSMK 7 **CONSTRUCTION OF ASPHALT KERBING** (CLAUSE 5)

Asphalt kerbing shall be placed on a finished road surface using an approved self-propelled slip form machine, except that for very short sections or make-up pieces the Engineer may approve compaction of asphalt in suitable steel forms. Immediately prior to laying the asphalt kerbing the road surface shall be cleaned of loose or foreign matter and a tack coat of 60% cationic emulsion shall be applied at the rate of 0,3 ℓ/m².

Each uninterrupted length of kerbing shall be placed in one continuous operation in order to avoid joints. Where it is necessary to join make-up sections the kerbing shall be cut vertically and a light tack coat of 60% cationic emulsion shall be applied before butting the new kerbing.

Immediately after the kerbing has hardened, backfill shall be placed and compacted to the density specified for completed verges.

PSMK 8 **CAST-IN-SITU CONCRETE KERBING AND CHANNELLING** (SUBCLAUSE 5.4)

Cast-in-situ concrete kerbing and/or channelling shall be monolithic i.e. cast in one operation and plastering or the addition of a mortar paste topping will not be permitted.

PSMK 9 **SUBBASE PREPARATION FOR EXTRUDED CONCRETE KERBING**
(SUBCLAUSE 5.8.3)

Immediately prior to placing the concrete, the subbase or base, as applicable, shall be swept clean of all loose or foreign matter and shall be dampened.

PSMK 10 **PROTECTION OF ALL TYPES OF CONCRETE KERBING AND CHANNELLING** (SUBCLAUSE 5.10)

Where concrete kerbing and channelling is installed prior to road layerworks a curing time of at least 7 days (refer subclause 5.8.5) must be allowed and backfilling behind the kerb shall have been completed to the density specified for verge compaction before layerworks are commenced.

Cement washing over discolored sections of kerbing and channelling will not be acceptable.

PSMK 11 **TOLERANCES FOR EXTRUDED CONCRETE KERBING AND CHANNELLING AND ASPHALT KERBING (SUBCLAUSE 6.1)**

Tolerances for precast kerbing and channelling and cast-in-situ kerbing and channelling shall be in accordance with Degree of Accuracy II as given under subclause 6.1.

Tolerances for extruded concrete kerbing and channelling and asphalt kerbing shall be as follows:

- Horizontal alignment shall not deviate from specified position by more than 30mm.
- Vertical alignment and level shall not deviate from designated finished road level by more than 15mm.
- Neither line nor level shall deviate from a 3m straight edge by more than 10mm.

PSMK 12 **TESTING - ASPHALT KERBING (CLAUSE 7)**

Prior to commencing construction, the Contractor shall submit mix design details and Marshall Test results of the proposed asphalt mix to the Engineer, for approval. During construction the Contractor shall provide aggregate grading, binder content, and Marshall Test results for every 50 tonnes of asphalt delivered to site.

PSMK 13 **CONCRETE TESTING (SUBCLAUSES 7.2.1 AND 7.2.2)**

The Contractor shall take a set of 3 cubes of nominal size 150mm for every day's pour, every 20m³ of concrete poured or every 500m of kerbing and channelling cast-in-situ or extruded, whichever gives the greater number of cubes.

Results of cube tests shall be handed to the Engineer not later than 3 days after crushing.

Should the Engineer reject any portion of kerbing or channelling for suspected lack of strength the Contractor may elect to provide core tests undertaken in accordance with SABS Method 865. Such core tests will be taken as conclusive evidence of in-situ concrete strength.

PSMK 14 **MEASUREMENT AND PAYMENT (SUBCLAUSES 8.1.1. AND 8.2.1)**

Each type, shape and size of kerb and channel will be measured linearly along the face. Deductions will be made for catchpits, including kerb transitions, scoops etc.

The unit rate for cast-in-situ and extruded kerbing and channelling shall include for all costs associated with testing as required in terms of clause PSMK 13.

PROJECT SPECIFICATION

PORTION 3: PARTICULAR SPECIFICATIONS

PE THE EMPLOYER'S PRE-CONSTRUCTION HEALTH AND SAFETY SPECIFICATION

PE 1 INTRODUCTION

PE 1.1 Purpose and Scope

This document describes the procedure upon which the COMPANY shall comply with the requirements set out in the employer's Health and Safety Specification. This document defines the Management System that is implemented by the COMPANY for the management of Health and Safety on the project, which includes ensuring subcontractor compliance with the same standards.

The aim of this document is to present the safety aspects that will be controlled and managed on the project.

PE 2 REFERENCE DOCUMENTS

- Occupational Health and Safety Act, (Act No. 85 of 1993)
- Compensation for Occupational Injury and Diseases Act.
- Client Health and Safety Specification.
- Construction Regulations 2014.
- The Construction Kit. (CD)

PE 3 DEFINITIONS

The following definitions will apply to the Safety Management Plan, acronyms given hereunder shall apply:

Construction/Building Work (as defined by the Occupational Health and Safety Act: Construction Regulations 2014):

Means any work in connection with –

- The erection, maintenance, alteration, renovation, repair, demolition or dismantling of or an addition to a building or any similar structure;
- The installation, erection, dismantling or maintenance of a fixed plant where such work includes the risk of a person falling;
- The construction, maintenance, demolition or dismantling of any bridge, dam, canal, road, railway, runway, sewer or water reticulation system or any similar civil engineering structure; or
- The moving of earth, clearing of land or making of an excavation or work on any similar type of work.

Hazard Identification and Risk Assessment and Risk Control (HRA)

Means a documented plan, which identifies hazards, assesses the risks and detailing the control measures and safe working procedures, which are to be used to mitigate and control the occurrence of hazards and risks during construction or operation phases.

Site

Means the area in the possession of the Contractor for the construction of the works. Where there is no demarcated boundary it will include all adjacent areas, which are reasonably required for the activities for the Contractor, and approved for such use by the Engineer and/or client.

The Act

Means, unless the context indicates otherwise, the Occupational Health and Safety Act, 1993 (ACT NO. 85 of 1993) and Regulations promulgated there under. (OHSA)

Hazard

Means a source of or exposure to danger (source which may cause injury or damage to persons, or property).

Risk

Means the probability or likelihood that a hazard can result in injury or damage.

Contractor's Responsible Person / s

Means any person appointed in writing by the Contractor to supervise construction or building work. The appointment shall be as required by the OHSA which shall stipulate health and safety responsibilities, area of responsibility and the proposed duration of the project.

Hazardous Chemical Substance (HCS)

Means any toxic, harmful, corrosive, irritant or asphyxiant substance, or a mixture or substances for which an occupational exposure limit is prescribed, or an occupational exposure limit is not prescribed, but which creates a hazard to health.

Construction Plant (TEM)

Encompasses all types of plant including but not limiting to, cranes, piling frames, boring machines, excavators, dewatering equipment and road vehicles with or without lifting equipment.

Contractor

Means "subcontractor".

Health and Safety Program

Encompasses the COMPANY safety planning spreadsheet.

Health and Safety Plan (HSP)

The content of this document which will be made available on site for inspection by an inspector, Technical Officer, Agent, subcontractor, employee, registered employee organisation, health and safety representative, or member of the health and safety committee.

Health and Safety File

Describes the safety file holding all records on health and safety for the project, which shall be available at all times for evaluation, and copy of which will be forwarded to the client upon completion of the project.

PE 4 RESPONSIBILITIES

PE 4.1 Notification of Intention to Commence Construction Work

The Provincial Director of the Department of Labour shall be notified by the appointed safety consultant to the COMPANY, immediately upon receipt of the Letter of Acceptance of project commencement in accordance with the following requirements:

- The demolition of a structure exceeding a height of 3 meters; or
- The use of explosives to perform construction work; or
- The dismantling of fixed plant at a height greater than 3 meters; or
- The work exceeds 30 days or will involve more than 300 person days of construction work; and
- Includes excavation work deeper than 1 meter; or
- Includes working at a height greater than 3 meters above ground or a landing.

A copy of the notification letter to the Provincial Director shall be forwarded to client for their records and shall be made available to an Inspector, Project Engineer or employee.

PE 4.2 Assignment of Contractor's Responsible Persons to Supervise Health and Safety on Site

The Contracts Manager and Site Agent shall ensure copies of all the appointment letters of the responsible persons appointed on site will be made available to the client and that all legal appointments shall be conducted in accordance with the requirements set out in the OHSA and Client specifications.

The above shall also be imposed upon all subcontractors.

PE 4.3 Safety Officer Appointment

A part-time Health and Safety consultant shall be appointed upon commencement of the project.

The safety officers shall be tasked with monthly inspections of the site, the results of which shall be forwarded to the client or his appointed representative.

PE 4.4 Risk Assessment Competent Person

The Project Manager shall appoint a competent person in writing at commencement of the project to control the risk assessment process on site. A copy of the risk assessment appointment is attached with duties and responsibilities defined. (Annexure E)

PE 4.5 Competency for Contractor's Responsible Persons

The Project Manager acknowledges that all management personnel (responsible for health and safety) shall undergo a half-day Health and Safety Management Course, which is to be arranged and conducted by the appointed safety consultant prior to commencement of activities on site.

PE 4.6 Health and Safety Representatives

At least one (1) Health and Safety Representative shall be nominated, elected and trained to carry out his / her functions in his / her area of responsibility. This will include areas where less than fifty (50) employees are engaged in activity. Employees elected shall be designated in writing for a specific area and period of time.

The designated persons shall conduct monthly inspections within their area of responsibility, the records shall be kept for auditing and that deviations recorded are reported to the responsible supervisor within the designated persons area so that appropriate action can be taken.

The designated person/s shall be permitted to participate in the Health and Safety Committee Meetings.

PE 5 OBJECTIVES AND TARGETS

- Compliance with the COMPANY Health and Safety Policy.
- Everyone is responsible for organising accident prevention at his or her own level on site.
- Safety training is important.
- Prevention.
- Working safely ensures your job.
- The COMPANY management commits itself to the objectives and targets.
- Disabling Injury Frequency Rate (DIFR) of 2.0 or less.
- 90% compliance on monthly Health and Safety Audits.
- Compliance with the legal requirements set out in the Occupational Health and Safety Act 85 of 1993, (OHSA) and Regulations.
- Compliance with the Client's Safety Specification for Construction.

PE 6 PLANNING AND PROCEDURES

The procedures to be used for the project are to be in accordance with the Safety Manual in use in the COMPANY under the guidance of the appointed safety consultant.

The sub-headings covered under the Safety Manual are as follows:

- Administration
- Appointments
- Safety Committees
- Registers, checklists and permits
- Incident Management
- Emergency Planning
- Contractors
- Risk Assessments
- Audits
- Hazardous substance control
- Training
- Mining Requirements
- Roads Requirements
- Planning

PE 7 IMPLEMENTATION OF THE OCCUPATIONAL HEALTH AND SAFETY SPECIFICATION

The COMPANY is committed to implementing client specific safety specification on the project and is committed see that this forms an integral part of the project. It is our intention to make this specification part of other Contractors and Suppliers operating procedures.

PE 8 APPLICATION OF THE HEALTH AND SAFETY SPECIFICATION

PE 8.1 Compensation of Occupational Injuries and Diseases Act, Act No. 130 of 1993 (COIDA)

The letter of good standing will be available on site for reference purposes as proof of good standing.

The COMPANY shall ensure all Contractors also comply with the above requirements defined in the COIDA.

PE 8.2 Occupational Health and Safety Policy

The COMPANY Health and Safety Policy is attached for reference purposes. (Annexure A).

PE 8.3 Hazard Identification Risk Assessment

The Contract Manager shall ensure the Site Agent shall prior to the commencement of any construction work perform Hazard Identification, and the assessed risks shall form part of the health and safety plan applied on site.

A copy of the HRA shall be made available for viewing to the client.

The Site Agent shall ensure that all HRA's conducted will be conveyed to all personnel and contractors through the site training program and that these training sessions will be presented by the competent person regarding the hazard and related work procedures before any work commences.

The HRA Team that will be established will comprise members as follows:

- Health and Safety Representative(s),
- Health and Safety Committee Member(s)
- Management Representative / Site Agent

Attached in the form of Annexure B and C, the Hazardous Task Identification and (HTI) and format of the Risk Assessment (RA) is included.

Method statements form part of the Risk Process and will be conducted in accordance with the Risk Process described above.

Based on the activities carried out on all projects Hazard Investigation and Risk Assessments (HRA's) will be done. Examples of which are:

- Site Establishment
- Demolition works
- Excavation
- Concrete works
- Lifting operations
- Hand held tools
- Motorised Equipment

PE 8.4 Health and Safety Committee

The Project shall convene a health and safety committee meeting monthly. All members required to be in attendance shall be notified of such meeting by means of a formal agenda.

The Site Agent shall ensure an attendance register and minutes are kept for auditing purposes, and that a copy of the minutes be circulated to all members in attendance well before convening the next meeting and within 7 days, a copy of the minutes will be forwarded to the project engineer.

Members of the committee shall include the following and are not limited to:

- Safety Consultant. (When available)
- Contractor's site representative. (Supervisory level)
- Contractor's site representatives. (Operating level)
- Project Engineer nominated representative. (Co-opted status)

PE 8.5 Health and Safety Training

Training of personnel is a legal requirement and a necessity and is acknowledged as such. The Training Planning Matrix shall be provided upon request.

PE 8.5.1 Induction Training

Induction training shall be attended with the Client as well as the the COMPANY Induction program requirements and records of attendance kept to prove the same.

The COMPANY Induction format is attached for reference purposes. (Annexure D).

PE 8.5.2 Awareness Training

Weekly awareness training shall be conducted using the The COMPANY Toolbox Talk documents, which shall be conducted by the site supervisors. (Annexure E)

PE 8.5.3 Competency

Training identified through the Risk Assessment Process and conducted through this process shall be kept on file as proof of competency and training. (This may include operators).

PE 8.5.4 First Aid and Health & Safety Representative Training

All safety representatives elected and designated, including first aiders, shall be trained should they not already be in possession of a valid certificate of training proving competence.

PE 8.6 GENERAL RECORD KEEPING

The Site Agent shall ensure that all the Health and Safety records, required by both the Occupational Health and Safety Act, 85 of 1993 and Regulations are kept for reference purposes and auditing.

Further to the requirements set out above, the Site Agent will also maintain records that may be defined through the risk assessment process, for auditing purposes.

In accordance with the requirements set out in the Construction Regulations 2014 and the requirement set out in Client Specification the Site Agent shall ensure that a copy of all Health and Safety records generated during the course of construction, be handed over to the Project Engineer upon completion of construction.

PE 8.6.1 Statistics

The Site Agent shall ensure injury and incident records (Near Hits, First Aid, Medical cases, Disabling Lost Time Incidents), training etc. referred to above are kept on site. All documents shall be made available to the client for inspection including the Department of Labour's Inspectors as required by the Occupational Health and Safety Act, 85 of 1993.

The statistics formula as listed below shall be adhered to.

DIFR (Disabling Injury Frequency Rate) $\frac{\text{DI's} \times 1\,000\,000}{\text{Man-hours}}$

DISR (Disabling Injury Severity Rate) $\frac{\text{Days Lost} \times 1\,000}{\text{Manhours}}$

PE 8.6.2 *General Inspection, Monitoring and Reporting*

The COMPANY shall comply with the requirements set out by the client. An agreed safety management plan must be prepared upon which the dates of inspections and training and awareness will be entered, conducted and monitored.

The COMPANY shall keep all records of inspections and investigations undertaken during the contract for the specified legal period as defined in the OHSA and Regulations.

PE 8.6.3 *Internal Audits*

Internal audits shall be conducted a minimum once per month by the project engineer, as well as the appointed safety consultant.

The Results shall be tabled and discussed at the Health and Safety Committee meetings.

The Audits to be conducted by the appointed safety consultant, shall be conducted on the audit schedule attached as per Annexure F.

Records of the audits shall be forwarded to the Project Engineer and shall be filed on site for reference purposes.

PE 8.7 **Incentives**

No incentive scheme is being identified unless required by the client.

PE 8.8 **Penalties**

Non-compliance with the client safety specifications can result in work stoppages and possible expulsion from site until the problem has been remedied including costs.

PE 8.9 **Emergency Procedures**

The Site Agent shall make available to the Project Engineer a detailed Emergency Plan to tie into the evacuation plan already in place on the client's premises.

PE 8.9.1 *First Aid Box and Contents*

The Site Agent shall ensure that all working areas area adequately provided with first aid attendants whether there are fifty (50) employees or less engaged on the contract. The First Aid attendant shall be trained in accordance with the requirements set out in the OHSA with recognised and accredited service providers as defined above.

Proof of training attended (certificate) shall be attached to the written acceptance of appointment. It will be the first aid attendant's responsibility to ensure the contents of the first aid boxes are monitored and inspections recorded on the contents of the first aid box register.

The first aid box shall be adequately stocked by The COMPANY at all times and will be accessible to all.

PE 8.9.2 *Accident and Incident Reporting and Investigation*

Should accident investigation need to be conducted, the Project Manager shall appoint a competent person in writing to conduct the said investigation. The procedure to be followed will be in accordance with the OHSA requirement on the Annexure 1 – Recording and Investigation of Incident form.

The Site Agent shall ensure that the results of all investigations are communicated to the employees engaged through incident recall and prescribed meetings. The Site Agent shall ensure that the investigations are kept for record purposes in accordance with the prescribed requirements set out in the OHSA and the company specific procedures.

Should there be an incident, the Project Engineer shall be notified within 48-hours if required by the client, of the occurrence. It is acknowledged that the client reserves the right to participate in all investigations into accidents or incidents.

PE 8.10 Hazards and Potentially Hazardous Situations

The Site Agent shall ensure that all other contractors or contractors are warned of hazardous or potentially hazardous situations, which may prevent them from effectively performing their duties, which includes the placement of adequate warning signs.

PE 8.11 Personal Protective Equipment and Clothing

The COMPANY shall comply with OHSA requirements to provide PPE.

The Site Agent shall through the Risk Assessment process identify the specific PPE needs per activity and then issue the PPE accordingly. (Reference to the OHSA General Safety Regulation 2 – Employer to provide Personal Protective Equipment).

Should PPE be lost or stolen, then the employee will be issued with a new set of PPE.

Should PPE be worn out or damaged, the user shall return the worn or damaged PPE and will be issued with a replacement set. Training in the use of this shall be provided. Overalls and hardhats shall be identifiable. (Principal Contractor different from the contractors)

PPE shall be provided to visitors as well.

PE 8.12 Safety Signage

The Site Agent in conjunction with the appointed safety consultant shall assess the Health and Safety Signage requirement in conjunction with the Risk Assessments conducted and will place the signage at strategic positions on the site works.

The COMPANY shall also maintain the signage to ensure its effectiveness at all times and under all conditions. Signage, which cannot be repaired, shall be replaced.

PE 8.13 Permits

The COMPANY shall ensure that access to site works is restricted to construction personnel.

- All attempts will be made to restrict spectator access.
- Access to the site shall be by the Project Engineers (Clients) authorisation on the prescribed form. (Permits and ID cards shall be issued by the client)
- Special permits for hot work and isolation permits shall be applied for to the Project Engineer prior to commencing with the activity.

PE 8.14 Contractors and Suppliers

The Site Agent shall enter into an Agreement with Mandatary in terms of Section 37(2) of the Occupational Health and Safety Act, 85 of 1993, with all contractors appointed by The COMPANY is entered into.

The Contracts Manager will ensure the contractors are issued with the Client Safety Specification where reasonably practicable including any the the COMPANY contractor pack for the project, should they not be contained in the Client Safety Specification.

The COMPANY shall assist and ensure the contractors engaged comply with all of these requirements and adhere to the requirements set out in the OHSA.

Contractors will be stopped from working in the event of unsafe conditions and activities being observed.

All contractors shall be covered by the COMPANY Safety Plan and will be issued the same.

PE 9 HEALTH AND SAFETY IN PRACTICE

PE 9.1 Excavations

The Site Agent shall ensure that all activities involving excavations, shoring, dewatering or drainage, a safe working procedure is submitted to the project engineer for approval prior to work commencing. Excavation work exceeding the specified depth as stipulated in the OHSA regulations, shall comply with the following requirements:

- The excavations are inspected before the shift starts, after heavy rain (inclement weather) and after any major condition which may effect the excavations stability and the findings are to be recorded and kept;
- All excavations regardless of the depth shall be adequately barricaded to prevent persons falling into the excavation;
- The safe working procedure shall be communicated to all employees who may be effected by the work; and
- The safe working procedures shall be enforced and maintained by the appointed excavation supervisor at all times.
- For high-risk activities, all personnel working in the excavation shall be attached by means of a lifeline.
- Material excavated shall be removed from the point of excavation.
- Ensure stability of adjoining structures.

PE 9.2 Demolition

No demolition work is being envisaged on this project.

PE 9.3 Explosives and Blasting

Blasting activities are envisaged on this project.

PE 9.4 Stacking of Materials and Housekeeping

The Site Agent shall ensure that all stacking will be supervised by a person competent to supervise over the activities, and that clearly defined and allocated storage areas are provided for and identified, and that materials being stored within this area are stacked in accordance with sound stacking principles of sort-by-sort, access to be maintained, level surface, and the height will not exceed three times the base width.

Housekeeping shall be maintained in accordance with the client requirements at all times.

PE 9.5 Hazardous Chemical Substances

The Site Agent shall ensure the necessary training and information regarding the use and storage of HCS is provided, and that the use and storage of HCS is carried out as prescribed by the HCS Regulations.

Furthermore, the Site Agent shall ensure that all chemicals brought to site have a Material Safety Data Sheet (MSDS) and the users are made aware of the Occupational hazards and precautions that need to be taken when using the chemical.

The First Aider shall be made aware of the MSDS and how to treat HCS incidents appropriately.

Access to all HCS records shall be afforded to the project engineer at all times.

PE 9.5.1 Fuel / Diesel

- Bulk storage areas shall be demarcated, secured and sign posted with the relevant warning pictograms.
- Bulk storage areas shall be bunded.
- Re-fuelling shall be conducted in designated re-fuelling areas only.
- Spill-kits shall be available at all times in these designated areas.
- The surface of the bunded areas and walls shall be of impermeable material.
- The bunded area shall be sloped towards a collection pit.

PE 9.6 Asbestos

No asbestos is to be used on this Project.

PE 9.7 Plant and Machinery

PE 9.7.1 Construction Plant

- All plant shall comply with the OHS Act requirements in relation to operation and maintenance thereof.
- Service and maintenance of the vehicles shall be of a high standard at all times.
- All plant shall subject to design be fitted with back-up alarms and audible indicating devices.
- The COMPANY shall ensure that all construction plants moving parts are adequately protected.
- Pre-start inspections shall be conducted on all motorised equipment daily, deviations of such inspections shall be recorded.
- Construction plant identified for use shall be operated by a trained and authorised operator.
- All construction plant shall be operated under the direct supervision of a person competent to identify potential hazards in the work he is conducting.
- Work involving the use of construction plant shall be conducted in accordance with an approved Risk Assessment.
- The Site Agent shall ensure all operators are equipped with the necessary PPE namely; safety shoes, overall, safety glasses, and gloves.
- Plant shall be fitted with an extinguisher where practicable.
- Washing shall be conducted in the designated washing areas.

The COMPANY shall ensure the all equipment moving to and from site is adequately secured, and that all contractors abide by this requirement.

PE 9.7.2 Transport of Personnel

- Safe vehicular transport shall be provided for personnel working on the project to the workplace, which shall include proper seating, side restraints and cover.
- No personnel shall be permitted to travel on any plant or equipment on the site works.
- Road safety principles shall be adhered to on and off site.

PE 9.7.3 Vessels under Pressure (VuP) or Gas Bottles

The COMPANY shall ensure they comply at all times with the requirements of Vessels under Pressure Regulations, with specific reference to the following:

- Ensuring all Equipment owned and hired-in Vessels under pressure, comply with the 36-month pressure vessel inspection, and a certificate of testing is available on site.
- Ensuring that all personnel who shall use this equipment are competent and trained.
- Ensuring the users of this equipment are issued with the required PPE.
- Ensuring the area is adequately identified as a noise area and warnings are posted.
- Ensuring daily pre-start inspections are carried out on all the equipment and the findings recorded.
- Ensuring the correct fire prevention and fighting equipment is available at all times.
- Noise levels where possible shall be kept within reasonable operating norms.

PE 9.7.4 Fire Equipment

The Site Agent shall ensure the following all fire equipment to be used on site comply with the following:

- Extinguishers shall be placed in positions to ensure fast and easy access is maintained at all times.
- Placement of all extinguishers shall be depicted with the required pictograms.
- Extinguishers shall be serviced once annually, and after discharge or visible signs of depressurisation.
- The Site Agent shall ensure all employees are adequately trained in the safe use of the extinguishers.
- The Site Agent shall ensure a person is appointed to inspect the extinguishers on a monthly basis and the results of which are to be entered into a register designed for that purpose.

PE 9.7.5 Hired Plant and Machinery

The Site Agent shall ensure the following criteria is adhered to when considering hired plant and machinery:

- Only approved hire companies shall supply equipment to the site.
- Hired plant shall be checked for safety compliance prior to being accepted for use on site.
- Should hired equipment be accompanied by an operator, The COMPANY shall ensure that the operators competency be verified and the operator undergo an induction training session.
- The Site Agent shall ensure the operators of hired plant attend weekly toolbox talks in conjunction with The COMPANY site personnel.
- The Site Agent shall ensure that all operators are equipped with the required PPE before commencing work on site.

PE 9.7.6 Scaffolding / Working at heights / Fall Protection

Work involving scaffolding and work at heights shall comply with the requirements set out in the Construction Regulations 2014 pertaining to these activities with reference to the SABS 085 code of practice.

Fall protection planning shall be done in conjunction with the risk assessment process.

All scaffold shall be erected under the control of a person trained and appointed to conduct such scaffold erection.

PE 9.7.7 Falsework / Formwork for Structures

Work involving scaffolding and work at heights shall comply with the requirements set out in the Construction Regulations 2014 pertaining to these activities with reference to the SABS 085 code of practice.

PE 9.7.8 Lifting Machinery and Tackle

The Site Agent shall ensure that the use of Lifting Machinery and Tackle is done in accordance with the requirements of the Regulations, which include but is not limited to the following:

- Lifting machinery and tackle to be used on site shall be marked with the Maximum Mass Load (MML), which is the safe limit in which the equipment may be used.
- Inspections on Lifting Machines and Lifting Tackle shall be inspected once per month on the register provided and the findings recorded.
- Daily pre-start checks shall also be conducted on all Lifting Machinery and Tackle.
- Records shall be kept of all lifting machinery and tackle inspections and Load Tests.
- Load tests shall be conducted a minimum of once per annum, and a certificate of compliance shall be kept on record.
- A valid logbook shall be maintained for all lifting machinery, which will comply with a minimum six-monthly service and maintenance.
- Lifting machinery shall be operated under supervision at all times with a trained banksman who shall inspect all tackle before each lift.
- All lifting equipment operators shall be trained once every two years and a copy of such training shall be attached to the appointment, which is to be made on site.
- The Operators shall be tested for medical fitness.

PE 9.7.9 Ladders and Ladder Work

The following requirements shall be complied with regarding Ladders and Ladder work:

- Ladders shall be clearly numbered, and inspected on the register provided.
- A competent person shall be identified and appointed as the ladder inspector.
- Where aluminium ladders cannot be used, then wooden ladders shall be straight grained, unpainted to allow for proper inspection of the grain for cracking.
- Ladders shall be secured at the top and chocked at the base to prevent slipping.
- Where chocking of the base is not possible, then the user shall ensure that the ladder is held in position by another employee when ascending the ladder.
- Ladders shall be inspected a minimum once per month by the person appointed as the ladder inspector.
- Proper storage shall be provided for all ladders when not in use.

PE 9.7.10 General Machinery

In accordance with General Machinery Regulation 2(1), The COMPANY shall:

- Ensure a competent person be appointed as defined in the above clause from the Occupational Health and Safety Act, 85 of 1993 and Regulations, to service and maintain all machinery in use on site.
- The COMPANY shall appoint additional competent persons to assist the competent person mentioned above in accordance with General Machinery Regulation 2(7)(a), as and when required.
- The COMPANY shall ensure that records are maintained of all services conducted.

PE 9.7.11 Lighting and Power

The Site Agent shall ensure lighting circuits and power circuits are fitted with suitable earth leakage systems in accordance with the client, which will include the following activities:

- Earth leakage system will be tested monthly.
- Malfunctions shall be repaired immediately or replaced.
- Lighting shall be so positioned as not to interfere with construction activities.

PE 9.7.12 Portable Electrical Tools / Explosive Power Tools

The Site Agent shall ensure the following procedure is adhered to regarding Portable Electrical Tools and Explosive Powered tools:

- Minimum compliance with legislation.
- Only competent persons shall be permitted to conduct routine and monthly inspections on the equipment.
- Persons competent to inspect the equipment shall be appointed in writing.
- Persons who are trained to operate such equipment shall be appointed and shall be the only authorised person to operate the equipment.
- The Site Agent shall ensure operation of the equipment is in accordance with the approved Risk Assessment and Safe Working Procedure set out.
- All users shall undergo regular awareness training to ensure compliance.
- The Site Agent shall ensure the required PPE and clothing is provided and maintained.

PE 9.7.13 Public Health and Safety

In the interests of public safety, The COMPANY shall ensure that all persons who may be affected by the work being conducted on site are informed and kept aware of the dangers, which may arise from the work being conducted on site.

This awareness shall be in the form of posters and inductions for visitors to site and warning signs.

PE 9.7.14 Night Work

Night work shall only be conducted upon approval of the project engineer, with the same safety standard being applied for these activities as with day work activities.

PE 9.7.15 Facilities for Safe Keeping / eating areas

The COMPANY shall ensure that adequate facility is provided for the personnel on site. The area shall be provide the following:

- Sufficient seating;
- Seating under cover;
- Protected change room;
- Toilets.
- Hand wash facility.
- Potable water.

No food preparation shall be conducted on site and designated eating areas will be made to allow adequate seating.


Waste bins shall be strategically placed and cleared regularly.

ANNEXURE A (Safety Policy)

CONTRACTOR TO PRODUCE AS SPECIFIED

ANNEXURE B (HTI)

| HAZARDOUS TASK IDENTIFICATION (HTI) | | | | | | | | | | | | |
|-------------------------------------|---|---|-------------------------|-----------------|-------------|---------------------------|-----------------|------|----------------|-----------|-----------------|---|
| Ser no: | INFORMATION REQUIRED | DETAILS | | | | | | | SIGNATURE | Key Table | | |
| 1 | Name of contract: | | | | | | | | | 0= | NONE | |
| 2 | Date prepared: | | | | | | | | | 1= | LOW | |
| 3 | Prepared by: | | | | | | | | | 2= | MEDIUM | |
| 4 | Name of person approving: | | | | | | | | | 3= | HIGH | |
| Risk Assessment (RA) Code | LIST OF ALL STANDARD TASKS | What is the future potential that this task can cause further.... | | | | | | | Total Score | Rating | Doc Required | |
| | | Is it a new or unusual task? | Is it a dangerous task? | Personal injury | Health risk | Impact on the environment | Property damage | Fire | | | | Has the task caused previous injury / loss? |
| RA-1 | Site clearing - manual labour & small tools | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 7 | LOW RISK | MST |
| RA-2 | Site clearing - using mechanical means | | | | | | | | | 0 | LOW RISK | MST |
| RA-3 | Site establishment - FSM erection / dismantling | | | | | | | | | 0 | LOW RISK | MST |
| RA-4 | Site establishment - Container store / office offload | | | | | | | | | 0 | LOW RISK | MST |
| RA-5 | Excavations - using manual labour | | | | | | | | | 0 | LOW RISK | MST |
| RA-6 | Excavations using motorised plan | | | | | | | | | 0 | LOW RISK | MST |
| RA-7 | Excavations - working inside < 1.5 metres | | | | | | | | | 0 | LOW RISK | MST |
| RA-8 | Excavations - working inside > 1.5 metres | | | | | | | | | 0 | LOW RISK | MST |
| RA-9 | Batching plants - erection / dismantle | | | | | | | | | 0 | LOW RISK | MST |
| RA-10 | Batching plants - general working and operation | | | | | | | | | 0 | LOW RISK | MST |
| RA-11 | Concrete mixing - using manual labour | | | | | | | | | 0 | LOW RISK | MST |
| RA-12 | Concrete mixing - using mechanical means | | | | | | | | | 0 | LOW RISK | MST |
| RA-13 | Concrete pours - using lifting machinery (Cranes etc) | | | | | | | | | 0 | LOW RISK | MST |
| RA-14 | Concrete pours - using motorised plant (dumpers etc) | | | | | | | | | 0 | LOW RISK | MST |
| RA-15 | Concrete pours - using mechanical pump | | | | | | | | | 0 | LOW RISK | MST |
| RA-16 | Lifting Equipment - Tower crane erection / dismantle | | | | | | | | | 0 | LOW RISK | MST |
| RA-17 | Lifting Equipment - Tower crane operation | | | | | | | | | 0 | LOW RISK | MST |
| RA-18 | Lifting Equipment - Mobile crane operation | | | | | | | | | 0 | LOW RISK | MST |
| RA-19 | Lifting Equipment - Telescopic handler operation | | | | | | | | | 0 | LOW RISK | MST |
| RA-20 | Lifting Equipment - Forklift operation | | | | | | | | | 0 | LOW RISK | MST |
| RA-21 | Lifting Equipment - using lifting tackle | | | | | | | | | 0 | LOW RISK | MST |
| RA-22 | Formwork - general erection / dismantling | | | | | | | | | 0 | LOW RISK | MST |
| RA-23 | Formwork - lifting and placing large panels | | | | | | | | | 0 | LOW RISK | MST |
| RA-24 | Formwork - work on support decks | | | | | | | | | 0 | LOW RISK | MST |
| RA-25 | Scaffolding - erect / dismantle small scaffolds < 2 m | | | | | | | | | 0 | LOW RISK | MST |
| RA-26 | Scaffolding - erect / dismantle large scaffolds > 2 m | | | | | | | | | 0 | LOW RISK | MST |
| RA-27 | Scaffolding - use of mobile scaffolds | | | | | | | | | 0 | LOW RISK | MST |
| RA-28 | Scaffolding - dismantling of scaffolding | | | | | | | | | 0 | LOW RISK | MST |
| RA-29 | Demolition - using small electric breakers | | | | | | | | | 0 | LOW RISK | MST |
| RA-30 | Demolition - using compressed air breakers | | | | | | | | | 0 | LOW RISK | MST |
| RA-31 | Demolition - using motorised mechanical means | | | | | | | | | 0 | LOW RISK | MST |
| RA-31 | Demolition - using explosives / blasting operations | | | | | | | | | 0 | LOW RISK | MST |
| RA-33 | Trades - Brickwork operations | | | | | | | | | 0 | LOW RISK | MST |
| RA-34 | Trades - Plastering operations | | | | | | | | | 0 | LOW RISK | MST |
| RA-35 | Trades - Painting operations | | | | | | | | | 0 | LOW RISK | MST |
| RA-36 | Trades - Ceiling operations | | | | | | | | | 0 | LOW RISK | MST |
| RA-37 | Trades - Roofing installations | | | | | | | | | 0 | LOW RISK | MST |
| RA-38 | Trades - glazing installations | | | | | | | | | 0 | LOW RISK | MST |
| RA-39 | Trades - Tiling operations | | | | | | | | | 0 | LOW RISK | MST |
| RA-40 | Trades - carpentry (Doors / windows) | | | | | | | | | 0 | LOW RISK | MST |
| RA-41 | Trades - Metal work (Doors / windows) | | | | | | | | | 0 | LOW RISK | MST |
| RA-42 | Trades - Steel erection | | | | | | | | | 0 | LOW RISK | MST |
| RA-43 | Trades - plumbing | | | | | | | | | 0 | LOW RISK | MST |



Copyright

ANNEXURE C (Risk Assessment)

| RISK ASSESSMENT | | | | | | | | | | | |
|-----------------------|------------|------------------|---|---|----|-----------|--------------|---------------------------|------------------------|--|--|
| TASK / ACTIVITY NAME: | | Risks identified | | | | | | AREA: | | | |
| Ser No | Task Steps | Probability | | | | Rating | SWP Required | Immediate Action Required | Safe Working Procedure | | |
| | | A | B | C | D | | | | | | |
| 1 | | 4 | 4 | 6 | 14 | HIGH RISK | ✓ | | | | |
| 2 | | 6 | 6 | 6 | 18 | HIGH RISK | ✓ | | | | |
| 3 | | 4 | 4 | 6 | 14 | HIGH RISK | ✓ | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | | | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | | | | | | | | | |
| 11 | | | | | | | | | | | |
| 12 | | | | | | | | | | | |
| 13 | | | | | | | | | | | |
| 14 | | | | | | | | | | | |
| 15 | | | | | | | | | | | |
| 16 | | | | | | | | | | | |
| 17 | | | | | | | | | | | |
| 18 | | | | | | | | | | | |
| 19 | | | | | | | | | | | |


| Methods Used to Minimise Risk | | Most Critical Hazards | | Control Methods | | RA Committee | |
|--------------------------------|--------------------------|-----------------------|--------------------------|----------------------|--------------------------|--------------|-------|
| | | | | | | Name: | Sign: |
| Engineering Risk Out | <input type="checkbox"/> | Fatigue | <input type="checkbox"/> | PPE Selection | <input type="checkbox"/> | | |
| Use of Specialized PPE | <input type="checkbox"/> | Speed | <input type="checkbox"/> | PPE Issue Records | <input type="checkbox"/> | | |
| Introduce Specialized Controls | <input type="checkbox"/> | Engine Failure | <input type="checkbox"/> | Signs at Area of Use | <input type="checkbox"/> | | |
| Training | <input type="checkbox"/> | | <input type="checkbox"/> | Safety Talks | <input type="checkbox"/> | | |
| | <input type="checkbox"/> | | <input type="checkbox"/> | Safe Work Procedures | <input type="checkbox"/> | | |
| | <input type="checkbox"/> | | <input type="checkbox"/> | | <input type="checkbox"/> | Approved: | Sign: |
| | <input type="checkbox"/> | | <input type="checkbox"/> | | <input type="checkbox"/> | | |

| A | | B | | C | | D | |
|-----------------------------------|-------------------|----------|---------------------------------|------------------|---------------------|--------------------------|-------------|
| Probability an accident may occur | | Severity | | Hazard Frequency | | Risk Score / Criticality | |
| 6 | Inevitable | 6 | Fatal and Permanent Dis | 6 | Artists every shift | 14 to 18 | High Risk |
| 4 | Probable | 4 | DLTI (50 000 - 499 999) | 4 | Artists every week | 8 to 13 | Medium Risk |
| 2 | Highly improbable | 2 | Medical Cases (10 000 - 49 999) | 2 | Artists every month | 0 to 7 | Low risk |
| 0 | No injury / loss | 0 | First Aid Case | 0 | Artists every year | | |




| Probability | | Severity | |
|-------------|----|----------|----|
| 6 | 18 | 6 | 4 |
| 4 | 16 | 12 | 10 |
| 2 | 10 | 8 | 6 |
| 0 | 6 | 4 | 2 |

| Frequency | |
|-----------|---|
| 6 | 6 |
| 4 | 4 |
| 2 | 2 |
| 0 | 0 |

ANNEXURE D (Safety Induction)

| SAFETY INDUCTION | | |
|--|----------------|---------|
| OHS Act 85 of 1993 Sections 8 & 14 | | |
| <p>Requirements:</p> <p>Every employer is required to take all reasonable measures to ensure that the requirements of the OHS Act, and regulations are observed. The general duties of employees are to carry out lawful instructions and to obey the Company's safety rules and procedures prepared in accordance with the provisions of the Act and Regulations. For this process to begin and to be formalized it is necessary for all employees to be formally inducted into the safety procedures and the completion thereof, formally acknowledged by both employer and employee.</p> | | |
| ITEM COVERED | DONE YES/NO | REMARKS |
| Explain Company Policy / Site Safety Rules Provide copies of same | | |
| Explain Section 14 of the Act | | |
| Explain the use of Personal protective Equipment and procedures. Re: Issuing and maintenance | | |
| Explain the meaning of symbolic signs | | |
| Explain the procedure in the event of injury | | |
| Explain the use of facilities and toilets | | |
| Explain the danger of moving machinery. (DUMPER, MIXER, SKILLSAW, GRINDER Etc.) | | |
| Explain the danger of hazardous substances (PETROL, DIESEL, OIL, GAS, PAINT Etc.) | | |
| Explain specific Job Duties and Requirements | | |
| Introduce : Supervisor, safety Representatives, First Aider | | |
| <p><i>This confirms that the above named acknowledges that he/she has been instructed in the safety items listed above and has received the necessary protective clothing / equipment to use in the performance of his/her work.</i></p> | | |
| <u>INDUCTION OFFICER / TRAINER</u> | | |
| Signature | Designation | Date |
| | | |
| <u>ACCEPTANCE</u> | | |
| <p>I, _____ hereby acknowledge receipt of and accept and understand the requirements of this induction.</p> | | |
| Signature | Designation | Date |
| | | |
|  | | |

ANNEXURE E (Toolbox Talks)

| TOOLBOX TALKS | | | | |
|---|---------------------------|-------|-------|-------|
| TALK NO: | 16 | DATE: | | |
| TALK TOPIC: | LIFTING MATERIALS BY HAND | SITE: | | |
| TALK PRESENTED BY: | | | | |
| <div style="display: flex; justify-content: space-around; align-items: center;">   <div style="text-align: center;">  <div style="background-color: #007bff; color: white; padding: 5px; border-radius: 5px; margin-top: 5px;"> Lift correctly </div> </div> </div> | | | | |
| <u>TALK CONTENT / DISCUSSION</u> | | | | |
| <p style="text-align: center;">HOW DO I LIFT EQUIPMENT SAFELY WITHOUT INJURING MY BACK?</p> <ol style="list-style-type: none"> 1. Stoop and bend the knees. 2. Keep your back straight. 3. Lift using the leg muscles. 4. Push upward with the load. 5. If the load is on a table, slide the load to the edge until you can get a firm grip under the load, and then proceed to lift as above. 6. If the load requires two or more persons to lift, then ensure the load is lifted on one side first and then the other, Ensure someone gives the command to lift so the lift occurs simultaneously. 7. Where it is practical to use a trolley, do so as it will safe guard against unnecessary injury. | | | | |
| <u>ATTENDANCE</u> | | | | |
| NAME: | SIGN: | | NAME: | SIGN: |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
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| | | | | |

ANNEXURE F (Audit Schedule)

CONTRACTOR TO PRODUCE AS SPECIFIED

PROJECT SPECIFICATION

PORTION 3: PARTICULAR SPECIFICATION

PZ EMPLOYER'S ENVIRONMENTAL MANAGEMENT SPECIFICATION FOR ENVIRONMENTAL MANAGEMENT OF CONSTRUCTION PROJECTS

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**PZ EMPLOYER'S ENVIRONMENTAL MANAGEMENT SPECIFICATION FOR
ENVIRONMENTAL MANAGEMENT OF CONSTRUCTION PROJECTS**

PZ1 INTRODUCTION

PZ1.1 SCOPE

This specification is additional to the South African Bureau of Standards Standardised Specification for Civil Engineering Contracts and must be read in conjunction with the said specification.

This specification covers the principles, responsibilities and requirements generally applicable to implement effective environmental management during the execution of any construction contract. The aim of this specification is to ensure that construction activities are conducted in an environmentally and socially responsible manner.

PZ1.2 INTERPRETATIONS

This specification contains clauses that are generally applicable to the implementation of effective environmental management on construction contracts. Interpretations of, and variations to, this specification are set out in the project specification.

PZ1.2.1 Supporting specifications:

Reference is made to the SABS 1200 standards which are to be read in conjunction with this specification. All aspects of these SABS requirements which are relevant to environmental management during construction contracts will apply.

PZ1.2.2 Principles

The following principles should be considered at all times during construction phase activities:

- The Environment is considered to be composed of both biophysical and social components.
- Construction is a disruptive activity and all due consideration must be given to the environment, particularly the social environment, during the execution of a project to minimise the impact on affected parties.
- Minimisation of areas disturbed by construction activities will minimise many of the construction related environmental impacts of the project and reduce rehabilitation requirements and costs.
- As minimum requirements, all relevant standards relating to international, national, provincial and local legislation, as applicable, shall be adhered to. This includes requirements relating to waste emissions (e.g. hazardous, airborne, liquid and solid), waste disposal practices, noise regulations, road traffic ordinance etc.
- All effort should be made to minimise, reclaim or recycle 'waste' material.

PZ1.3 DEFINITIONS

For the purpose of this specification, the definitions given in SABS 1200 shall apply.

Additional definitions which shall apply to this specification are as follows:

Environmental Control Officer: Either an Employer's staff member or an Environmental Consultant assigned to the project on a part or full-time basis. The Environmental Control Officer will be part of the Project staff and will advise the Engineer on all environmental matters relating to the works, in terms of this specification and the project specification, if applicable.

Environmental Officer: Either an Employer's employee (e.g. Quality Assurance Inspector) or Consultant designated to monitor the implementation and compliance with the environmental specifications and environmental management plan on a daily basis.

Cleared surface: "surface vegetation" as referred to in SABS 1200 C 2.3 will be deemed to be any woody or herbaceous vegetation but exclude grasses, sedges, rushes and reeds. Clearing and grubbing shall for the purpose of this specification mean the removal of all woody and herbaceous vegetation including stumps, but excluding grass and groundcover vegetation.

Engineer: Is to read Engineer or Supervisor (in the case of the NEC contract), whichever is applicable to the Contract.

Interested and Affected Parties (IAP): All persons who may be affected by the project either directly or indirectly, or who have an interest or stake in the area to be affected by the project. IAPs include landowners, tribal or local authorities, public interest groups etc.

Liquid Waste Stream: Any reagent solutions, fuels, oils, greases, contaminated run-off, sewerage and wash water, etc.

Open Trench: Open trench will, for the purpose of this specification, be deemed to include: clearing and grubbing; stripping of topsoil; trenching; placing of bedding; pipe-laying; placing of selected fill; backfilling to ground level; removing excess material; construction of cross berms to channel water (if required); and replacement of topsoil to final finished level (refer to Figure 1: Appendix A).

Progressive Reinstatement: Reinstatement of disturbed areas to topsoil profile on an ongoing basis, immediately after selected construction activities (e.g. backfilling of a trench) are completed. This allows for passive rehabilitation (i.e. natural recolonisation by vegetation) to commence. See also 'Open Trench' and 'Rehabilitation'.

Project Manager: The person responsible for co-ordinating and integrating activities across multiple, functional lines.

Rehabilitation: Rehabilitation is defined as the return of a disturbed area to a state which approximates the state (where possible) which it was before disruption. Rehabilitation for the purposes of this specification is aimed at post-reinstatement revegetation of a disturbed area and the ensurance of a stable land surface. Revegetation should aim to accelerate the natural succession processes so that the plant community develops in the desired way, i.e. promote rapid vegetation establishment.

Riparian vegetation: Vegetation occurring on the banks of a river or stream (i.e. vegetation fringing a water body). In this specification, riparian vegetation in terms of removal, storage and replacement (see PZ3 17.1 and PZ3 17.2), is only applied to sedge, grass, ground-cover, reed, bulrush, or herbaceous component of riparian vegetation and excludes the woody component.

Sedges: Grass-like plants growing in wetland/ marshy areas or adjacent to water.

Subsoil: Subsoil is the soil horizons between the topsoil horizon and the underlying parent rock. Subsoil often has more clay-like material than the topsoil. Subsoil is of less value to plants, in terms of nutrient (food) and oxygen supply, than topsoil. When subsoil is exposed it tends to erode fairly easily.

Timeous: At least 5 working days prior to an activity.

Topsoil: This is defined as the A horizon of the soil profile. Topsoil is the upper layer of soil from which plants obtain their nutrients for growth. It is often darker in colour, due to the organic (humic) fraction. Topsoil is deemed for the purposes of this specification as the layer of soil from the surface to the specified depth required for excavation (see PZ3 5.3, relevant SABS 1200 clause and project specification). Where topsoil is referred to, it is deemed to be both the soil and grass / ground cover fraction. (see 'Cleared Surface')

Veld: This is defined for the purpose of this specification as unimproved natural vegetation areas (e.g. grasslands).

Water body: Any open body of water including streams, dams, rivers, lakes, and the sea.


Wetland: A seasonally, temporally, or permanently wet area which also may exhibit a specific vegetation community. It is often marshy in character.

Wetland Vegetation: Vegetation which is indicative of a wetland environment - for example, sedges, rushes, reeds, hydrophilic grasses and ground-covers, but for the purposes of this specification excludes woody species.

Xeriscaping: Landscaping with vegetation which has a low water usage. The objective is to conserve as much water as possible, whilst still beautifying an area (i.e. conservation and aesthetics). Concept embraces utilising indigenous as opposed to exotic plants.

PZ1.4 ABBREVIATIONS

| | |
|------|--|
| DWS | Department of Water and Sanitation |
| ECO | Environmental Control Officer |
| EMP | Environmental Management Plan |
| EMPR | Environmental Management Programme Report |
| EO | Environmental Officer |
| IAPs | Interested and Affected Parties |
| IEM | Integrated Environmental Management |
| MSDS | Material Safety Data Sheet |
| NEC | New Engineer Contract or The Engineering and Construction Contract |

 Indicates the project specification must be referred to, to clarify the clause.

PZ1.5 DRAWINGS

Drawings referred to in this specification are included in C4.4 Drawings of Section C4 Site Information.

PZ1.6 FORMS

Forms referred to in this specification are included in Part T2 or attached to this environmental specification.

PZ1.7 CONDITIONS OF CONTRACT

PZ1.7.1 Duties and Powers of the Project Manager

The Project Manager is ultimately responsible for ensuring compliance with the environmental specification and upholding the Employer's Environmental Policy on a project.

The Project Manager:

- arranges information meetings for or consults with IAPs about the impending construction activities;
- may on the recommendation of the Engineer and /or Environmental Officer order the Contractor to suspend any or all works on site if the Contractor or his Subcontractor/ supplier fails to comply with the said specifications;
- maintains a register of complaints and queries by members of the public at the site office as per attached pro-forma. This register is forwarded to the Environmental Control Officer on a monthly basis.

PZ1.7.2 Duties and Powers of the Engineer / Supervisor (NEC)

The Engineer or Supervisor is responsible for:

- enforcing the environmental specification on site;
- monitoring compliance with the requirements of the specification;
- assessing the Contractor's environmental performance in consultation with the Environmental Officer from which a brief monthly statement of environmental performance is drawn up for record purposes;
- documenting, in conjunction with the Contractor, the state of the site prior to construction activities commencing. This documentation will be in the form of photographs or video record.

PZ1.7.3 Duties and Powers of the Environmental Control Officer

The Environmental Control Officer:

- briefs the Contractor about the requirements of the Environmental Specification and/ or Environmental Management Plan, as applicable;
- advises the Project Manager and Engineer/ Supervisor about the interpretation, implementation and enforcement of the Environmental Specification and other related environmental matters;
- attends site meetings, as necessary;
- monitors the Constructor's compliance with this specification and the project environmental specification as applicable;
- undertakes periodic audits of the effectiveness of the environmental specifications on the site;
- communicates environmental policy issues to the Project Manager;
- provides technical advice relating to environmental issues to the Engineer/ Supervisor and Project Manager;
- reports on the performance of the project, in terms of environmental compliance.

PZ1.7.4 Duties and Powers of the Environmental Officer

The Environmental Officer:

- attends site meetings;
- monitors the site for compliance with the Environmental Specification and EMP;
- reports on the performance of the project in terms of environmental compliance to the ECO and Project Manager as per the pro-forma attached;
- liaises with the ECO on matters of policy and those requiring clarity and advice.

PZ1.7.5 Extent of the Contractor's Obligations

The Contractor is required to:

- provide information on previous environmental management experience and company environmental policy;
- supply method statements for all activities requiring special attention as specified and/or requested by the Project Manager, Environmental (Control) Officer and/or Engineer during the duration of the Contract;
- be conversant with the requirements of this environmental specification and the project specification as applicable;
- brief his staff about the requirements of the environmental specification;
- comply with requirements of the Environmental (Control) Officer in terms of this specification and the project specification, as applicable, within the time period specified;
- ensure any sub-contractors/ suppliers who are utilised within the context of the contract comply with the environmental requirements of the Employer, in terms of the specifications. The Contractor will be held responsible for non-compliance on their behalf;
- bear the cost of any delays, with no extension of time granted, should he or his Sub-Contractors/ Suppliers contravene the said specifications such that the Engineer orders a suspension of work. The suspension will be enforced until such time as the offending party(ies), procedure, or equipment is corrected;
- bear the costs of any damages/ compensation resulting from non-adherence to the said specifications or written site instructions;
- comply with all applicable legislation in terms of 7.6 below;
- ensure that he informs the engineer timeously of any foreseeable activities which will require input from the Environmental (Control) Officer.

The Contractor will conduct all activities in a manner that minimises disturbance to directly affected residents and the public in general, and foreseeable impacts on the environment.

PZ1.7.6 Compliance with Applicable Laws

The supreme law of the land is "The Constitution of the Republic of South Africa", which states:

"Every person shall have the right to an environment which is not detrimental to his or her health or well being"

Laws applicable to protection of the environment in terms of Environmental Management (and relating to construction activities) include but are not restricted to:

- Animals Protection Act, Act No 71 of 1962
- Atmospheric Pollution Prevention Act, No 45 of 1965
- Conservation of Agricultural Resources Act, No 43 of 1983
- Environmental Conservation Act, No 73 of 1989
- Environmental Planning Act, Act No 88 of 1967
- Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, No 36 of 1947
- Forest Act, No 122 of 1984
- Forest and Veld Conservation Act, Act No 13 of 1941
- Hazardous Substances Act, No 15 of 1973
- Lake Areas Development Act No 34 of 1975
- Land Survey Act, No 9 of 1921
- Minerals Act, No 50 of 1991
- Mountain Catchment Act, No 63 of 1970
- National Monuments Act, No 28 of 1969
- National Parks Act, No 57 of 1976
- National Resources Development Act, Act no 51 of 1947
- Occupational Health and Safety Act, No 85 of 1993
- Provincial and Local Government Ordinances and Bylaws
- Soil Conservation Act, Act No 76 of 1969
- Water Act, No 54 of 1956
- Water Services Act No 108 of 1997

and all regulations framed thereunder and amendments there to.

PZ1.7.7 Compliance with the Environmental Specification

The Contractor is deemed not to have complied with the Environmental Specification if:

- within the boundaries of the site, site extensions and haul/ access roads there is evidence of contravention of clauses;
- if environmental damage ensues due to negligence;
- the Contractor fails to comply with corrective or other instructions issued by the Project Manager or Engineer within a specified time,
- the Contractor fails to respond adequately to complaints from the public.

Application of a penalty clause will apply for incidents of non-compliance. The penalty imposed will be per incident. Unless stated otherwise in the project specification, the penalties imposed per incident or violation will be:

| | |
|---|-------|
| Failure to demarcate working servitudes | R1000 |
| Working outside of the demarcated servitude | R2000 |
| Failure to strip topsoil with intact vegetation | R1000 |
| Failure to stockpile topsoil correctly | R500 |
| Failure to stockpile materials in designated areas | R500 |
| Pollution of water bodies (including increased suspended solid loads) | R1000 |
| Failure to control stormwater runoff | R1000 |
| Failure to provide adequate sanitation | R500 |
| Unauthorised removal of woody vegetation | R2000 |
| Failure to erect temporary fences | R500 |
| Failure to provide adequate waste disposal facilities and services | R500 |
| Failure to reinstate disturbed areas within the specified time-frame | R3000 |
| Failure to rehabilitate disturbed areas within the specified time-frame | R3000 |
| Any other contravention of the project specific specification | R400 |
| Any other contravention of the particular (general) environmental specification | R300 |

PZ2 SITE ESTABLISHMENT AND HOUSEKEEPING

PZ2.1 LAYOUT

The Contractor will take into account any of the limitations identified in the project specification with regard to establishment of site, in particular the location of access routes, and establishment layout.

Notwithstanding the provision of a project specification, the Contractor will provide the Project Manager and Environmental Control Officer with a layout design of the site indicating the position of all of the following, as applicable: offices, ablution facilities, storage areas, workshops, laboratories, batching plant, particulate matter stockpile area (i.e. soil/ granular chemicals/ cement fines etc), waste disposal facilities, hazardous substances storage area, access routes, etc. This layout plan is to be submitted prior to site establishment for acceptance. Any changes to this plan require review by the Project Manager in conjunction with the ECO.

The Contractor will take into account prevailing wind directions when designing the site layout to minimise impacts due to dust, unpleasant odours etc.

The Contractor will take into account the positions of residences when designing the site layout in order to minimise noise impacts on the residents.

Site security lighting is to be positioned such that the direct beam is focused away from residential properties and does not pose a nuisance or danger to road users.

No site establishment will be allowed within 100 m of a water body or drainage channel or on a flood plain unless approved by the Environmental (Control) Officer or specified in the project specification.

PZ2.2 SITE CLEARANCE

No trees or shrubs may be removed without the prior permission of the Environmental Officer, unless in keeping with the final site reinstatement and rehabilitation plan. Topsoil is to be stripped from all areas where permanent or temporary structures and access roads are to be constructed. Topsoil conservation is to be in terms of clause PZ3 5.3 of this document.

PZ2.3 SERVICES

PZ2.3.1 Sanitation

Portable chemical toilets are to be utilised at site unless a connection to sewer is possible or a proper septic tank system is installed. In the case of the septic tank, the installation will require the relevant approvals from the local authority and will require removal upon completion of the contract, unless otherwise directed.

Sanitation facilities will be located within 100 m from any point of work, but not closer than 50 m to a water body.

PZ2.3.2 Solid Waste Facilities

Facilities for solid waste collection are to be provided. These are to be at least a 200 l drum and clearly identified as the point for waste disposal.

Waste is to be separated into paper, glass and metal with separate collection points for each. The Contractor will ensure that the appropriate recycling contractors receive this waste.

The Contractor is to institute a daily litter collection programme. The collected waste is to be disposed of regularly and proportionately to its generation at a site designated for waste disposal.

No burning will be permitted on any site unless by approved incineration methods and in a low risk fire area. In the case of incineration, ash is to be co-disposed with spoil in a designated spoil dump.

No burying of waste will be allowed on any site.

PZ2.3.3 Cooking and Heating Facilities

No open fires will be allowed anywhere on site.

Contained fires (i.e. in a fire drum) will be allowed for heating and cooking only in designated areas, in other cases cooking is restricted to gas or electrical equipment.

PZ2.4 FUELS, HAZARDOUS SUBSTANCES AND OTHER LIQUID POLLUTANTS

PZ2.4.1 Storage and handling

All potentially hazardous raw and waste materials are to be handled by trained staff and stored on site in accordance with manufacturer's instructions and relevant legal requirements. The product MSDS is to be lodged with the Engineer.

Storage and handling areas for fuels, lubricants, chemicals and other hazardous substances are to be paved with concrete to prevent accidental contamination of the soil. Alternatively, an impermeable liner may be placed beneath above-ground storage tanks. The integrity of the liner is to remain intact for the duration of the contract, until removal.

Open storage vessels, for example shutter lubricant drums, are to be stored under cover to prevent 'splash' contamination.

All storage areas are to be bunded (with at least sandbags) and have a peripheral collection drain, with oil interceptors (if required).

The bunded area is to be sufficiently large to contain a spillage equivalent to the volume of one container of the substances stored.

All products to be dispensed from 200 litre drums will be done so with appropriate equipment, and not dispensed by tipping of the drum.

Daily checks are to be conducted on the dispensing mechanism of above-ground storage tanks to ensure the timeous identification of faults.

Collection containers (e.g. drip trays) are to be placed under all dispensing mechanisms of hydrocarbon or hazardous liquid substances to ensure contamination from leaks and dispensing is contained.

The dispensing mechanism of diesel and petrol storage tanks is to be stored in a container when not in use.

PZ2.4.2 Control of pollutants

A drainage diversion system is to be installed to divert runoff from areas of potential pollution, e.g. batching area, vehicle maintenance area, work shops, chemical and fuel stores, etc if applicable.

Contaminated runoff and waste water is to be directed into a collection system (e.g. sump, attenuation dam, PVC porta-ponds etc.) for treatment or collection and disposal. The final collection point (e.g. sump) is to be PVC lined.

Collected contaminated runoff/ wastewater is to be pumped out of the final collection point and disposed of at an appropriate landfill site. Sump liners are to be treated in the same manner.

The treated waste water, effluent and contaminated runoff may require analysis prior to discharge as detailed in the project specification or instructed by the Environmental Officer.

Details regarding proposed methods for treatment of pollutants are to be submitted to the Environmental (Control) Officer for acceptance upon award of the Contract.

Any spillages, irrespective of their size, are to be contained and cleaned up immediately. The Pollution Control section may provide technical assistance for clean up, if required. No spills may be hosed down into a stormwater drain or sewer.

Use of specialised cleanup techniques and/ or products may be required depending on the spill. This will be instructed by the Environmental Control Officer. These will be to the Contractor's cost.

PZ2.5 GENERAL

Site staff are not permitted to use any open water body or other natural water source (e.g. springs) for purposes of bathing, or the washing of clothes, machinery or vehicles. Nor draw water from a spring without the permission of the community utilising that spring.

PZ2.6 MEASUREMENT AND PAYMENT

Measurement and payment for compliance with clauses PZ2.1 to 5 of the specification are deemed to be fully included in the Contractor's rates for fixed and time related Preliminary and General Items scheduled under SABS 1200 A or AA.

PZ3 CONSTRUCTION

PZ3.1 CONSTRUCTION METHODS AND PROGRAMME

PZ3.1.1 Construction Method

The Contractor will provide method statements for construction activities (14 working days prior to the activity commencing) relating to the following environments and those listed in the project environmental specification, unless methods have been prescribed in this or the project environmental specification:

- rivers, streams, or any other open water body;
- wetlands;
- access roads (see PZ3.13 below);
- steep slopes (i.e. steeper than 1:4) or less if friable material is present;
- indigenous bush/ forest;
- close proximity (i.e. 50 m or less) to a residential dwelling;
- drilling and/or blasting of rock.

If a construction method employed by the Contractor is not environmentally acceptable to the Employer, the Contractor may be instructed to cease the utilisation of that method in favour of a more environmentally acceptable one, proposed either by himself or the Employer.

PZ3.1.2 Construction Programme

The Contractor will programme construction so as to minimise the impact on the environment and provide this programme to the Environmental Control Officer for perusal and acceptance at the onset of the contract period. The Environmental Control Officer is to made aware of any amendments to the construction programme or alterations to the scope of work in order that their impacts on the environment can be assessed.

The Contractor (through the Project Manager) will ensure that all affected landowners/ authorities are advised of the proposed programme at the beginning of the contract period.

PZ3.2 AREAS OCCUPIED / DEMARCATION OF SITE

Routes for temporary access and haul roads are to be located within the approved demarcated areas and vehicle movement is to be confined to these roads. Movement of vehicles outside the designated working areas is not permitted without authorisation from the Engineer.

All construction activities are restricted to working areas designated on the drawings and/or demarcated and approved by the Engineer. Materials including spoil are stockpiled at designated areas.

Any areas disturbed outside of the demarcated areas or without permission of the Environmental (Control) Officer or Engineer will be subject to reinstatement and rehabilitation (as per PZ4 below) to the Contractor's cost.

In terms of Pipeline projects, a general maximum working servitude width of 15 m will apply for machine excavation unless otherwise indicated in the project specification. A

maximum width of 6 m will apply for manual excavation. These maximum working servitude widths may vary depending on the sensitivity of the environment, as detailed in the project specification.

In sensitive biophysical environments, for example wetlands, indigenous forest / bush, pristine natural grasslands, and sensitive social environments, as defined in the project specification or by the Environmental Control Officer, the working servitude is reduced as indicated in the project specification.

The working servitude shall contain all construction related activities, including, stockpiling of materials, placing of toilets, vehicle movement areas, etc.

Demarcation of linear projects (executed with machine excavation) and features (e.g. Pipelines, access roads, etc.) will be by means of wooden stakes. These stakes will be at least 1 m high, painted white and placed at least every 15 m, on either side of the linear feature, in all areas where works are occurring. Progressive movement of stakes is required as linear projects progress.

In the case of a fenced site, the boundary fences will be denoted as the outermost limit of the site, but internal areas may be demarcated with stakes as above. The site boundaries of non-fenced, but 'contained' projects are to be delineated using stakes or temporary fencing, depending on the hazard which that site poses.

PZ3.3 SUPPLY OF WORKS FACILITIES

No water may be abstracted from water bodies for the purposes of construction, without approval of the Engineer in consultation with the Environmental Control Officer.

PZ3.4 CLEANLINESS

SABS 1200 AD, clause 5.2.4, second sentence, is to read: "No rubbish or debris shall be deposited below the full supply level (FSL)."

PZ3.5 SITE CLEARANCE

PZ3.5.1 Clearance

Spoil sites will require clearing and grubbing in addition to those areas in terms of SABS 1200 C 5.1.

The site shall only be cleared immediately prior to construction activities commencing i.e. at the last practicable stage.

No trees or indigenous shrubs may be removed without the prior permission of the Environmental (Control) Officer, unless in keeping with the final site reinstatement and rehabilitation plan.

PZ3.5.2 Disposal of materials

Material obtained from clearing and grubbing operations shall be disposed of at appropriate municipal disposal facilities. They are not to be disposed of as per Paragraph 1 of Sub-clause 3.1 of SABS 1200 C.

Wood obtained from clearing and grubbing operation remains the property of the landowner/ community and must be stacked at sites designated by relevant person. The

Contractor will be required to remove and dispose of any wood from site at a designated site for vegetation disposal, should the landowner/ community not require it.

All tree trunks and branches of diameter greater than 50 mm are to be cut into lengths not exceeding 2400 mm.

Brush wood (i.e. < 50 mm diameter) is to be disposed of, or utilised as specified in the project specification or upon instruction of the Engineer.

PZ3.5.3 Conservation of topsoil

The Contractor is required to strip topsoil (as defined in this specification) together with grass, groundcover and sedges from all areas where permanent or temporary structures are located, construction related activities occur, and access roads are to be constructed, etc. The depth to which topsoil will be stripped shall be 200 mm unless stated otherwise in the project specification.

Topsoil is to be handled twice only - once to strip and stockpile, and secondly to replace, level, shape and scarify.

Topsoil is to be replaced along the contour.

Topsoil is to be replaced by direct return (i.e. replaced immediately on the area where construction is complete), rather than stockpiling it for extended periods. This is feasible for progressive construction (e.g. Pipelines), but not necessarily so for reservoirs, site establishments, dams, etc.

Topsoil stockpiles are not to exceed 2 m in height.

Topsoil stockpiles are to be maintained in a weed free condition (i.e. no 'broad-leafed' plants regarded as weeds in terms of the Conservation of Agricultural Resources Act No 43 of 1989, or those plants regarded as a 'general nuisance in the area' are to be growing on the stockpiles). The Environmental Control Officer will provide guidance as to which plants are weeds and require removal.

The stockpiles are not to be contaminated with sub-soil, or any other waste material.

Topsoil may not be compacted in any way, nor may any object be placed or stockpiled on it.

Topsoil may not be compacted in any way, nor may any object be placed or stockpiled on it.

Topsoil which is to be stockpiled for periods exceeding 4 months is to be vegetated. In summer a mixture of *Eragrostis tef* (Teff) and *Eragrostis curvula* (Weeping Lovegrass) (ratio 1:2) is to be applied at an application rate of 6 kg/ha, unless otherwise instructed in the project specification.

In winter, a mixture of *Lolium multiflorum* (Annual/Italian Rye grass) and *Eragrostis curvula* (Weeping Lovegrass) (ratio 1:1) is to be applied at an application rate of 6kg/ha (see PZ4 5.3 for sowing times), unless otherwise instructed in the project specification. Fertiliser is to be applied as per PZ4 5.2.

PZ3.5.4 Cutting of trees

Any tree branches which require removal are to be properly pruned and sealant applied to the cut surface, if required.

The Contractor's attention is drawn to Sub-clause 5.2.3.3 of SABS 1200 C with respect to work in indigenous forests.

Any indigenous trees or bush which require removal in terms of the project, and which have not been identified in the project specification or EMP, are to be timeously indicated to the Environmental Officer prior to work affecting them.

PZ3.5.5 Landscape Preservation and Conservation of Flora

Notwithstanding Clause 5.7 of SABS 1200 C, the Contractor will be required to transplant designated plants to alternative locations as specified in the project specification or identified by the Environmental Control Officer, upon the instruction of the Engineer. Transplanting shall be undertaken by employing the following method:

Removal

- Mark the orientation of the tree/shrub (for example, the north-facing side of the trunk indicated by a small arrow made with indelible ink) trunk. Do not scratch a mark on the surface of the trunk;
- Delineate a circle from the trunk with a radius equivalent to the drip-line of the tree, or as indicated by the Environmental Control Officer on site;
- Excavate the tree with an intact rootball.

Replanting

- A hole 500 mm larger in diameter than the anticipated rootball must be prepared in advance of the tree removal in order that the tree can be replanted immediately;
- The tree must be positioned as per its original orientation;
- A planting method known as 'puddling' must be employed. This method involves the addition of soil and water simultaneously to expels air from the planting hole. Place the tree in its new hole, making sure the top surface of the rootball is level with the ground level. Place a hose pipe in the hole and leave it running whilst extra soil is added around the rootball;
- 'Compact' the tree in the hole and attach tree stays for stabilisation.

Compensatory planting of species may be required should transplantation not be feasible, as indicated in the project specification or upon instruction of the Engineer.

PZ3.6 EARTHWORKS

PSZ3.6.1 Backfill material

With reference to SABS 1200 DB sub-clause 3.5, no material stripped or excavated which is classed, in terms of this specification, as topsoil, may be used as backfill in any excavation.

PZ3.6.2 Excavation and backfilling

During excavation 'conservation of topsoil', as specified in PZ3 5.3 above will apply.

Excavated material is to be stockpiled along a Pipeline trench within the working servitude, unless otherwise authorised.

Surplus excavated soft, intermediate and hard rock material shall not be disposed of along the Pipeline trench as indicated in SABS 1200 DB sub-clause 5.6.3 and 5.6.4, but shall be removed to a spoil site (see PZ3.15 below) designated during the project if applicable, or agreed by the Engineer in conjunction with the Environmental Control Officer and Project Manager.

In certain cases, for example to help stabilise the disturbed area or to reinstate the natural aesthetics of an area, excess excavated intermediate and hard material may be disposed of in a designated manner along a Pipeline trench, as indicated by the Environmental Control Officer and Project Manager, or in the project specification. In this case, rock material shall not exceed 250 mm in maximum dimension (see PZ4 2.1).

In terms of SABS 1200 DB 5.6.5 and SABS 1200 LB 3.4.2, deficiency of backfill material shall not be made up by excavation within the free haul distance of 0.5km of site, without the prior approval of the Engineer of the source of the material. Where backfill material is deficient, it should ideally be made up by importation from an approved borrow pit (i.e. one which operates within the ambient of an EMPR.) (See also PZ3 14 below).

The Contractor will backfill in accordance with the requirements of progressive reinstatement.

The maximum length of open trench shall be specified in the project specification.

PZ3.7 SAFETY

All works which may pose a hazard to humans and animals are to be adequately protected and appropriate warning signs erected. The Contractor's attention is drawn to SABS 1200 D section 5.1 in this regard.

With reference to SABS 1200 D 5.1.1.3, where blasting is required in terms of the project, the Contractor will ensure that all structures in the vicinity that could be affected by the activity will be inspected and their condition photographically recorded (as necessary), prior to blasting.

Notice of intent to blast is to be provided to landowners timeously.

Speed limits, appropriate to the vehicle driven, are to be observed at all times on access roads. Operators and drivers are to ensure that they limit their potential to endanger humans and animals at all times, by observing strict safety precautions.

PZ3.8 PLANT

PZ3.8.1 Silencing of plant

With reference to SABS 1200 A amend: "built up areas": to read as "all areas within audible distance of residents (albeit urban, peri-urban or rural areas)."

Appropriate directional and intensity settings are to be maintained on all hooters and sirens.

Silencer units on equipment and vehicles are to be maintained in good working order.

Construction activities are to be confined to normal working hours (07h30 - 17h00) Mondays to Saturdays, except for the activities designated to be carried out at night.

PZ3.8.2 Appropriate use of plant

The Contractor will at all times use plant which is appropriate to the task in order to minimise the extent of damage to the environment.

PZ3.9 DEALING WITH WATER ON WORKS

PZ3.9.1 Disinfection of Potable Water Infrastructure

Disinfection water is to be neutralised before release of this water to the environment.

PZ3.9.2 Discharge of water from site

Any water which is discharged from site is to comply with the relevant Water Quality Guidelines implemented by DWS.

Water discharged to the stormwater / sewer system may only be done so with the permission of the relevant local authority.

PZ3.10 CONTROL OF EROSION

Surface erosion protection measures will be required to prevent erosion where slopes are steeper than 1:8 on all soil types.

Erosion protection measures required may include all or some of the below, as specified in the project specification or upon instruction of the Engineer in conjunction with the Environmental (Control) Officer:

- use of groundcover or grass
- construction of cut off berms (earth and/or rockpack) - these are to be angled across the contour and normally would approximate an angle of 30o from the bisector of the contour.
- placing of brush wood on bare surface;
- pegging of wattle trunks or branches along the contour;
- hard landscaping, e.g. use of Loffelstein walls, ground anchors, gabions etc.

Scour chambers are to be fitted with energy dissipaters, or the jet of water directed onto a protected (i.e. grouted stone pitching/ rock pack/ reno mattress) area to dissipate water velocity and to control and prevent erosion.

Storm water drainage measures might be required on site to control runoff and prevent erosion.

PZ3.11 CONTROL OF POLLUTION

No waste in a solid, liquid or gaseous state shall be emitted from or spilled on the site without the approval of the Engineer.

No mixed concrete shall be deposited directly onto the ground prior to placing. A board or other suitable platform is to be provided onto which the mixed concrete can be deposited whilst it awaits placing.

Excess concrete from mixing shall be deposited in a designated area awaiting removal to an approved landfill site.

The Contractor will contain wash water from cement mixing operations, by directing the water into a sump for collection. The material contained in the sump will be removed to an appropriate landfill site.

No concrete rubble shall be present at the site.

Liquid wastes will not be disposed of to storm water drains. They may be disposed of to sewer only if permitted by (local council) legislation.

In the event of pollution of a water body (including sediment loading), the Contractor will provide alternative water supply to users of that water body until the quality of the water body is restored to its previous unpolluted state. For the sake of this clause, pollution is deemed to be a state which is substandard to the normal quality of the water body, but is not necessarily in contravention of the South African Water Quality guideline standards for a prescribed activity.

Any ancillary damages resulting from pollution of a water body will be repaired / remediated at the Contractor's cost.

Where, due to construction requirements, pollution of a water body may potentially occur, the Contractor is to ensure adequate measures (e.g. attenuation/ settlement dams / oil absorbent products) are in place to prevent pollution. A method statement is to be provided to this effect (see PZ3 1).

PZ3.12 CONTROL OF FIRE

The Contractor will ensure he has the necessary fire fighting equipment on site in terms of SABS 1200. This will include at least rubber beaters when working in 'veld' areas, and at least one fire extinguisher of the appropriate type when welding activities are undertaken, irrespective of the site.

PZ3.13 USE AND MAINTENANCE OF ACCESS FACILITIES

PZ3.13.1 Responsibility

The Project Manager [not the Contractor (SABS 1200 AD 5.3.1)] will be responsible for obtaining permission for temporary and permanent rights of way over all private property affected by project activities.

The Project Manager will ensure that the Contractor has kept a photographic record of all access facilities and that these are reinstated to a state not worse than upon commencement of the project and to the satisfaction of the landowner (not withstanding that the project's objective is not to upgrade landowners' access roads).

PZ3.13.2 Fencing

Temporary fencing is to consist of 1.2 m bonnox fencing, or similar, suitably tensioned and supported on 1.8 m fencing standards at 3 m intervals, with all necessary straining posts and stays.

All temporary fencing as indicated by the Engineer is removed on completion of the contract.

PZ3.13.3 New Access Roads

Any construction roads created for execution of the project are to be designed to incorporate adequate drainage and water attenuation structures.

Any access roads which incorporate 'cut and fill' aspects and/or which are to be surfaced during construction are to be authorised by the Environmental Control Officer and Project Manager. Prior to construction of the road, the Contractor will be required to provide a sketch plan of the road layout (referenced to local topographic, natural and man-made structures). Slope steepness, road width, drainage structures and their frequency will need to be documented and accompany the sketch layout.

Construction access roads may not be wider than that necessary (maximum width 4 m) for movement of vehicles in one direction only. Should two way traffic be required, points people are to control vehicle movement on the 'single lane' road or passing bays are to be used where specified in the project specification or as identified by the Engineer in conjunction with the Environmental Control Officer, unless otherwise stated in the project specification.

The cut and fill slopes of permanent roads will require grassing, as specified in the project specification or by the Environmental Control Officer, to increase stability and reduce aesthetic impacts. Hard landscaping may be required as per the project specification.

Temporary construction roads will require rehabilitation on completion of construction activities for which they were required. These roads will require rehabilitation as per PZ4 4 or as specified in the project specification. In the case of access 'tracks', only ripping to loosen compaction will be required unless otherwise stated by the Environmental Control Officer or project specification.

Access roads created by the project may only remain unrehabilitated on written request of the landowner, with his acceptance of the state of the road and a clause that the landowner accepts all responsibility for the road and its state.

PZ3.13.4 Maintenance of Existing Access Roads

The Contractor will record, photographically, the state of existing roads which are to be used for access, prior to plant utilising these roads.

During the contract period, the Contractor will ensure that all existing water attenuation and drainage structures are maintained in a state in which they can optimally perform their function.

Upon completion of the construction period, the Contractor will ensure that the access roads are returned to a state not worse than prior to construction commencing.

PZ3.14 BORROW PITS

Where the Contractor is required to import material this shall be from commercial sources or borrow areas specified in the project specification.

The Contractor may source material from alternative borrow pits provided: the site location; method of winning material and reinstatement and rehabilitation are environmentally acceptable and approved by the Environmental Control Officer.

In this regard, the Contractor shall give the Environmental Control Officer in writing, 30 days prior to opening up alternative borrow pits the following information for acceptance:

- quantities of borrow material required;
- method statement for excavation of material including depth and extent of excavation;
- anticipated 'active life' of the borrow area;
- proposal for reinstatement and rehabilitation of borrow area, including final profile;
- written approval from the landowner/ relevant authority that material may be removed from their land subject to their stated conditions, requirements, and royalties, and if the proposal is acceptable to the Environmental Control Officer.

Development and rehabilitation of borrow pit areas are likely to include the following activities (but these must not be regarded as exhaustive):

- Stripping and stockpiling of topsoil as per PZ3 5.3 of this specification;
- Removal (to nominal depth of 500 mm) and stockpiling of sub-soil;
- Infill of borrow pit with spoil material;
- Contouring of borrow pit to approximate natural topography and/ or reduce erosion impacts on the site;
- Placement of excavated subsoil over spoil material;
- Placement of stripped topsoil on subsoil;
- Grassing of topsoil in terms of clause PZ4 4 of this specification.

The Contractor is to familiarise himself with the requirements of the Minerals Act No 50 of 1991 in terms of borrow pit development, and the requirements of the EMPR, as applicable.

PZ3.15 SPOIL SITES

Where the Contractor is required to spoil material, spoil sites must be identified which are environmentally acceptable and approved by the ECO, unless spoil site areas have been identified in the project specification, in which case these will be the designated spoil sites.

If no spoil sites have been previously identified together with reinstatement and rehabilitation criteria, the Contractor is to provide the following information to the ECO at least 30 days prior to requiring sites to spoil material:

- the location, description of and access to alternative sites identified in order that they may be assessed;
- the quantity of material to be spoiled;
- the type of material to be spoiled (i.e. blast rock/ excavated rock/ soft shale/ subsoil etc.);
- the proposed method of spoiling;
- the proposed reinstatement and rehabilitation plan including final profile;
- written approval from the landowner/ relevant authority that material may be spoilt on land subject to their stated conditions and requirements and if the proposal is acceptable to the ECO.

Development and rehabilitation of spoil areas are likely to include the following activities (but these must not be regarded as exhaustive):

- Stripping and stockpiling of topsoil as per PZ3 5.3 of this specification;
- Removal (to nominal depth of 500 mm) and stockpiling of sub-soil;

- Placement of spoil material;
- Contouring of spoil site to approximate natural topography and/ or reduce erosion impacts on the site;
- Placement of excavated subsoil over spoil material;
- Placement of stripped topsoil on subsoil;

Grassing of topsoil in terms of clause PZ4 4 of this specification.

PZ3.16 NUISANCE

PZ3.16.1 Dust

At all times the Contractor shall control dust on the site, access roads, borrow pits and spoil dumps with water, chemical soil stabilisers or temporary surfacing as specified in the project specification or upon instruction of the Engineer.

Dust control shall be sufficient so as not to have significant impacts in terms of the biophysical and social environments. These impacts include visual pollution, decreased safety due to reduced visibility, health aspects, and ecological impacts due to dust particle accumulation.

On gravel or earth roads, vehicle speeds may not exceed 30km per hour.

PZ3.16.2 Noise

The operational layout of the construction site is to be designed to control and reduce noise from source (see clause PZ2 1).

Machinery and vehicle silencer units are to be maintained in good working order. Offending machinery and /or vehicles will be banned from use on site until they have been repaired.

Construction activities generating output levels of 85 dB(A) or more (excessively noisy), in residential areas, are to be confined to working hours (08h00 - 17h00) Mondays to Fridays only.

'Normal' or 'noisy' working hours may only be extended with the prior written approval of the Project Manager, who has been notified, at least 7 days in advance, of the impending work requiring extension.

The Project Manager will ensure that the neighbours are timeously forewarned of imminent noisy activities.

Should community complaints be received with regard to noise generation, the Contractor will, at the discretion of the Project Manager and Environmental Control Officer, provide an independent and registered noise monitor to undertake a survey of noise output levels from site, and implement measures to reduce noise to legislated levels.

PZ3.16.3 Visual

All site establishment components, as well as equipment, will be positioned to limit visual intrusion to neighbours (see clause PZ2 1 above).

The type and colour of roofing and cladding materials are to be selected to reduce reflection.

Security lighting (both temporary and permanent) and lighting required for specific works activities must be placed such that it is not a nuisance to residents and the general public.

PZ3.16.4 Interference with neighbours and public

No construction staff may approach site neighbours, for whatever reason, without the knowledge and permission of the Project Manager.

Complaints from neighbours and public with regard to interference from contract staff will be regarded in a serious light, and the offender(s) may be subject to disciplinary action.

PZ3.16.5 Disruption of Services

Disruption of services, e.g. road access, water and electricity, must be kept to a minimum at all times.

Where service disruption is unavoidable, the Contractor is to advise the Project Manager (at least 7 days in advance), who in turn will timeously warn the affected parties.

PZ3.17 SPECIAL ENVIRONMENTS

PZ3.17.1 Wetlands

Pipeline trenches which traverse wetlands shall be constructed as specified in the project specification. The Contractor will submit a method statement for work in wetland areas as per PZ3 1.1

Construction may not permanently alter the surface or subsurface flow of water through the wetland.

The Contractor shall submit a method statement for review at least 14 days prior to commencing construction in a wetland.

The Contractor will remove all wetland vegetation with their root ball intact. This vegetation is to be kept moist at all times. It is to be placed in the shade and covered with moistened hessian cloth until replanting, which is to be undertaken immediately surface reinstatement is complete.

No construction materials may be stockpiled in any wetland areas.

The pre-construction profile of the wetland shall be returned to one similar as before construction, with no created "ridge or channel" features present.

PZ3.17.2 River/ stream courses

The Contractor shall submit a method statement for review 14 days prior to commencing construction. The method statement should highlight (but not be confined to) the following issues:

- detailed plan of crossing including pipe protection works;
- how water flow will be diverted during construction (if applicable);
- containment of contaminated runoff and waste water;

- width of working servitude (if not already detailed in project specification);
- final expected profile of river/ stream banks;
- reinstatement and rehabilitation of river/ stream banks.

The Contractor will remove herbaceous riparian vegetation as indicated in the project specification or by the Environmental Control Officer, with their root ball intact. This vegetation is to be kept moist by means of placing it in the shade, covered with moistened hessian cloth until it is replanted.

The Contractor shall not modify the banks or bed of a water course unless as specified in the project specification.

Rocks for use in gabion baskets/reno mattresses may not be obtained from a water course.

The Contractor will not pollute any water body as a result of construction activities (see also PZ3 11).

The Contractor shall not cause any physical damage to any aspects of a water course, other than those necessary to complete the works as specified and in accordance with the accepted method statement

Where a stream or river-crossing requires the diversion of water, a method statement is to be provided to the Environmental Control Officer in this regard for review.

PZ3.18 MEASUREMENT AND PAYMENT

Measurement and payment for compliance with clauses of the specification will be made as follows. All other costs of compliance are deemed to be included in the Contractor's rates.

| Item | Unit |
|--|------|
| a) Areas occupied/ Demarcation of Site <u>Wooden Stakes</u> Supply installation and removal on completion per linear meter (i) of boundary staked..... m | |
| b) Site Clearance Site Clearance as specified shall be scheduled in SABS 1200 and shall include the costs of complying with this specification | |
| c) Conservation of Topsoil Measurement for this item will be per m3 and will be inclusive of clearing and grubbing all in one operation. Removal and replacement of topsoil as specified shall be as scheduled in the relevant SABS 1200 specification (SABS 1200 D) and shall include: <u>Grassing of temporary topsoil stockpiles</u> (i) Supply of materials and planting as specified (ii) Maintenance by watering, weeding and fertilising | |
| d) Landscape preservation and Conservation of flora <u>Transplanting of trees/ shrubs of main stem girth:</u> | |

- (i) up to 400 mm Sum
(ii) over 400 mm Sum
The rate shall include removal, replanting and watering of plants as specified.

- e) Control of Fire
Provision of fire fighting equipment as specified shall be scheduled in SABS 1200 A, AA, AD and AH.
- f) Temporary Fencing
(i) Supply, installation, maintenance and removal of temporary fencing as per specification m
- g) Nuisance
(i) Dust
Control of dust as specified shall be scheduled in the applicable SABS 1200 specification
- h) Special Environments
(i) Wetlands
Removal of vegetation with intact root zone
(minimum depth 150 mm) m²

PZ4 REINSTATEMENT AND REHABILITATION

Scope: The intention of this section is to ensure that the condition of the areas disturbed by the project are returned to a state that approximates what they were before the project or better, within reason. The concept of progressive reinstatement is fundamental to cost effective (both financial and environmental) rehabilitation of a site. This concept must be followed at all times. Where landscaping is utilised, the concept is to utilise and restore indigenous plants to the site, in terms of the concept of xeriscaping.

Reinstatement will be required for all areas disturbed by the project. For Pipeline projects, this will include the full working servitude, not just the top of actual excavation as per SABS 1200 DB (subclause 5.9.1.1)

Reinstatement and rehabilitation will ensure that all areas disturbed by the project are returned, within reason, to a state not worse than before the project commenced.

The Contractor will reinstate and rehabilitate all disturbed areas outside of the demarcated working area (as defined in terms of clause PZ3.2 or the project specification) at his own cost and to the satisfaction of the Environmental Control Officer and Project Manager.

PZ4.1 HOUSEKEEPING

All areas are to be cleared of rubble associated with construction. This includes the removal of surplus materials, excavation and disposal of consolidated waste concrete and concrete wash water, litter, etc.

All soil contaminated by hydrocarbons, for example from leaking machines, refuelling spills etc., is to be excavated to the depth of contaminant penetration, placed in 200 litre drums and removed to an appropriate landfill site.

PZ4.2 FINISHING

PZ4.2.1 Final Grading

Final levels of all disturbed areas are, where feasible in terms of the project requirement, to be consistent with the natural topography of the area.

In certain instances, it will be acceptable to reinstate rock onto a works area (e.g. Pipeline servitude), provided that that rock does not exceed 250 mm in maximum dimension and is placed in a manner consistent with the natural surrounds as indicated by the Environmental Control Officer and Project Manager.

All drainage lines affected by construction are to be reinstated to approximate their original profile. Where this is not feasible due to technical constraints, the profile is to be agreed upon by the Environmental Control Officer and Project Manager.

All compacted (disturbed) areas (including stockpile areas) are to be ripped (along contour) to a depth of 150 mm prior to the replacement of topsoil.

PZ4.2.2 Topsoiling

Topsoil is to be replaced to a minimum depth of 100 mm.

Topsoil is not to be compacted, but once replaced is to be scarified (to a depth of 50mm) consistent with the natural contour.

If insufficient topsoil is available, subsoil or similar material may be used that may be a suitable substrate after addition of soil improving substances e.g. compost, pH rectifiers (lime or gypsum) etc. Soil testing may be required at an approved facility.

PZ4.3 REINSTATEMENT OF WATER COURSES AND WETLAND AREAS

The Contractor will ensure that water course banks are returned to their original profile unless the project specification states otherwise.

The surface reinstatement of wetland areas is to ensure that no depressions remain which could act as channels for preferential water flow thereby affecting the hydrological regime of the wetland.

The Contractor will preserve all riparian and wetland vegetation for use in rehabilitation of those environments. This vegetation is to be kept moist at all times. It is to be placed in the shade and covered with moistened hessian cloth until replanting, which is to be undertaken immediately surface reinstatement is complete.

Plants are to be, as nearly as possible, replanted in areas from which they were removed.

PZ4.4 VEGETATION RE-ESTABLISHMENT

The Contractor will ensure that all areas disturbed by contract activities are revegetated to the specified standard.

This standard is deemed to be an 85 % cover with no areas in excess of 0.04 m² / m² remaining unvegetated.

Revegetation shall match the vegetation type which previously existed (e.g. kikuyu pastures are to be returned to kikuyu pasture; 'veld' grass to 'veld' grass, etc.), unless stated otherwise in the project specification.

Prior to re-grassing, and if required:

- the area is to be scarified or ripped (along contour) to a depth of 50 mm to loosen compaction.
- weeds present on site are to be removed.

Re-grassing, where required, will be either by means of seeding, instant turf (sods), sprigs or plugs as specified in the project specification or as specified by the ECO.

Where sprigs or plugs are utilised, they are to be planted at 200 mm centres. The fertiliser shall be applied as per PZ4 5.2. During summer, 25mm of irrigation shall be applied each week until reasonable (60%) ground cover has been obtained. During winter 15mm of irrigation shall be applied each week until reasonable (60%) ground cover has been obtained. The amount of irrigation to be applied will make up the difference between rainfall recorded on site and minimum requirement.

Where instant turf is utilised, it shall be laid as specified in the project specification. The fertiliser shall be applied as per PZ4 5.2. During summer, 25mm of irrigation shall be applied each week until all the turf is visibly growing. During winter 15mm of irrigation shall be applied each week until all the turf is visibly growing. The amount of irrigation to be applied will make up the difference between rainfall recorded on site and minimum requirement.

Grassing shall be undertaken by a specialist grassing Sub-contractor, unless permission is granted otherwise by the Engineer upon receipt of a written motivation from the Contractor.

The Contractor shall state in writing when the regressing operation will commence and its expected duration (dates).

Grassing in 'veld' areas is to be undertaken as per PZ4 5 below. Cynodon dactylon species may be excluded or substituted from this mixture at the discretion of the Environmental Control Officer, or as specified in the project specification. The seed bulk may be made up with the Eragrostis tef.

PZ4.5 "VELD GRASS" GRASSING SPECIFICATION

The area to be grassed should be estimated and converted to hectares, e.g. 100m X 100m = 10 000m² = 1ha. All fertilizer and seeding rates used in this specification are with respect to hectares.

PZ4.5.1 Regional areas

For re-grassing three distinctive areas exist. These are defined as:

- the Coastal area (a narrow band running from the coast to ≈15km inland of the coast)
- the Coastal hinterland (a broad band (≈50km wide), generally defined as westwards of the coastal belt, and below 800m a.s.l.)
- the area above ≈ 800m a.s.l. (also called Midlands area).

PZ4.5.2 Fertiliser

Standard 2:3:2 (N:P:K) fertiliser shall be used on all sites.

The rate of application will be:

- 200 kg/ha in the Coastal Hinterland areas, and
- 300 kg/ha in the Midlands and Coastal areas.

PZ4.5.3 Planting times

Summer (includes Spring) is considered to be between the 1 September and 28 (29) February.

Winter (includes Autumn) is considered to be between 1 March and 31 August.

Re-grassing will be undertaken (as far as possible) in summer as germination and establishment of grasses is most effective, assuming reasonable spring rains.

Vegetation re-establishment is likely in many cases to be held off until this suitable growing season.

Hydroseeding with a winter mix will only be specified where regressing is urgently required and cannot wait until the summer season. In this case irrigation will be required as per PZ4 5.4 below.

PZ4.5.4 Establishment and maintenance

During summer, 25mm of irrigation shall be applied each week until reasonable (60%) ground cover has been obtained.

During winter (where annual rye grass is specified) 15mm of irrigation shall be applied each week until reasonable (60%) ground cover has been obtained.

If rapid establishment is required, additional watering may be necessary as specified in the project specification

The amount of irrigation to be applied will make up the difference between rainfall recorded on site and the minimum requirement.

PZ4.5.5 Grass Seed Selection and Application Rates

The specific seed selection and application rates for each of the defined areas are covered separately, as follows.

PZ4.5.5.1 Coastal area

Summer mix (1 September - 28 February)

| Grass species | Common name | General application rate (kg/ha) |
|--------------------|--------------------|----------------------------------|
| Eragrostis tef | Teff | 5 |
| Eragrostis curvula | Weeping lovegrass | 10 |
| Chloris gayana | Rhodes grass | 10 |
| Digitaria eriantha | Smuts' fingergrass | 5 |
| Total | | 30 |

Winter mix (1 March - 31 August)

| Grass species | Common name | General application rate (kg/ha) |
|--------------------------------------|--------------------------|----------------------------------|
| Lolium multiflorum cultivar - Midmar | Annual/Italian rye grass | 10 |
| Eragrostis curvula | Weeping lovegrass | 10 |
| Chloris gayana | Rhodes grass | 5 |
| Total | | 25 |

PZ4.5.5.2 Coastal hinterland.

Summer mix (1 September - 28 February)

| Grass species | Common name | General application rate (kg/ha) |
|--------------------|------------------------|----------------------------------|
| Eragrostis tef | Teff | 5 |
| Eragrostis curvula | Weeping lovegrass | 10 |
| Chloris gayana | Rhodes grass | 10 |
| Cenchrus ciliaris | Blue buffalo grass | 2 |
| Cynodon dactylon | Couch/Kweek/Star grass | 10 |
| Total | | 37 |

Winter mix (1 March - 31 August)

| Grass species | Common name | General application rate (kg/ha) |
|--------------------------------------|--------------------------|----------------------------------|
| Lolium multiflorum cultivar – Midmar | Annual/Italian rye grass | 10 |
| Eragrostis curvula | Weeping lovegrass | 10 |
| Chloris gayana | Rhodes grass | 5 |
| Cenchrus ciliaris | Blue buffalo grass | 2 |
| Cynodon dactylon | Couch/Kweek/Star grass | 3 |
| Total | | 30 |

PZ4.5.5.3 Midlands area

Summer mix (1 September - 28 February)

| Grass species | Common name | General application rate (kg/ha) |
|--------------------|------------------------|----------------------------------|
| Eragrostis tef | Teff | 4 |
| Eragrostis curvula | Weeping lovegrass | 10 |
| Chloris gayana | Rhodes grass | 10 |
| Digitaria eriantha | Smuts' fingergrass | 2 |
| Cynodon dactylon | Couch/Kweek/Star grass | 2 |
| Paspalum notatum | Lawn paspalum | 2 |
| Total | | 30 |

Winter mix (1 March - 31 August)

| Grass species | Common name | General application rate (kg/ha) |
|--------------------------------------|--------------------------|----------------------------------|
| Lolium multiflorum cultivar - Midmar | Annual/Italian rye grass | 10 |
| Eragrostis curvula | Weeping lovegrass | 10 |
| Chloris gayana | Rhodes grass | 5 |
| Paspalum notatum | Lawn paspalum | 2.5 |
| Total | | 27.5 |

PZ4.5.6 Seeding methods

Two methods are recommended, namely hydroseeding and hand-broadcasting. The required method shall be as specified in the project specification.

All seed supplied should be labelled in accordance with the Government Seed Act No. 20 of 1961 and the Contractor shall be required to produce such certification, if requested by the Engineer.

PZ4.5.6.1 Hydroseeding

The Grassing Contractor shall be conversant with this method.

Cellulose pulp (consisting of either wood shavings, shredded straw, shredded paper or cotton waste) shall be added to the mix to be applied at a rate of 250 kg/ha.

In addition to the cellulose pulp, compost (consisting of either chicken litter, kraal manure, sugar cane filter cake or mushroom compost) shall be incorporated at a rate of 5m³/ha (≈100 X 50kg fertiliser bags/ha).

PZ4.5.6.2 Hand-broadcasting

Fertiliser, at the appropriate rate, is to be distributed by hand in a manner to ensure that there is an even spread of fertiliser over the site. This is to be done prior to seeding.

The seed mix is to be weighed and made up in an appropriately large container which shall be stirred to ensure no settling out of the grass seed, and a uniform distribution of the different types of seed.

The seed is to be distributed by hand in a regular grid broadcasting manner to ensure that there is an even spread of grass over the entire site.

The area seeded is to be raked over once the seed and fertiliser have been applied to incorporate these elements into the topsoil.

PZ4.5.7 General

Where there is a possibility of neighbourhood livestock grazing a rehabilitated site these should, as far as is practicable, be excluded for the first 3 months of re-grassing.

PZ4.6 LANDSCAPING

Landscaping of the site may be required as indicated in the project specification.

Compensatory planting of trees or shrubs may be required should the transplantation of such not be successful in terms of PZ3 5.5 or due to plants removed in terms of PZ3 5.4

Planting of trees will be in accordance with the following method:

- All tree holes shall be square in plan;
- Tree holes shall be a minimum of 600 mm by 600 mm square by 700 mm deep;
- Holes are to be backfilled with excavated soil in a ratio of 3:1 with compost. The compost is to be weed free and have been composted at temperatures in the order of 65°C. Where possible, any available topsoil should be placed in the hole at the level where the tree rootball will rest. A handful (half-a-cup) of each Superphosphate and 2.3.2 should be mixed into the soil-compost mix;
- The tree holes are to be backfilled to the point where the tree and its rootball are in the desired position. The tree is to be removed temporarily and the hole filled with water and allowed to drain away. This operation of watering and draining should be repeated at least four times in order that the surrounding ground and hole are thoroughly moist. The tree is then to be replaced and the remaining soil replaced;
- All trees shall be tied (using a tree tie) to a suitable timber stake planted in the ground to a depth of at least 500 mm. The stake shall have a minimum diameter of 35 mm and shall be at least 300 mm higher than the planted tree;
- Water retaining basins of at least 500 mm diameters are to be formed around each tree;
- The Contractor is to apply at least 10 litres of water per tree per fortnight for a period of at least 3 months.

The planting of shrubs will be in accordance with the tree planting method with the exception that the holes are to be a minimum of 400 mm by 400 mm square by 500 mm deep, and that the tree stakes and ties are not required.

PZ4.7 ALIEN PLANT CONTROL

All sites disturbed by construction activities will be monitored for colonisation by invasive alien plant species.

The Environmental Control Officer will identify those plants which require removal during both the construction and maintenance period, for the Contractor's action.

The Environmental Control Officer will provide advice as to effective methods of removal and control of alien plant species.

PZ4.8 MEASUREMENT AND PAYMENT

Measurement and payment for compliance with clauses of the specification will be made as follows. All other costs of compliance are deemed to be included in the Contractor's rates.

| <u>Item</u> | <u>Unit</u> |
|--|----------------------|
| (a) Finishing | |
| (i) Final Grading | |
| Ripping of compacted and disturbed areas to 150 mm depth..... | m ² |
| Handtrimming | m ² |
| (ii) Topsoiling | |
| Replacement of topsoil to minimum depth of 100 mm or such other depth as specified in the project specification..... | m ² |
| Scarification of replaced topsoil to depth of 50 mm and final hand trimming using spades and rakes | m ² |
| Soil testing at an approved facility sum per sample | |
| Soil Improvements required prior to vegetation re-establishment: | |
| Compost (supplied, placed and mixed into the soil) | ton |
| pH Rectifiers (supplied, placed and mixed into the soil) | kg or ton |
| Fertiliser (2:3:2) (supplied, placed and mixed into the soil)..... | ton |
| (iii) Vegetation Re-establishment | |
| Hand-broadcasting with appropriate grass seed mix..... | m ² or ha |
| Deemed to be inclusive of soil preparation and improvements, materials and labour as specified in PZ4 5. | |
| Hydroseeding with appropriate grass seed mix..... | m ² or ha |
| Deemed to be inclusive of soil preparation and improvements, materials and labour as specified in PZ4 5. | |
| Sprig planting..... | m ² or ha |
| Deemed to be inclusive of soil preparation and improvements, materials and labour | |
| Plug planting | m ² or ha |

Deemed to be inclusive of soil preparation and improvements, materials and labour

Instant Turf m² or ha

Deemed to be inclusive of soil preparation and improvements, materials and labour

Maintenance m² or ha

Deemed to be inclusive of watering, weeding, etc.

(c) Landscaping

(i) Planting of trees in bag sizes:

a) up to and including 10 litre Sum

b) over 10 litre up to and including 20 litre..... Sum

c) over 20 litre Sum

(ii) Planting of shrubs in bag sizes:

a) up to and including 10 litre Sum

b) over 10 litre up to and including 20 litre..... Sum

The rate shall include supply of plants and materials, preparation of plant holes, planting and maintenance until established

PUBLIC COMPLAINTS REGISTER

| DATE | COMPLAINANTS NAME | DESIGNATION/ AFFILIATION | REASON FOR COMPLAINT | ACTION TAKEN | ACTION BY | ACTION BY DATE | ACHIEVED BY DATE | DATE REFERRED TO NW environmental control officer |
|------|----------------------|-----------------------------|-------------------------|--------------|-----------|-------------------|---------------------|---|
| | | | | | | | | |
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| | | | | | | | | |

MONITORING OF COMPLIANCE WITH ENVIRONMENTAL SPECIFICATIONS

PROJECT NAME:

CONTRACT NUMBER:

PROJECT MANAGER:

ENGINEER'S REPRESENTATIVE / SUPERVISOR:

CONTRACTOR:

CONTRACT PERIOD
(including start and completion dates):

PERIOD COVERED:

REPORT PREPARED BY:

Signature

ENVIRONMENTAL CONTROL OFFICER REPORT

PROJECT NAME:

CONTRACT N°

DATE OF SITE INSPECTIONS DURING REPORTING PERIOD:

| Specification Breach | Spec. No. | Remedial Action Recommended | Due Date | Authority Responsible | Action Taken |
|-----------------------------|------------------|------------------------------------|-----------------|------------------------------|---------------------|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

PUBLIC COMPLAINTS

| Complainant | Designation/ Affiliation | Date of complaint | Reason for Complaint | Action taken and date |
|-------------|-----------------------------|----------------------|-------------------------|--------------------------|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

GOOD PERFORMANCE REPORT

List any aspects of the Contract in which the Contractor is performing well and beyond that which is required in terms of the specification.

Photographs

Include photographs which illustrate aspects of non-compliance and good performance.

| | |
|--------------|--------------|
| Photograph 1 | Photograph 2 |
| Caption | Caption |

PROJECT SPECIFICATION

PORTION 3: PARTICULAR SPECIFICATION

PC TOPSOILING AND GRASSING

PC 1 SCOPE

This specification covers the requirements for topsoiling and grassing required for road cut banks, reservoir embankments, reinstatement of sensitive areas around structures and along Pipeline routes.

PC 2 SUPPORTING SPECIFICATIONS

The following Specifications shall, inter alia, form part of this Particular Specification:

| | |
|---------------|------------------------------|
| SABS 1200 DM: | Earthworks (Roads, Subgrade) |
| SABS 1200 D: | Earthworks |
| SABS 1200 DA: | Earthworks (Small Works) |
| SABS 1200 DB: | Earthworks (Pipe Trenches) |

PC 3 MATERIALS

3.1 Fertilizer

The type of fertilizer used shall be one or more of the following:

- a) 2:3:2(30)Zn
- b) Limestone Ammonium-Nitrate
- c) Agricultural Lime
- d) Super Phosphate

3.2 Grass Cuttings

Grass cuttings shall be of an approved type of local Kweek or Kikuyu showing strong growth tendencies.

3.3 Hydroseed Mixture

Only good quality fresh seed shall be used and the types of seed in the seed mixture shall be as follows:

| | |
|--------------------|----------------------------|
| Eragrostis Curvula | 3,0 |
| Eragrostis Teff | 3,0 |
| Festuca K31 | 5,0 |
| Chloris gayana | 10,0 |
| Cynodon Dactylon | 10,0 |
| Lolium Multiflorum | <u>7,0</u> |
| | <u>38,0</u> kg per hectare |

3.4 Anti-Erosion Compounds

Anti-erosion compounds shall consist of a plastic material in dispersion which can be sprayed on the soil to bind and protect it against erosion, such as "Surfsol" or a similar approved compound.

PC 4 PLANT

4.1 Topsoiling and Grass Planting

Except for vehicles necessary for carting topsoil and grass cuttings to the work areas the spreading of topsoil and planting of grass cuttings, etc., shall be done manually.

4.2 Hydroseeding

The hydroseeding mixture, fertilizer, stabilizer and mulch shall be applied using an approved hydroseeding machine capable of even distribution at a rate of application of not less than 38 kg of seed mixture per hectare.

PC 5 CONSTRUCTION

5.1 Topsoiling

This work comprises the topsoiling of cut banks above the level of the open side drain, where directed by the Engineer.

The surface to be topsoiled shall be prepared by trimming to a semi-rough surface finish, essential for the proper placing of topsoil.

Material for topsoiling shall be recovered from stockpiles, formed as part of site preparation, and transported to cut banks for distribution.

The topsoil shall be spread to cover the whole surface area forming a loose layer of topsoil nowhere less than 100mm in thickness measured after trimming.

The transport of topsoil up to a distance of 2 Km from stockpile will be regarded as free haul.

After completion of topsoiling the Contractor shall protect and maintain the topsoiled areas and bear all costs involved in repairs to damaged work.

5.2 Grassing

Topsoiled cut bank surfaces shall be protected by grassing which shall consist of establishing and maintaining grass growth by either grass planting or hydroseeding, as directed by the Engineer.

Grassing shall be carried out at the earliest convenient stage in the construction programme, be arranged to suit seasonal weather conditions and shall be completed in a minimum of three planting

operations to suit hand over of the Road in Sections, as described under Clause PS 5.

Full responsibility for the establishment and maintenance of the grassed areas shall rest with the Contractor until the end of the maintenance period.

a) Grass Planting

The area to be planted shall be prepared and fertilized using chemical fertilizer 2:3:2(30)Zn at an application rate of 500 kg per hectare.

Planting of the grass shall be carried out manually by the method of continuous root planting in rows not more than 300mm apart. Planting shall only take place in moist soil and on completion, each planted area shall be well watered.

Once grass has been established a top-dressing of limestone ammonium-nitrate shall be applied at an application rate of 300 kg per hectare.

Maintenance shall include watering, re-fertilization if necessary, re-grassing of unsatisfactory areas, weeding and any other work the Contractor may consider necessary for the establishment of a satisfactory stand of grass.

Maintenance shall also include the repair of erosion damage to grassed areas.

b) Hydroseeding

Fertilizer, stabilizer and mulch shall be added to the hydroseed mix, as specified under Subclause PD 3.3 at the following application rates:

- | | | |
|------|-------------|--|
| i) | Fertilizer: | 500 kg of 2:3:2(30)Zn per hectare |
| ii) | Stabilizer: | 400 kg of Surfsol A.C. or equivalent per hectare |
| iii) | Mulch: | 500 kg of Woodpulp or equivalent per hectare |

Hydroseeding shall then be applied by machine at an application rate of not less than 38 kg of seed mixture per hectare.

PC 6

TOLERANCES

6.1 **Topsoil**

Topsoil in the loose shall nowhere measure less than 100mm in thickness after trimming.

6.2 Grass Planting

Grass planting shall be in rows not more than 300mm apart.

PC 7 TESTING

7.1 Grass Planting

Success of grass planting will be determined by the achievement of satisfactory cover, defined as a living grass in which no bare patches exist larger than 0,1m².

7.2 Hydroseeding

Success of hydroseeding will be determined by the achievement of satisfactory cover, defined as a living grass cover over 75% of the seeded area in which no bare patches exist larger than 0,01m².

PC 8 MEASUREMENT AND PAYMENT

8.1 Topsoiling

Topsoiling will be measured in square metres (m²) of slope area covered.

The rate shall cover the supply of topsoil from stockpile, transport from the stockpile inside a free haul distance of 2 Km, spreading in a manner described, trimming and finishing.

8.2 Overhaul of Topsoil

Overhaul of topsoil will be measured in cubic-metre-kilometer (m³.km).

The overhaul distance shall be the distance in kilometres between centres of position of loading and its authorised positions of placing, less the 2 Km free haul.

The volume of the overhauled material shall be determined by converting area and thickness of completed work to cubic metres.

8.3 Grass Planting

The work in grass planting will be measured in square metres (m²) of area effectively covered with a satisfactory cover of living grass.

Measurement will be on a tentative basis until the final measure at the end of the maintenance period, payment being made as follows:

- a) As a progress payment of 60 percent of the tendered rate, over the area planted, on completion of the work; and
- b) As a final payment at the end of the maintenance period at the full tendered rate over the area covered by a satisfactory cover of grass.

The rate shall cover the supply of grass and fertilizer, preparation, application of fertilizer, planting and for the maintenance of the planted area.

8.4 **Hydroseeding**

Hydroseeding will be measured in square metres (m²) of slope area effectively covered with a satisfactory stand of grass.

Measurement will be on a tentative basis until the final measure at the end of the maintenance period, payment being made as follows:

- a) As a progress payment of 60 percent of the tendered rate, over the area seeded, on completion of the work: and
- b) As a final payment at the end of the maintenance period at the full tendered rate over the area covered by a satisfactory cover of grass.

The rate tendered shall include for the supply of all materials (including fertilizer, stabilizer and mulch), preparation, application and for the maintenance of the seeded area.

PROJECT SPECIFICATION

PORTION 3: PARTICULAR SPECIFICATION

C1W **100 TON WEIGHBRIDGES (10969-001-2040-R-0001)**

10969/001/2040/R/0001 – Rev T1

**SAFDA MKHUZE RAIL SIDING
PROJECT**

**ENGINEERING SPECIFICATION
WEIGHBRIDGES**

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CONFIDENTIAL Any information contained herein is to be treated as confidential and may not be divulged to any other party without the prior written approval of Bosch Projects (Pty) Ltd and South African Farmers Development Association.

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TECHNICAL SPECIFICATION

1. ABBREVIATIONS, TERMS AND DEFINITIONS

The following abbreviations, terms and definitions shall apply for this contract:

1.1 Abbreviations

| | |
|-----|---|
| dc | Direct Current |
| DB | Distribution Board |
| DOL | Electrical Direct On-line Starting of Electric Motors |
| I/O | Input / Output |
| ISO | International Standards Organisation |
| LV | Low Voltage |
| mA | Milliamps |
| MCC | Motor Control Centre |
| NDT | Non-Destructive Testing |
| OEM | Original Equipment Manufacturers |
| PLC | Programmable Logic Controllers |

1.2 Terms and Definitions

In interpreting this specification, the following words shall have the meanings herein assigned:

| | |
|-----------------------------|---|
| Bidder: | means the natural or juristic person supplying the Goods and/or services as indicated in the contract. |
| Company: | means South African Farmers Development Association |
| Connection elements: | means all holding down, anchor or connection bolts including all washers, nuts, screws, spacers, shims etc. |
| Goods: | includes all equipment, materials, plant and temporary works |
| Drive Assemblies: | means all motors, gearboxes, couplings, bearings, torque arms, guards and base plates. |

Punch List Category A Items: These items effect the safe operation of the Goods.

Punch List Category B items: These items effect the completeness of the Goods.

Punch List Category C items: These items effect the aesthetics of the Goods only.

2. INTRODUCTION

The project entails construction of a transloading facility at Mkhuze Rail siding, where cane will be transferred from road trucks to rail wagons and transported by Transnet Freight Rails to the mill, a total journey length of 350kms.

2.1 Background and Overview

The cane grown in the Makhathini region currently being transported to the Felixton mill by road requires a more economically, sustainable, and efficient way of transporting the cane to the mill as of March 2021.

3. SCOPE OF WORK

The specification covers the minimum requirements for the design, supply of raw materials, manufacturing, inspecting, testing, packaging and commissioning of Above ground sugar cane Weighbridges as well as ancillaries for the Mkhuze Rail Siding project.

The technical specification is to be read in conjunction with all of its Annexures in order to obtain a complete view of the scope of work. The Equipment to be supplied by the Bidder shall include but is not limited to the following:

- a) Two Steel deck above ground Weighbridges;
- b) Computers and printing equipment;
- c) Digital indicators;
- d) Weighbridge Control Room (Existing Building);
- e) All related computer software;
- f) Traffic indicator Lights, Tagging System and PLC control system; and
- g) Surveillance system (3 camera's).

Note the information supplied in this Technical Specification in the form of data, drawings, descriptions, and Equipment sizes, etc, is intended to serve as a guide to the requirements of the Purchaser. The Bidder shall however be responsible for the performance of the Equipment and shall verify and confirm all size selections. Should the Bidder not be in agreement with the concepts presented, alternative concepts and designs shall be offered with full justification for the change.

It is preferred that only proven technologies be incorporated into the design of all Equipment. However, if the Bidder believes that there are significant savings to be made by offering alternative technologies, it is encouraged to include details of these alternatives clearly outlining their advantages and cost implications in the tender submission, in addition to the proven/requested technology option. The acceptance of the information in this Technical Specification shall in no way relieve the Bidder of its responsibilities and obligations in terms of the design and engineering performance of the Works.

3.1 Scope Inclusions

- a) Project management of this Contract's scope of work including planning, scheduling and reporting to the Purchaser and the Engineer;
- b) Implementation of an appropriate quality system and quality control;
- c) Submission of all documentation, drawings and technical data as outlined in the schedule of Documents and Drawings included in this Technical Specification as well as those required for statutory regulation and project control;
- d) Selection of suitable materials of construction and appropriate codes of practice, standards and specifications applicable to the Works where not already specified herein;
- e) Design, manufacture, procurement and supply of all mechanical, structural, electrical and instrumentation Equipment and Materials including all service facilities;
- f) Supply of all related software and licences if applicable;
- g) Assizing of weighbridges in accordance with local regulations;
- h) Surface preparation, protection coatings, painting and finishing of all Equipment and Materials;
- i) Workshop and Site inspections including NDT and factory acceptance testing of electrical equipment as per the relevant codes and standards;
- j) Packing, marking and protection of all Equipment for shipping/transport including loading supervision were necessary;
- k) Supervise the positioning, assembly, alignment, and installation of all Equipment;
- l) A maintenance and Training of the Purchaser's/Client's staff during first year of operations;
- m) Pre-commissioning, commissioning, trial operation, performance testing and punch listing activities;
- n) The supply of any special Equipment required for erection, commissioning and performance testing of the Equipment as required;
- o) Performance Guarantee and Warranty;
- p) A programme indicating manufacturing and delivery schedule; and

- q) Supply of all equipment and personnel required to comply with all local regulations;

3.2 Scope Exclusions

The following nominated items are specifically excluded from the scope of supply:

- a) Overall project management of this project;
- b) Construction power and water;
- c) Environmental impact assessments;
- d) Environmental impact management plans;
- e) Civil Works – foundations, grouting, concrete floors and earth works;

3.3 Terminal Points

| Description | Terminal Point | In/Out |
|-----------------|---|----------|
| Civil | Top of concrete level | In / Out |
| Electrical | Outgoing breaker cable terminals in building distribution board | In |
| Instrumentation | Network cables to control room IT system | Out |

Table 3-1 – Terminal Points

4. OVERALL DESIGN PARAMETERS

The design of the weighbridges shall meet the following parameters:

| Description | Units | Design Values |
|---|---------|----------------|
| Length | m | 22 |
| Width | m | 3.5 (Standard) |
| Rated Capacity (inclusive of all dynamic loads) | kg | 100,000 |
| Overload Capacity | % | 50 |
| Maximum time between weightings | seconds | 100 |
| Accuracy | kg | +50kg |
| Calibration Interval | months | >6 |

Table 4-1 – Design parameters

4.1 Design and Operation

All Equipment shall be designed for reliable continuous operation based on a 7-day work week, with 24 hours of operation per day and 98% availability. When designing and selecting Equipment the Bidder shall take into account commonality between Equipment to reduce spares holdings.

5. DETAILED SCOPE OF WORKS

5.1 Process

The cane will be delivered by truck and trailer combinations. When these loaded trucks enter the rail siding, it is grossed over the “In” weighbridge. Once offloading has been completed, its masses (tare mass) over the “Out” weighbridge before leaving the rail siding. The computer shall calculate the net mass by taking the difference of the gross mass and the tare mass.

One “In” weighbridge will be positioned at the entrance to handle the incoming traffic and One “Out” weighbridge will be positioned at the exit to accommodate outgoing traffic.

5.2 Mechanical

- a) There shall be two new weighbridges supplied under this contract.
- b) All weighbridges shall be of a steel deck surface mounted, on load cells (integral cables and mountings) suitable for all weather conditions.
- c) The weighbridges will be operating in a moderate to highly corrosive environment (cane juice) and the bidder must indicate what form of corrosion protection he is offering
- d) The load cell mounting assembly shall be constructed to perform as a cradle assembly which is free to move in the horizontal axes.
- e) The one side of the weighbridge will open for maintenance and cleaning purposes.
- f) The Bidder shall also provide a sealing arrangement to limit the ingress of dirt into the area underneath the decks.
- g) The weighbridge scale shall be fully electronic in design and shall not incorporate any mechanical weighing including check rods, flexures, or chain links for stabilization.
- h) The weighbridges shall also be fitted with suitable wheel guide rails on both sides of the weighbridges.

5.3 Electrical

- a) The incoming LV (low voltage) and Substation building supply will be provided by others.
- b) A dedicated 220V supply point will be provided within 100m of the weighbridge digitiser installation in the Mkhuze Siding Main building.
- c) The Bidder is responsible for all interconnecting cabling and racking where required, including providing power where required from the supply point.

- d) The Bidder shall provide all power and control cabling to the Mkhuze Siding Main building including termination and junction boxes. The bidder will supply his/ her own sub distribution board.
- e) The Bidder shall install all power and control cabling in cable routes to be provided by another contractor;
- f) The Bidder shall also provide a suitable UPS and ensure adequate connection thereof to the earthing protection ring installed by another contractor. The UPS shall allow for back-up power of no less than twenty (20) minutes.

5.4 Instrumentation

- a) The Bidder shall allow for a complete control system including but not limited to PLC hardware and software, SCADA and operator interface hardware and software, field equipment and all associated cables, fittings, cable supports, and all other materials required for the system.
- b) The system shall be highly automated in that all monitoring and control functions shall be accomplished wherever possible by the control system.
- c) The system shall be controlled from the weighing system control room located at in the building. This room will be air conditioned and designed to be suitable for the installation of electronic equipment by others.
- d) The transport control system shall be designed such that a failure of any single piece of equipment will not stop the operation of the weighing system.
- e) The following shall be supplied and installed in the weighbridge control room;
 - i) One digital indicator per weighbridge with the following facilities, Company identity plus address, 1000 weight memories, Consecutive numbering and Time and date.
 - ii) One computer terminal linked to each of the weighbridges and a suitable printer. The terminal shall include suitable weighing software, two serial port and two parallel ports (serial ports RS232 with the format of the output string programmable);
- f) The preferred signal type for all device communication shall be:
 - i) Analogue signals - 4-20mA
 - ii) Digital signals - 24V dc
 - iii) MCC/PLC Interface - Hardwired (Interposing relays 24V dc)
 - iv) Communications network – Ethernet
- g) Every input and output to the field shall have a fused disconnect terminal. All discrete signals shall be 24V dc supply as furnished by redundant power supplies.

- h) All weighing systems will communicate with the PLC SCADA system in the control room. Details of compatibility requirements are not available as yet and will be finalized prior to contract award.

5.4.1 Transport Control System

This transport control system shall comprise of a system that allows efficient continuous monitoring and weighing of all trucks entering the Rail Siding. A combination of traffic lights and infra-red beams shall ensure that trucks are positioned and parked on the weighbridge for a minimum time. Cameras shall ensure security to negate multiple weighing's of the same load.

a) Traffic Lights

- i) Single traffic lights with red and green lamps shall be positioned as shown in **ANNEXURE 3 – TRAFFIC CONTROL SYSTEM**
- ii) E-tag readers to be located ahead of each weighbridge

b) In Weighbridge

- i) Once the system has captured the e-tag vehicle data, the weighbridge is clear and the scale is zeroed, the system will change the incoming traffic light from red to green allowing the truck to enter the weighbridge.
- ii) Once the weight has been taken the system will change the entry light from green to red and the light at the exit of the weighbridge to from red to green allowing the truck to proceed.
- iii) Traffic lights shall be interlocked with the scale such that the scale has to be zeroed before allowing traffic onto the weighbridge and the weight has to have been taken prior to the exit light changing to green.
- iv) Once the vehicle has exited the weighbridge the exit traffic light must revert to red
- v) The traffic light at hold point HP3 shall be operated manually from the control clerk's desk.

c) Out Weighbridge

- i) Once the vehicle has been unloaded under the spiller crane and the Out Weighbridge is free it will enter the weighbridge after passing through the exit e-tag reader
- ii) The system will capture both the vehicle e-tag detail plus it's mass where upon the exit traffic light is set to green allowing the vehicle to exit the site. On moving off the scale the exit light will revert to red.
- iii) Traffic lights shall be low voltage type with suitable "hoods" to allow clear vision in bright sunlight. Poles shall be steel suitably protected against corrosion and mounted on concrete plinths.

d) Vehicle Positioning

- i) Infra-red beams shall be installed at either end of the weighbridge positioned such that when a truck is centralized on the weighbridge neither beam is broken. If either beam is broken, then the scale shall be interlocked with the beams such that the weight cannot be taken. Only when the truck is in the correct position on the weighbridge can the weight be taken.
- ii) Infra-red beams shall be rugged units and have been proven for long term use in similar applications.

e) Cameras

- i) A camera fitted with suitable zoom lens shall be installed on top of the spiller crane to overlook the rail wagons in order for the control clerk to be able to clearly read and capture the wagon number.
- ii) Surveillance Camera's shall be fitted to the entry of each weighbridge (not linked to the PLC) and record to a hard drive capable of recording for a minimum of 72 hours.
- iii) The control clerk shall be able to view all three cameras on one screen.

f) Monitoring Equipment

- i) The transport monitoring system shall comprise of a PC (one per weighbridge) running suitable software to provide an operator interface, a PLC or suitable proprietary hardware to control and monitor the traffic lights, infra-red positioning and the camera initiation.
- ii) The system PC/PLC may comprise of proprietary hardware and software but shall then include for the cost of annual support, maintenance and 24-hour standby support.
- iii) The PC's screens shall be a minimum 19" LED type and of a make and model readily available in South Africa.
- iv) The server shall have adequate memory/hard disc space to store the information for the time required.
- v) There shall be a data interface from the weighing system to the transport system to allow for the necessary interlocks between the two except for cameras.

g) Communications Network

The entire system shall be networked using Ethernet and suitable switches. The design and components of this local network are included within the scope. All

necessary programming for the operation of the system as described above is included in the scope.

5.5 Civil and Structural

5.5.1 Concrete Requirements

The Bidder shall provide conceptual drawings of concrete requirements for ramps and weighbridge decks. The Bidders drawings will indicate the following design parameters:

- a) Entrance and exit ramp length, width, gradient, vehicle wheel guides and kerbing details, cast in items, details of sacrificial platework in kerbing to prevent concrete damage, textured finish of exposed concrete surfaces to ensure vehicle operations during all weather conditions.
- b) Cast in angles and joint details between ramps and weighbridge deck.
- c) Weighbridge deck length, width, cross fall and position of drainage sleeves, vehicle wheel guides and kerbing details, cast in items and conduits.
- d) Terminal box for conduits, number of pull wires in conduits, position of load cells and shape of load cells box outs in concrete (including dummy load cells if required).
- e) Clearances and cross fall of concrete slab below the weighbridge deck.
- f) Position of conduits between terminal box and PC/PLC location in the Weighbridge Control Building.
- g) Unfactored loads at each load cell position, stating separate horizontal and vertical loads for self-weight of the concrete and vehicle / load cell design loads, for foundation design by others.

6. GENERAL REQUIREMENTS

6.1 Units

The metric system of units shall be adopted for this project.

6.2 Built in items

The Bidder must establish the full requirements relating to all built-in items (i.e. electrical conduits, steel platework, bolts, cast in items, etc), and arrange for their earliest delivery to Site to suit the programme.

6.3 Materials and Finishing

Materials of construction and finishes shall be selected to withstand all environmental exposure conditions, internally and externally. Particular attention to protection of the weighbridge steel structural elements is required. All inside and outside surfaces shall be painted in accordance with the Project Specific

Standards but excluding final coat on structural steel work and mechanical vessels unless otherwise approved by the Purchaser and the Engineer. All materials, where applicable, shall conform to the Project Specific Standards in respect to quality, manufacture, testing and performance.

6.4 Life Span

All Equipment shall be designed for a minimum lifespan of 25 years.

6.5 Corrosion Allowance

A corrosion allowance on steel work shall be made were necessary to ensure the life span period is achieved.

The Bidder shall submit Painting and Corrosion Protection specification, with the tender, for approval by the Engineer.

6.6 Ease of Operation and Maintenance

The Equipment shall be designed and constructed for ease of operation and maintenance to ensure the availability, reliability, operating requirements and time efficiencies stated in this Technical Specification are achieved and maintained throughout the lifetime of the Equipment.

The Bidder shall provide as part of the operation and maintenances manual, a specification and procedure for the safest and most efficient way to carry out maintenance and cleaning of all Equipment. In addition, the Bidder shall supply all specialised tools and facilities (fixed and mobile) to enable safe access and efficient maintenance of the Equipment.

6.7 Post Installation Support and Breakdown Response

The ability of the bidder to provide post installation support, servicing and response to breakdowns will be an important consideration in the adjudication of bids.

The bidder is to indicate the nearest location to the site and capability of his support centres and give a guarantee of response time in the event of a breakdown call-out

6.8 Marking, Packing and Shipping

All Equipment shall be suitably marked and correctly packed to prevent damage during loading, transportation and offloading as well as to ensure ease of storage, retrieval and unpacking on Site. The Bidder shall be required to make good all loading damage.

The Bidder shall ensure that they are fully conversant with all packing and shipping requirements.

All invoices and shipping documentation (Bills of Lading and packing lists) shall strictly match in terms of detail.

Certificates of compliance shall also be included in the shipping documentation i.e. electric cables supplied from EU, UK, RSA and shall have the appropriate certificate accompanying the shipment.

6.9 Spare Parts

The Bidder shall make allowance for the supply of all necessary spares, which will be required during the start-up, commissioning and trial operation of the Works and until the Works are suitable for commercial operation.

The bidder will indicate the essential spares he will hold in stock in his local agency/support premises.

6.10 Codes and Standards

Unless specified otherwise, all materials and workmanship shall be of a standard recognised within the industry generally as being the most appropriate standard for the type of work concerned and completely fit and suitable for the duties required of the Equipment.

6.11 Quality Control

The Bidder shall be required to submit to the Engineer for approval a Quality Control Plan (QCP) that shall conform to the requirements of ISO 9001 (2000).

6.12 Inspection and Inspection Authorities

The Bidder shall give the Engineer and the Purchaser full opportunity to inspect progress, measurements, materials and workmanship associated with the Works.

6.13 Installation Supervision

The Bidder shall provide an experienced and skilled installation supervisor/s as required to monitor, advise and assist the main contractor where necessary in all aspects of the mechanical, structural, electrical and instrumentation installation.

The Bidders Installation Supervisor/s in consultation with the Purchaser's Site Manager and the Engineer shall be required to make such adjustments as are necessary to enable construction to proceed safely and efficiently.

The Bidders Installation Supervisor/s will not directly control any personal associated with the Installation Contractor except in a situation where specialist knowledge of the supplied Equipment is required.

The Bidders Installation Supervisor/s shall be fluent in the English language.

6.14 Training

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The Bidder shall develop and submit to the Purchaser and the Engineer a comprehensive training manual in English for all Equipment to be supplied

In addition, the Bidder shall lead, direct and implement all training activities up to the point of Provisional Acceptance by the Purchaser/Client. Training shall be carried out using the Bidder's own resources, the resources of the Installation Contractor and the Purchaser's/Client's future operating, maintenance and supervisory personnel, as selected.

7. TESTS ON COMPLETION AND PROVISIONAL ACCEPTANCE

The required Tests on Completion shall consist of the following:

- Pre-commissioning tests;
- Commissioning tests;
- Trial operation.

7.1 Commissioning and Testing plan

The commissioning of the Equipment will take place after the Bidder has issued a Notice of Completion Certificate and in accordance with an integrated commissioning plan for the entire project.

7.2 Commissioning and Testing manual

The Bidder shall be required to submit to the Purchaser/Purchaser's Commissioning Manager a commissioning and testing manual.

7.3 Bidder's Commissioning Supervision

The Bidder shall appoint an appropriately skilled and experienced Commissioning Supervisor/s as soon as is practicable after this Contract has been awarded to lead, co-ordinate and carry out the various commissioning activities.

Note: The Bidder/Bidders commissioning supervisor shall not be relieved of any responsibilities, obligations or liabilities under the Contract when the Purchaser's/Client personnel are operating the Equipment under the direction or supervision of the Bidder during Training or Test on Completion.

7.4 Pre-Commissioning Tests

The pre-commissioning tests shall be carried out after the Bidder has issued the Purchaser's Commissioning Manager with commissioning and testing manuals and the relevant construction drawings.

7.5 Commissioning Tests

The Bidder shall, as soon as is practicable after carrying out the pre-commissioning tests on the Equipment/Works and once all **Punch List** items have been attended to, carry out the commissioning tests.

7.6 Trial Operation

As soon as practicable after completion of the commissioning tests, a trial operation of the Equipment shall take place. During this period the Bidder/Bidder's Commissioning Supervisor shall operate the Equipment/Works with the assistance of the Installation Contractor. These tests shall demonstrate to the Purchaser and the Client that the Equipment/Works and systems are complete, free of defects, safe for operation and operate in accordance with the Requirements outlined in this Technical Specification.

7.7 Provisional Acceptance Certificate

The Works shall be provisionally accepted when all pre-commissioning, commissioning and trial operation tests have been passed and all **Punch List** items have been attended to. Prior to Provisional Acceptance the Bidder shall demonstrate to the Purchaser and/or the Engineer, the following:

- a) That the Bidder has completed all Works, supplied all Equipment and Materials and carried out all commissioning and testing activities, except for items of an unimportant nature which do not affect the safe and reliable start-up and commercial operation of the Works and which are not required in terms of the Laws to be completed by start-up and for commercial operation of the Works
- b) That the Equipment is ready for commercial operation;
- c) That the Purchaser's Commissioning Manager has accepted that the Works have passed all pre-commissioning, commissioning and trial operation testing and checks;
- d) That the Works are safe for use and all safety devices and interlocks have been proven to function correctly and have been accepted by the Purchaser's Commissioning Manager;
- e) That the Bidder has conducted the training of the Purchaser's/Client's personnel as required to operate the Works properly and safely and in accordance with the training manuals supplied by the Bidder.
- f) The Bidder has supplied to the Client all manuals, Data books, drawings and other data required to operate, strip, maintain and reassemble the Works along with all specialised tools as required;
- g) All QCP documents have been completed and signed off by the relevant Parties;

Thereafter the Purchaser shall arrange for performance testing to be conducted as soon as practicable after a Provisional Acceptance Certificate has been issued.

8. PERFORMANCE TESTING AND FINAL ACCEPTANCE

Performance testing shall be carried out by the Client/Purchaser and the Client's/Purchaser's staff as soon as reasonably practicable after a Provisional Acceptance Certificate has been issued and as mutually agreed upon with the Bidder.

8.1 Minimum Performance Guarantee Parameters

All aspects of the weighbridge performance characteristics shall comply with the latest version of the Trade Metrology Act, 1973. Relevant reference or site conditions applicable to achieving these parameters shall be specified in the Bidder's submission.

8.2 Completion and Final Acceptance

Upon the performance of the Works reaching The Guaranteed Performance Parameters as stipulated in this Technical Specification and the completion of all Punch List items, the Equipment shall be deemed to be completed. Upon successful completion the Purchaser shall execute and provide the Bidder with a Final Acceptance Certificate.

If the Purchaser does not issue the Final Acceptance Certificate within the period of ten (10) business days following the completion of the Works, then the Final Acceptance Certificate shall be deemed executed and delivered at the end of the above period of ten (10) business days.

9. PROJECT MANAGEMENT AND PROGRESS REPORTING

The Bidder shall in the tender document confirm its company's ability to implement and maintain a recognised project management, reporting and planning system, to ensure that all facets associated with this Contract are controlled from implementation through to Final Acceptance.

9.1 Two Weekly Progress Reporting

The Bidder shall maintain a system of reporting to the Purchaser and or the Engineer on a monthly basis. These reports shall include the following as a minimum:

- a) Design and Engineering progress and updates;
- b) Procurement and manufacturing progress updates;
- c) A detailed project managers report outlining current progress to date as well as any new aspects or issues which have developed that affect the project timeline and cost. These shall be accompanied by possible solutions to the problems highlighted in the report.

- d) Updated overall project plan outlining current progress against base line.

The Purchaser and the Engineer are to be notified immediately in the event that an issue, delay or potential risk arises during the execution of this Contract which may have a major effect on the project or its completion date.

10. SCHEDULE OF DRAWINGS AND DOCUMENTS

All documents, drawings and data sheets submitted by the Purchaser and Bidder throughout the course of the project including all manuals shall have the title “Mkhuze Transloading Facility”. British units may be used for reference only in addition to the metric units and shall be specified in parentheses. All bolt and screw sizes and treads shall be in accordance with the International Standards Organization (ISO).

10.1 Drawings and Documents to be Supplied by Bidder

10.1.1 General

The Schedule of Drawings and Documents constitutes a part of the Technical Specification and outlines the drawings and data to be supplied as part of the Bidder’s tender submission as well as those that will be required in the event that the Bidder is successfully awarded the Contract. The Bidder’s submission and subsequently the Contract shall not be regarded as complete unless these requirements are fully met.

10.1.2 Drawings

Drawings submitted by the Bidder with the tender submission and those drawings (electronic and hard copy) that will be required in the event that the Bidder is successfully awarded the Contract, shall be in accordance with the relevant Project Specific Standards and the followings categories:

Tender drawings: All drawings and documents submitted with the tender submission shall be the Bidder’s standard drawings and provide sufficient detail to enable the Purchaser/Engineer to comparatively adjudicate the tender. In addition these drawings shall provide enough information to allow the Purchaser to assess the overall project layout with respect to drive positions, maintenance and operational access routes and platforms, building and foundation designs, etc.

Review drawings These drawings shall be supplied by the Bidder following the successful award of this Contract. These drawings shall be in AutoCAD or compatible Format, stamped “For Review” and signed by the Bidder. These drawings shall be reviewed and approved in principle by the Purchaser/Engineer to ensure conformity to the Specifications. This review shall not relieve or mitigate the Bidder’s responsibilities in any way.

Construction drawings shall be in AutoCAD or a compatible Format, stamped “For Construction” and signed by the Bidder.

As built drawings shall detail the finally constructed Works, shall be in AutoCAD or a compatible Format, be stamped “As Built” and signed by the Bidder.

10.1.3 Information data sheets

In addition to tender drawings the Bidder shall complete all data sheet as per **ANNEXURE 1 – EQUIPMENT DATA SHEET** in sufficient detail to enable the Purchaser to comparatively adjudicate the submission with that of other Bidders.

These data sheets shall be returned with the tender submission both in hardcopy and electronic format (excel format). The Bidders tender submission shall not be considered complete and compliant should the data sheets not be filled in correctly and comprehensively.

10.1.4 Process Description and Functional Design Specification

In the event that the Bidder is successful award the Contract, the Bidder will be required to submit a detailed standard operating procedure as well as a control strategy/FDS for all Equipment.

The process description shall incorporate a written description of the process with all main control loop associated with the Equipment and be in sufficient detail to enable the operator to understand the control and operation of the various process involved.

Functional design specification shall incorporate a written description or control logic diagrams of all instrument loops and motors to enable programming of the PLC software.

10.1.5 Equipment and Instrumentation List

The Bidder’s submission shall include a list of all Equipment and instrumentation required to successfully operate all Equipment in accordance with this Technical Specifications and the Project Specific Standards supplied. In addition the Bidder shall also list any instrumentation which fall outside the terminal points but are required for the effective operation of the Equipment.

10.1.6 Installation History Schedule

The Bidder’s tender submission shall also include a list of locations, factories, sites, etc in which the Equipment to be supplied under this Contract has previously been supplied and/or installed.

10.1.7 Delivery Schedule

Following the successful award of this Contract the Bidder shall as per the schedule of documents and drawings provide the Purchaser with a

comprehensive packing and delivery schedule. This schedule shall outline the number of segments, dimensions and weights in which the Equipment and Materials are to be delivered to Site. This will help to ensure that all pieces of Equipment and Materials supplied by the Bidder are accommodated and accounted for by the Installation Contractor.

10.1.8 Installation and Erection Manual

The Bidder shall design, manufacture, and supply all Equipment and Materials to facilitate ease of installation and erection based on their respective location within the site taking into account accessibility to each location. The Bidder shall submit to the Purchaser/Purchaser's Site Manager and Engineer for approval an installation and erection manual which shall include but may not be limited to the installation and erection methodology, installation and erection QCP, all data, drawings, tolerances, preparation procedures, restrictions and limitations, etc, required to successfully install all Equipment and Materials in accordance with all relevant specifications, codes, statutory requirements and the Project Specific Standards.

All integral and internal supports, service facilities such as crawl beams, support brackets, lifting lugs, alignment plates, tabs and brackets, etc, required for the correct alignment, installation and erection of the Works as outlined in the installation and erection manual shall be supplied by the Bidder; The Bidder shall also outline and supply all specialised tools required for the installation of the Works as required.

10.1.9 Operating and Maintenance Manual

For all mechanical, electrical and instrumentation Equipment supplied under this Contract, the Bidder shall, as per the schedule of documents and drawings, provide the Purchaser/Engineer with the operating and maintenance manuals. These manuals shall also include a fully priced recommended spare parts and process consumables (for 1 year of operation) list. All lists shall highlight critical spares and consumables. These documents shall be in sufficient detail to enable the Purchaser/Client to operate, dismantle, re-assemble and adjust all parts of the Works. A specification and procedure for the safest and most efficient way to carry out maintenance and cleaning of all Equipment shall also form part of these manual. Special cognisance shall be taken to locality and skills levels of the Client's staff. The Equipment shall not be considered to be complete to commence Test on Completion and ultimately Provision Acceptance until such documents have been supplied and accepted by the Purchaser/Engineer.

10.1.10 Data Books

The Bidder shall be required to submit to the Purchaser individual Data Books for all Equipment covered by this Contract. These Data books shall include but may not be limited to the following:

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- a) All Manufacturer's Data Books
- b) All final on-site testing certificates for all parts of the Works as per the Bidder's commissioning and testing plan.
- c) A copy of the installation and erection manual as well as all relevant drawings for the equipment.
- d) A copy of the training manual and training certifications
- e) A copy of the commissioning and testing manual (including signed off check sheets).
- f) A copy of the operation and maintenance manual.
- g) A full set of "As Built" drawings
- h) All QCP documentation as signed off by the relevant parties

10.1.1 Schedule of Documents and Drawings requirements **(ALL DISCIPLINES)**

| Description | With Tender (‘x’ days after Award) | For Approval (‘x’ days after Award) | For Construction (‘x’ days after Award) | As-Built (‘x’ days before take over) |
|---|--|---|--|---|
| Programme level 2 (prelim), level 5 (after award) | 0 | 14 | 30 | |
| Outline Civil drawing with loads | 0 | 14 | 30 | |
| Overall general arrangement drawing | 0 | 14 | 30 | |
| Quality control plan | | 14 | 40 | |
| Material test certificates | | 30 | 40 | |
| Installation drawing and manual | | | 40 | |
| Training and testing manual | | | 50 | |
| Operational and maintenance manuals, | | | | 60 |
| As Built documentation & drawings | | | | 30 days After Take Over |
| Data books for all equipment | | | | 30 |
| Equipment list with estimated power consumption | 0 | | | |

Table 10-1 – Required documents

10.1.2 Clarification Period

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Upon the successful award of this Contract the Bidder shall allow for a two- three-week period to spend with the Purchaser/Engineer to further clarify the scope of works, review layout drawings, identify problems, risks, develop construction methodologies, etc. The details of this period will be further discussed upon award as this may not be a continuous period.

ANNEXURE 1 – EQUIPMENT DATA SHEET

| Drawing No. | Description |
|-----------------------|-----------------------|
| 10969-001-4054-D-0001 | Weighbridge Datasheet |
| | |
| | |

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ANNEXURE 2 - DRAWINGS

| Drawing No. | Description |
|-------------------------|-------------------|
| 10969-001-002- GGL-0001 | Overall Site Plan |
| | |

ANNEXURE 3 – TRAFFIC CONTROL SYSTEM

| Drawing No. | Description |
|------------------------|----------------------|
| 10969-001-002-PFD-0001 | Traffic Flow Diagram |
| | |

PROJECT SPECIFICATION

PORTION 3: PARTICULAR SPECIFICATION

C1P **DESIGN, SUPPLY AND INSTALL MCC PANEL (10969-001-2040-R-0005)**

10969/001/2040/R/0005 – RevT1

**SAFDA MKHUZE RAIL SIDING
PROJECT**

**ENGINEERING SPECIFICATION
PDB & MCC PANEL**

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TECHNICAL SPECIFICATION

1. ABBREVIATIONS, TERMS AND DEFINITIONS

The following abbreviations, terms and definitions shall apply for this contact:

1.1 Abbreviations

| | |
|-----|---|
| dc | Direct Current |
| DB | Distribution Board |
| DOL | Electrical Direct On-line Starting of Electric Motors |
| I/O | Input / Output |
| ISO | International Standards Organisation |
| LV | Low Voltage |
| mA | Milliamps |
| MCC | Motor Control Centre |
| NDT | Non Destructive Testing |
| OEM | Original Equipment Manufacturers |
| PLC | Programmable Logic Controllers |
| VFD | Variable Frequency Drive |

1.2 Terms and Definitions

In interpreting this specification, the following words shall have the meanings herein assigned:

| | |
|----------------------------|---|
| 3PH | means 3 phase |
| CT | means Current Transformer |
| Codes and Standards | means the design and construction codes and standards that are applicable to the Works and which are listed as Project Standards, National Standards, Local Standards and International Codes and Standards in the Codes and Standards section of the Specification |
| Contractor | means the natural or juristic person supplying the Goods and/or services as indicated in the contract. |
| Company | means South African Farmers Development Association |

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| | |
|---|---|
| Connection elements | means all holding down, anchor or connection bolts including all washers, nuts, screws, spacers, shims etc. |
| Contractor's Data Book for the Works | means the Contractor's record of all Goods certifications, and all other statutory tests and certifications required in terms of the Laws and/or the Codes and Standards |
| Drive Assemblies | means all motors, gearboxes, couplings, bearings, torque arms, guards and base plates. |
| Facility | means the Company's sugarcane transloading facility at Mkhuze, KwaZulu-Natal, South Africa |
| Goods | includes all equipment, materials, plant and temporary works |
| Inspection Authority | means an approved inspection authority appointed by the Supplier to independently inspect and approve the design and manufacture of the Goods as well as the certification of all welders to ensure compliance with the relevant Codes and Standards, and any applicable statutory requirements |
| Hz | means Hertz |
| kA | means kilo Amps |
| kV | means kilo Volt |
| kVA | means kilovolts ampere – apparent power |
| LV | means Low Voltage |
| MVA | means mega volt amperes |
| ONAN | means natural oil and natural air cooled |
| Punch List Category A items | These items effect the safe operation of the Goods |
| Punch List Category B items | These items effect the completeness of the Goods |
| Punch List Category C items | These items effect the aesthetics of the Goods only |
| QCP | means Quality Control Plan |
| R, W & B | means Red, White and Blue |
| Shall | is mandatory |
| Should | is strongly recommended |
| Third Party Inspector | means an inspection authority appointed by the Company to independently review and approve the Supplier's Data Book for the Goods to ensure that the Supplier has complied with the applicable Codes and Standards and any applicable statutory requirements. |
| V | means Volts |
| VT | means Voltage Transformer |

2. INTRODUCTION

The project entails construction of a transloading facility at Mkhuze Rail siding, where cane will be transferred from road trucks to rail wagons and transported by Transnet Freight Rails to the mill, a total journey length of 350kms.

2.1 Background and Overview

The cane grown in the Makhathini region currently being transported to the Felixton mill by road requires a more economically, sustainable, and efficient way of transporting the cane to the mill as of March 2021.

3. SCOPE OF WORK

The scope of work includes the design, manufacture, supply, delivery, offloading into position, testing and commissioning, of the new main Power Distribution Board and Hilo Spiller MCC:

The technical specification is to be read in conjunction with all of its Annexures in order to obtain a complete view of the scope of work. The Equipment to be supplied by the Contractor shall include but is not limited to the following:

- a) A new Main Power Distribution Board and Hilo Spiller MCC as specified;
- b) Supply of all equipment and personnel required to comply with the Occupational Health and Safety Act, 1993;
- c) Supply and installation of all safety equipment (guards, notices, etc.);
- d) Supply of all holding down bolts, anchors, studs or any other retaining devices as required.
- e) Any other item not specifically mentioned above but deemed necessary for the satisfactory performance of the equipment to be supplied.

Note the information supplied in this Technical Specification in the form of data, drawings, descriptions, and Equipment sizes, etc, is intended to serve as a guide to the requirements of the Purchaser. The Contractor shall however be responsible for the performance of the Equipment and shall verify and confirm all size selections. Should the Contractor not be in agreement with the concepts presented, alternative concepts and designs shall be offered with full justification for the change.

It is preferred that only proven technologies be incorporated into the design of all Equipment. However, if the Contractor believes that there are significant savings to be made by offering alternative technologies, it is encouraged to include details of these alternatives clearly outlining their advantages and cost implications in the tender submission, in addition to the proven/requested technology option.

The acceptance of the information in this Technical Specification shall in no way relieve the Contractor of its responsibilities and obligations in terms of the design and engineering performance of the Works.

3.1 Scope Inclusions

- a) Project management of this Contract's scope of work including planning, scheduling and reporting to the Purchaser and the Engineer;
- b) Implementation of an appropriate quality system and quality control;
- c) Submission of all documentation, drawings and technical data as outlined in the schedule of Documents and Drawings included in this Technical Specification as well as those required for statutory regulation and project control;
- d) Selection of suitable materials of construction and appropriate codes of practice, standards and specifications applicable to the Works where not already specified herein;
- e) Supply of all related software and licences if applicable;
- f) Surface preparation, protection coatings, painting and finishing of all Equipment and Materials;
- g) Workshop and Site inspections including NDT and factory acceptance testing of electrical equipment as per the relevant codes and standards;
- h) Packing, marking and protection of all Equipment for shipping/transport including loading supervision where necessary;
- i) Supervise the positioning, assembly, alignment, and installation of all Equipment;
- j) Pre-commissioning, commissioning, trial operation, performance testing and punch listing activities;
- k) The supply of any special Equipment required for erection, commissioning and performance testing of the Equipment as required;
- l) Performance Guarantee and Warranty;
- m) A programme indicating manufacturing and delivery schedule; and
- n) Supply of all equipment and personnel required to comply with all local regulations;

3.2 Scope Exclusions

The following nominated items are specifically excluded from the scope of supply:

- a) Overall project management of this project;
- b) Construction power and water;
- c) Environmental impact assessments;
- d) Environmental impact management plans;
- e) Civil Works – foundations, grouting, concrete floors and earth works;
- f) All power and control cables; cable racking; start/stop stations etc.;

3.3 Terminal Points

The terminal points of this scope of supply shall be as follows:

- a) Incoming power terminals of the panel provided in this scope of works;
- b) Outgoing power terminals to motors and feeders;

- c) Incoming and outgoing control signal terminals to motor control panels and emergency stops;

4. TECHNICAL SPECIFICATION

4.1 Electrical Parameters

| | |
|------------------------------|---------------------------|
| System voltages | 400 V AC 3PH and 230 V AC |
| LV fault level at Main LV DB | 10 kA |
| Lighting impulse withstand | 8 kV |
| Power frequency withstand | 2 kV |
| Phase rotation and colours | R, W and B |
| Site supplies | 400 V 3PH and 230 V 1PH |
| Frequency | 50 Hz |

4.2 Main PDB and Hilo Unloader MCC

The new Main PDB & Hilo Unloader MCC shall include but not necessarily be limited to the following:

| | | |
|---------------------|---|---|
| Name | : | Main PDB & Hilo Unloader MCC |
| Location | : | Facility building Electrical Room |
| Type | : | Floor standing, front access only, compliant to SANS 1973 – 8 |
| Supply | : | 400/230VAC (3Ph + N), 50Hz |
| Preferred Equipment | : | Schneider Electric or equivalent. All AC drives and motor overload protection to be Schneider Electric or equivalent. |
| Form | : | 4 |
| Co-ordination | : | Type 2 as per IEC 60947-4-1 and IEC 60947-4-2. |
| Type Tested | : | Partially |
| Incomer CB Type | : | MCCB with current and voltage monitoring and Class 0.2 power metering. |
| Incomer CB Rating | : | 300Amps |
| Incomer Conductor | : | 1 x 120mm ² , 4-core power cable & 1 x 70mm ² , single core earth cable. |
| MCC Busbar Rating | : | 300 Amps |
| MCC kA Rating | : | 10kA |
| Cable Entry | : | Bottom |
| Colour | : | Electrical orange |

4.2.1 Incoming Unit

The incomer tier shall be equipped as follows:

- 1 off three pole moulded case circuit breaker with both thermomagnetic and adjustable electronic trip units.
- 1 off 4 pole type 1&2 Dehnventil M TNS (FM) or equivalent combined lightning current and surge arrester with indication complete with fuse protection.
- 3 off cable live indication lights.
- 1 No 3 phase and neutral network analyzer power meter.

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- e) 1 No. phase failure and phase reversal relay.
- f) Terminals for all outgoing and incoming wiring;
- g) 1 No. 500VA 400/110V control voltage transformer with protection. This size shall be confirmed by the contractor during detailed design.

4.2.2 Hilo Hoist VFD, 110kW

This starter shall be equipped as follows:

- a) Circuit label;
- b) 1 No. 3 pole door interlocked pad lockable fused isolator, with suitably rated ultra rapid fuses to provide full range breaking capacity (overload and short circuit protection) for the protection of semi-conductors, cables and all switchgear for Variable Frequency Drives with rotary handle and auxiliary contacts as required;
- c) One suitable Variable Frequency Drive with built in protection and Contactor complete with input filters, output chokes and braking resistor;
- d) 2 No. Rittal or equivalent ventilation fans and filter units to VFD manufacturer's specifications;
- e) One 22,5mm diameter red STOP pushbutton with label;
- f) One 22,5mm diameter green START pushbutton with label;
- g) One 22,5mm diameter yellow LED TRIP indication with label;
- h) One 22,5mm diameter red LED STOP indication with label;
- i) One 22,5mm diameter green LED RUN indication with label;
- j) One selector switch: HAND/OFF/AUTO with label;
- k) One Control Circuit Fuse and MCB;
- l) Terminals for all outgoing and incoming wiring;
- m) All auxiliary relays and wiring required for control functions.

The following potential free changeover contacts for signals shall be made available to the PLC or control panel:

- a) Motor Running /Stopped;
- b) Fault Indication.

Provide for operation of the motor drive from the following:

- a) 230 Vac - Motor Stop from the Field Emergency Stop Station;
- b) 230 Vac - Motor Start/Stop from the control panel;
- c) 4-20mA Analogue Input and Output Motor Speed and Current monitoring.

4.2.3 Spiller Retract VFD, 4kW

This starter shall be equipped as follows:

- a) Circuit label;

- b) 1 No. 3 pole door interlocked pad lockable fused isolator, with suitably rated ultra rapid fuses to provide full range breaking capacity (overload and short circuit protection) for the protection of semi-conductors, cables and all switchgear for Variable Frequency Drives with rotary handle and auxiliary contacts as required;
- c) One suitable Variable Frequency Drive with built in protection and Contactor complete with input filters, output chokes;
- d) 2 No. Rittal or equivalent ventilation fans and filter units to VFD manufacturer's specifications;
- e) One 22,5mm diameter red STOP pushbutton with label;
- f) One 22,5mm diameter green START pushbutton with label;
- g) One 22,5mm diameter yellow LED TRIP indication with label;
- h) One 22,5mm diameter red LED STOP indication with label;
- i) One 22,5mm diameter green LED RUN indication with label;
- j) One selector switch: HAND/OFF/AUTO with label;
- k) One Control Circuit Fuse and MCB;
- l) Terminals for all outgoing and incoming wiring;
- m) All auxiliary relays and wiring required for control functions.

The following potential free changeover contacts for signals shall be made available to the PLC or control panel:

- a) Motor Running /Stopped;
- b) Fault Indication.

Provide for operation of the motor drive from the following:

- a) 230 Vac - Motor Stop from the Field Emergency Stop Station;
- b) 230 Vac - Motor Start/Stop from the control panel;
- c) 4-20mA Analogue Input and Output Motor Speed and Current monitoring.

4.2.4 Spiller Clamp Hydraulic Drive, DOL, 5.5kW

This starter shall be equipped as follows:

- a) Circuit label;
- b) One motor starter incorporating a suitably sized motor circuit breaker, contactor and thermal overload protection. All auxiliary contacts shall be provided as required. The main breaker circuit shall be interlocked with the rotary lockable door handle;
- c) One 22,5mm diameter red STOP pushbutton with label;
- d) One 22,5mm diameter green START pushbutton with label;
- e) One 22,5mm diameter yellow LED TRIP indication with label;
- f) One 22,5mm diameter red LED STOP indication with label;
- g) One 22,5mm diameter green LED RUN indication with label;

- h) One selector switch: HAND/OFF/AUTO with label;
- i) One Control Circuit Fuse and MCB;
- j) Terminals for all outgoing and incoming wiring;
- k) All auxiliary relays and wiring required for control functions;

The following potential free changeover contacts for signals shall be made available to the PLC:

- a) Motor Running /Stopped
- b) Fault Indication

Provide for operation of each motor drive from the following:

- a) 230 Vac - Motor Stop from the Field Emergency Stop Station.
- b) 230 Vac - Motor Start/Stop from the control panel.

4.2.5 Spiller Hoist Brake Motor, DOL, 5.5kW

This starter shall be equipped as follows:

- a) Circuit label;
- b) One motor starter incorporating a suitably sized motor circuit breaker, contactor and thermal overload protection. All auxiliary contacts shall be provided as required. The main breaker circuit shall be interlocked with the rotary lockable door handle;
- c) One 22,5mm diameter red STOP pushbutton with label;
- d) One 22,5mm diameter green START pushbutton with label;
- e) One 22,5mm diameter yellow LED TRIP indication with label;
- f) One 22,5mm diameter red LED STOP indication with label;
- g) One 22,5mm diameter green LED RUN indication with label;
- h) One selector switch: HAND/OFF/AUTO with label;
- i) One Control Circuit Fuse and MCB;
- j) Terminals for all outgoing and incoming wiring;
- k) All auxiliary relays and wiring required for control functions;

The following potential free changeover contacts for signals shall be made available to the PLC:

- a) Motor Running /Stopped
- a) Fault Indication

Provide for operation of each motor drive from the following:

- b) 230 Vac - Motor Stop from the Field Emergency Stop Station.
- c) 230 Vac - Motor Start/Stop from the control panel.

4.2.6 Diesel Generator Control Panel & Auxiliaries Supply, 30A

This feeder shall be equipped as follows:

- a) Circuit label;

- b) 1 No. 3 pole moulded case circuit breaker;
- c) Door handle;
- d) One 22,5mm diameter yellow LED TRIP indication with label;
- e) One 22,5mm diameter red LED OFF indication with label;
- f) One 22,5mm diameter green LED ON indication with label;
- g) Terminals for all outgoing and incoming wiring;

4.2.7 Weighbridge Control System DB, 30A

This feeder shall be equipped as follows:

- a) Circuit label;
- b) 1 No. 3 pole moulded case circuit breaker;
- c) Door handle;
- d) One 22,5mm diameter yellow LED TRIP indication with label;
- e) One 22,5mm diameter red LED OFF indication with label;
- f) One 22,5mm diameter green LED ON indication with label;
- g) Terminals for all outgoing and incoming wiring;

4.2.8 Main Building SP&LDB, 30A

This feeder shall be equipped as follows:

- a) Circuit label;
- b) 1 No. 3 pole moulded case circuit breaker;
- c) Door handle;
- d) One 22,5mm diameter yellow LED TRIP indication with label;
- e) One 22,5mm diameter red LED OFF indication with label;
- f) One 22,5mm diameter green LED ON indication with label;
- g) Terminals for all outgoing and incoming wiring;

4.2.9 High Mast Lighting DB's, 30A

These three feeders shall be equipped as follows:

- a) Circuit label;
- b) 1 No. 3 pole moulded case circuit breaker;
- c) Door handle;
- d) One 22,5mm diameter yellow LED TRIP indication with label;
- e) One 22,5mm diameter red LED OFF indication with label;
- f) One 22,5mm diameter green LED ON indication with label;
- g) Terminals for all outgoing and incoming wiring;

4.2.10 Spares

Two spare 30A feeders shall be supplied.

Spare cubicle space shall be provided to allow for at least 3 No. 11kW DOL starters and 3 No. 25A Feeders.

4.3 Project Standards

Listed below are the specifications and codes that shall be complied with:

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4.3.1 Project Specific Standards

These will be the applicable Bosch Projects standards:

| | |
|-----|-----------------------|
| E07 | Motor Control Centres |
| | |

4.3.2 Company Specific Standards

Not applicable.

4.3.3 Codes of Practice

| | |
|------------------------|---|
| SANS 10142 | Wiring of Premises (Part 1 and 2) |
| IEC 60204 | Safety of Machinery |
| OHS Act No. 85 of 1993 | Occupational Health and Safety (OHS) Act No. 85 of 1993 (RSA) |
| NOSA | N.O.S.A. Safety Guidelines |

4.3.4 National and International Standards

| | |
|--------------|--|
| SANS 1091 | SA National Colour standards for paint |
| SANS 61439 | Low voltage switchgear and control gear assemblies |
| SANS 1195 | Standard specification for busbars |
| SANS 1973-1 | Low-voltage switchgear and control assemblies Part 1: Type tested, partially type tested and specially type tested assemblies with a rated short-circuit withstand strength above 10kA |
| SANS 60044 | Instrument transformers |
| SANS 60269 | Low Voltage Fuses |
| SANS 156/556 | Moulded-case circuit breakers |
| SANS 60529 | Degrees of protection provided by enclosures (IP Code) |
| SANS 60947 | Low voltage switchgear and control gear |
| SANS 61000-1 | Electromagnetic compatibility (EMC) Part 1: General |
| SANS 10064 | The preparation of steel surfaces for coating |
| SANS 1274 | Coatings applied by the powder-coating process |
| SANS 10142-1 | Low Voltage Electrical installation |
| VC 8003 | Manually operated switches for fixed installations |
| VC 8035 | Compulsory specification for earth leakage units |
| VC 8036 | Compulsory specification for circuit breakers <= 125A and <= 10kA |
| SANS 61312 | Protection against lightning and electromagnetic impulse |

Note: National and International Standards must be adhered to as a minimum requirement. The Supplier may propose equivalent acceptable standards however these must be specified. In the event of differing requirements, the most stringent Code or Standard shall apply.

5. GENERAL REQUIREMENTS

5.1 Units

The metric system of units shall be adopted for this Contract.

The Supplier is required to provide all manpower-supervision, equipment, materials, tools and services to meet the following requirements which will form part of this Contract.

5.2 Project Management

The Supplier shall be responsible for the project management of this Contract scope of work which will include planning, scheduling and reporting to the Company.

5.3 Engineering Design

The information supplied in this Contract in the form of data, drawings, etc., is intended to serve as a guide to the Company's requirements. The acceptance of this information shall in no way relieve the Supplier of its responsibilities in terms of the design, engineering and performance guarantee of the Goods. When designing and selecting equipment, the Supplier shall consider commonality between equipment to reduce spares holding. All units used in the design of the Goods shall be to the International System of Units ("SI").

5.4 Integral Components

All Connection Elements (means all holding down, anchor or connection bolts including all washers, nuts, screws, spacers, shims etc) and Integral Equipment such as local instrumentation gauges, local piping, service or supply manifolds, sight glasses, light glasses and lamps located within the terminal points is considered an integral part of the Goods and is to be provided by the Supplier. Where applicable, all integral components as well as all nozzles, are to be supplied complete with all mating flanges, connection elements, gaskets, seals and bolt sets.

5.5 Early Delivery of Built-in Items

Upon commencement of this Contract, the Supplier shall establish the full requirements relating to all built-in items and arrange for their earliest manufacture and delivery to Site to suit the overall Project programme.

5.6 Materials, painting and finishing

Materials of construction and finishes shall be selected to withstand local environmental exposure conditions with an appropriate corrosion allowance. All surfaces, where necessary, shall be painted in accordance with the Project Standards.

5.7 Name Plates

The Supplier shall provide engraved stainless steel name plates for all Goods. These name plates shall display the manufacturer's data, the relevant equipment details and the identification names and numbers in English.

Access

All areas of the Goods that require daily or frequent service access shall have permanent access facilities such as stairways, platforms, railing and cat ladders, which are wide enough for safe and easy passage. This shall include access to all manholes, inspection hatches, sample points and emergency systems.

Safety

The Supplier shall supply all the necessary safety protection equipment such as vent valves, hot surface guards, railings, notices, etc., in accordance with the latest Occupational Health and Safety Act, 85 of 1993. In addition, the plant noise level shall be less than 85 dB when measured at any point further than 3 (three) meters from the source(s) of the noise.

At all times that the Supplier is required to be on Site, the Supplier shall comply with the Company's Health and Safety Specifications

5.8 Transportation

All Goods to be delivered shall be suitably marked and correctly packaged to prevent damage during loading, transportation and offloading as well as to ensure ease of storage, retrieval and unpacking on Site. All invoices and shipping documentation (Bills of Lading and packing lists) shall strictly match in terms of detail.

5.9 Quality Control and Inspection

The Supplier shall be required to submit a quality control plan (QCP), which shall highlight all manufacturing aspects associated with the Goods and all inspection points (i.e. verification points, witness points, hold points) to be carried out by the Supplier.

The QCP shall also allow the Company to highlight any inspection points to be carried out by the Company during manufacture. The Supplier shall provide a minimum of 14 (fourteen) days' notice of when the Goods will be ready for the Company to carry out inspections. All tests, including simulated Site conditions, shall be carried out at the Supplier's factory / workshop in the presence of the Company prior to acceptance. Goods dispatched without inspection may be rejected, and all additional costs resulting from rectification or corrective action, thereafter, shall be for the Supplier's account.

5.10 Non-Destructive Testing (NDT)

The Supplier shall make allowance for all workshop/off-Site inspections and NDT as per the codes of manufacture and the Projects Standards. The Company reserves the right to review all NDT procedures and results.

5.11 Preferred Plant

The Supplier shall adhere to the Company's preferences for certain equipment and clearly state any differences in the tender. This requirement must not, however, be to the financial or technological disadvantage of the Client.

The final responsibility for the choice of suitable Goods must remain vested with the Supplier who is responsible for the performance of all Goods and associated equipment.

| | |
|-------------------------------|------------------------------------|
| Operating Voltage | 400 Vac |
| Control Voltage | 220 Vac |
| Electric Motors | WEG or Siemens or equivalent |
| Motor Control Centre (panels) | IEC 61439 |
| Miniature circuit breakers | Schneider Electric or equivalent |
| Isolators | Schneider Electric or equivalent |
| Contactors and overloads | Schneider Electric or equivalent |
| Terminal connectors | Weidmuller or equivalent |
| Panel lights | Schneider Electric or equivalent |
| Push buttons | Schneider Electric or equivalent |
| Panel Door Switches | Schneider Electric or equivalent |
| Panel Mount Current Indicator | Schneider Electric or equivalent |
| Metering CT | PCI or equivalent |
| Soft Starters | WEG or Siemens or equivalent |
| Variable Speed Drives | WEG or Siemens or equivalent |
| Timers | Schneider Electric or equivalent |
| PLC Interposing Relays | Schneider Electric or equivalent |
| General lighting | Phillips / Magnitech or equivalent |

5.12 Life Span

All Equipment shall be designed for a minimum lifespan of 25 years.

5.13 Marking, Packing and Shipping

All Equipment shall be suitably marked and correctly packed to prevent damage during loading, transportation and offloading as well as to ensure ease of storage, retrieval and unpacking on Site. The Contractor shall be required to make good all loading damage.

The Contractor shall ensure that they are fully conversant with all packing and shipping requirements.

All invoices and shipping documentation (Bills of Lading and packing lists) shall strictly match in terms of detail.

Certificates of compliance shall also be included in the shipping documentation i.e. electric cables supplied from EU, UK, RSA and shall have the appropriate certificate accompanying the shipment.

5.14 Inspection and Inspection Authorities

The Contractor shall give the Engineer and the Purchaser full opportunity to inspect progress, measurements, materials and workmanship associated with the Works.

6. INSPECTION

The accredited representative of the Purchaser shall have access to the Contractor's works at any time during working hours for the purpose of inspection of manufacture or test on the plant and selection of samples of the materials going into the equipment. The Contractor shall provide necessary facilities for such inspection or test.

All the type / special / routine tests on the generator as per SANS / IEC of latest issue and indicated below will be witnessed by the Engineer and all necessary facilities for inspection and testing shall be provided by the Contractor. The generator shall be completely assembled and tested at the Contractor's factory.

The Contractor shall ensure that the test instruments have calibration certificate issued by an approved standard laboratory, not earlier than six months from the date of testing.

7. TESTING

The commissioning activities which the Supplier is required to supervise, shall be carried out in the following sequence:

- a) pre-commissioning tests, which shall include the appropriate inspections and ("dry" or "cold") functional tests to demonstrate that each item of the Goods can safely undertake the next stage, (b);
- b) commissioning tests, which shall include the operational tests to demonstrate that the Goods can be operated safely and as specified, under all available operating conditions; and
- c) trial operation, which shall demonstrate that the Goods perform reliably and in accordance with the Contract.

The Supplier must develop a testing plan in MS Project format as well as a testing manual for all commissioning and performance testing activities. These documents must be submitted to the Company's Representative for review and approval prior to delivery of the Goods. The Company's Representative will integrate the Supplier's testing plan into the Company's overall commissioning and testing plan for the Project.

This overall commissioning and testing plan and the overall management of commissioning and testing thereof, shall be carried out by the Company or Company's Representative.

The Supplier's commissioning and testing manual must include the following information:

- i) the number of trained personnel required to be provided by the Company for all commissioning and testing activities as outlined in the commissioning and testing plan;
- ii) all settings, check sheets, tests procedures, etc. required for all commissioning activities (i.e. pre-commissioning, commissioning and trial operation) to ensure that the Goods are safe for operation;
- iii) all settings, check sheets, tests procedures, etc. required for all performance testing to ensure that Goods operate safely and in accordance with the requirements of the Contact; and
- iv) all punch listing forms required by the Supplier to ensure that defects are notified to the Supplier, recorded, and remedied.

The Supplier shall not be relieved of any responsibilities, obligations or liabilities under the Contract when the Company's Personnel are operating the Goods under the direction or supervision of the Supplier during training or commissioning.

7.1 Pre-Commissioning tests

The pre-commissioning tests must be carried out in the presence of the Company's Representative, the Company and a third party Inspector appointed by the Company (if required) as required and only after the Company's Representative has accepted that the Goods have been correctly installed and can operate safely.

The Supplier must actively supervise and co-ordinate all the pre-commissioning activities carried out on all Goods. In addition, the Goods shall be operated by the Supplier's personnel during this period.

The Supplier shall also be required to supervise trials as necessary to simulate operational conditions, and any tests required by the Company's Representative, the third party inspector (if required) or the Company to insure the Goods are in an acceptable and safe condition for further testing.

A punch list of items that are required to be remedied prior to the commissioning tests being undertaken ("**Punch List Category A items**") must be compiled by the Supplier and all Punch List Category A items attended to prior to the commencement of the commissioning tests.

7.2 Commissioning tests

Commissioning tests will be carried out by the Company under the Supplier's supervision and direction. The Supplier's commissioning engineer shall direct the Company's personnel to make such adjustments to the Goods as are necessary to enable commissioning to proceed safely and efficiently.

The Company shall provide all Company's Personnel required for training and assistance during this period.

Commissioning tests shall include all tests recommended by the Supplier in the commissioning and testing manuals. These tests shall include all start-up, operation, shutdown, and liquation activities as required. These tests may also include emergency operation activities as necessary.

In addition, the Supplier shall be required to direct the performance of on-load testing of the Goods (at gradually increasing loads) as necessary for the purpose of adjusting certain pieces of the Goods to ensure they are functioning properly.

A punch list of items that must be remedied prior to the Goods being operated by the Company ("**Punch List Category B items**") must be compiled during these commissioning tests and all Punch List Category B items attended to prior to the commencement of the trial operation of the Works.

8. SCHEDULE OF DRAWINGS AND DOCUMENTS

- **Drawings Supplied With Tender**

The drawings listed in Annexure 2 are provided with this Tender. Contractors should ensure that they are in possession of a full set of drawings.

- **Drawings And Documents To Be Supplied By Contractor**

This schedule of drawings and data requirements constitutes a part of the Specification.

The Purchase Order shall not be regarded as complete unless these requirements have been complied with.

Contractor's drawings will be approved only as to arrangement, conformity to the specifications and related drawings and approval shall not relieve or mitigate the Contractor's responsibility for accuracy and suitability of materials and/or equipment represented thereon. Contractor shall note:

- **Tender Drawings**

Shall be manufacturer's standard drawings in sufficient detail to allow appraisal of layout of equipment, drives, access for maintenance and operation and building and foundations.

- **Approval Drawings**

Shall be complete with equipment number(s). Approval drawings shall be stamped "DRAWINGS FOR APPROVAL" and must show all information necessary for the design of foundations and any connections to other equipment or steelwork.

- **Final Drawings**

Shall be stamped "CERTIFIED FOR CONSTRUCTION" and signed by the Contractor's Engineer.

Certification warrants that delivered equipment shall conform to the final drawings. Should delivered equipment fail to conform, Contractor's shall furnish all materials, labour and equipment required to correct such failures to the satisfaction of the Engineer.

Document and Drawing QUANTITIES and TYPE are indicated below in the following manner:

P = Print

S = copy on computer CD either in the latest published version of AutoCad or DXF file format.

The Document / Drawing Scheduling is indicated below in the following manner:

O = Order Date

T = Take-Over Date

A = Availability Date

C = Commissioning date

e.g. O + 30 = 30 calendar days after Order date.

C - 90 = 90 calendar days before commissioning

| Document | With Tender | After Award | | |
|--|----------------|-----------------|-------------------------------|----------|
| Description | | For Approval | Certified for Construction | As-Built |
| Submission of design, manufacture, procurement, erection and commissioning programme (Level 2 to 5) | | O + 5 | | |
| **Submission of equipment loadings, fixing and interface details to enable the Engineer to fully design all civil and structural works | ü | O + 10 | | |
| **Equipment and general arrangement drawings | ü | O + 10 | O + 15 | ü |
| **Submission of all MCC, panel, cubicle, layout drawings and schedules, loop diagrams etc. | | O + 10 | O + 15 | ü |
| **Submission of detailed design calculations and drawings for approval | | O + 10 | O + 15 | |
| Submission of factory acceptance test certification | | | | A + 5 |
| Commissioning and testing manual | | | | C - 10 |
| Operations and maintenance manuals | | | | T + 0 |
| “As Built” documentation & drawings | | | | T + 0 |
| Contractor's Data Book | | | | T + 0 |
| A copy of the ISO 9001 accredited quality system certificate or international alternative. | ü | | | |
| Quality Control Plan | ü | | | |
| Submission of design, manufacture, procurement, delivery and erection programme | ü | | | |

CONFIDENTIAL Any information contained herein is to be treated as confidential and may not be divulged to any other party without the prior written approval of Bosch Projects (Pty) Ltd and South African Farmers Development Association.

ANNEXURE 1 – PROJECT SPECIFIC STANDARDS

| Document No. | Description |
|--------------|-----------------------|
| E07 | Motor Control Centres |
| | |

PROJECT STANDARDS

MOTOR CONTROL CENTRES – E07

MARCH 2012



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MOTOR CONTROL CENTRES

(FOR HEAVY INDUSTRIAL AND COMMERCIAL USE)

All major motor control centres and equipment shall be designed and manufactured in accordance with SANS 1473/60439. The equipment shall conform to SANS 60947 Parts 1 -7, unless otherwise stated, and shall be suitable for operation on supply voltages of 230/400 Volts and/or 500/550 Volts, 50 Hz, AC. Reference must be made to the detailed technical specification, the relevant line diagrams, as well as to the following specific requirements.

1. CONSTRUCTION OF MOTOR CONTROL CENTRE ASSEMBLIES

All motor control centres shall generally be of the free standing, floor mounted, multi-tiered, individual motor starter with individual main MCCB/Isolator for each motor starter, with front and back access, suitable for bottom cable entries from cable trenches below the assembly. The schematic drawings show the specific requirements applicable to each assembly.

The assembly shall be constructed of electrolytically deposited zinc coated mild steel sheet similar to Zintex manufacture. Where specified the assembly enclosure may be required to be manufactured from stainless steel or 3CR-12.

The minimum thickness of 1.6mm for panels less than 0.5m wide and 2mm thick for larger panels, except for gland plates which shall be a minimum of 3mm. Thicker sheets shall be used for very large panels and where the weight of the equipment would cause buckling or vibration.

Unless otherwise specified, the metal enclosures, internal panels and all equipment support frames shall be manufactured from the same type of plate. When required, glass panels may be specified for viewing indication equipment.

The degree of protection shall not be less than IP53, for an assembly installed in an enclosed unpressurised room or IP53 for an assembly installed in a general plant area or outdoors in a semi protected area in accordance with SANS 1222 and capable of withstanding the temperature, humidity and conditions normally associated with heavy industrial applications. The assembly shall be fully vermin proofed.

A hot dipped galvanised steel base frame with predrilled holes for fixing the MCC to the floor shall be provided and removable lifting eyes with blanking off plugs shall be provided for lifting heavy assemblies. All panels shall be suitably braced to ensure rigidity. The method of preparing platework, priming and painting shall be in accordance with the standard painting specification.

The MCCs are to be fully assembled in the manufacturer's factory for final acceptance tests. Where broken down for transportation to site, the MCCs will be provided with all items required for re-assembly. Provision must be made for future extension at either side of the MCC. All holes provided for such extension to be suitably plugged or covered.

The overall outside dimensions of the assembly shall be suitable for easy handling of the switchgear as indicated on the drawings. The height of the assembly shall generally not exceed 2100mm above floor level.

All hinged front panels shall be fitted with stainless steel or heavy duty rustproof hinges of Barker & Nelson or Zeus manufacture with an 180° movement and shall be secured in the closed position by means of locking devices of approved quality. Hinged front panels in excess of 450mm height shall be secured at both the top and bottom. Lockable catches are required on all hinged front panels. All hinged front panels are to be fitted with earth straps.

Covers, other than the hinged type, shall be provided with chromium plated handles to facilitate removal. Removable covers shall be secured in position by means of patent screw locking devices approved by Bosch Projects. All removable covers and hinged front covers shall have a neoprene or rubber gasket to ensure that the required IP rating of the panel is achieved.

All the equipment shall be mounted behind the hinged front panels and neat machine punched openings shall be provided for the purpose of operating handles etc. Bosch Projects's drawings will detail the instruments required which will be flush mounted. The positions of instruments shall be such that the glass cannot be broken by other equipment when the hinged front panels are in the fully open position.

Cut outs which are provided for future equipment and instruments shall be neatly blanked off by means of removable dummy frames. Back plates shall be provided in all spare cubicles for the specified future starters.

To avoid damage to paintwork, screws, bolts, door lock, etc. must not be in direct contact with painted surfaces.

Bosch Projects must approve the manufacturer's detailed working drawings of the assembly before any fabrication commences. Any other construction or type of assembly proposed as an alternative to that specified must have the approval of Bosch Projects in writing. The drawings will detail all dimensions of busbars, connections, electrical component make, type and rating. Positions and layout of busbars, earth bars and gland plates will be shown in front and side elevation drawings.

1.1 Starter Cubicle Sizes

The following chart schedules the minimum recommended cubicle size for motor starter sizes however these must be verified with the equipment manufacturer. MCC general arrangement drawings shall be provided with the tender submission.

| Start kW Rating | Type of Starter | Dimension of Cubicle |
|-------------------|-----------------|--------------------------|
| 0 – 22kW | DOL | 300mm high x 600mm wide |
| 30 – 55kW | DOL | 600mm high x 600mm wide |
| 75 – 132kW | DOL | 900mm high x 600mm wide |
| 0 – 22kW | YD | 300mm high x 600mm wide |
| 30 – 55kW | YD | 600mm high x 600mm wide |
| 75 – 110kW | YD | 900mm high x 600mm wide |
| 132 – 160kW | YD | 1200mm high x 600mm wide |
| 0 – 37kW | SOFT STARTER | 900mm high x 600mm wide |
| 45 – 75kW | SOFT STARTER | 1200mm high x 600mm wide |
| 90 – 250kW | SOFT STARTER | 1800mm high x 600mm wide |
| 0 – 37kW | VSD | 900mm high x 600mm wide |
| 45 – 75kW | VSD | 1200mm high x 600mm wide |
| 90 – 250kW | VSD | 1800mm high x 600mm wide |
| Cable Way | | 1800mm high x 300mm wide |
| Marshalling panel | | 600mm wide |
| Incomer | | 600mm wide |
| Busbar Chamber | | 300mm high |

2. PAINT SPECIFICATION

All metal used for the fabrication of the board shall be painted, i.e. internally and externally. Baked enamel, electro statically applied powder coating or similar proven methods, other than standard enamel paint applied by brush, shall be used.

In general, the following standard colours shall be used, but the final colours are to be confirmed with Bosch Projects.

| | |
|-----------------------------|---|
| Non-essential sections | Electric orange (colour B26 - SANS 1091). |
| Essential sections | Signal red (Colour A11 - SANS 1091). |
| Uninterrupted power (UPS) | Purple. |
| Instrumentation and control | Blue. |

2.1 Edges

Care shall be taken to ensure that all edges and corners are properly covered, after all burrs and sharp edges have been removed.

2.2 Surface Preparation

Surface preparation shall comply with SANS 10064. Prior to painting, all metal parts shall be thoroughly cleaned of rust, mill scale, grease and foreign matter to a continuous metallic finish. Sand or shot blasting or acid pickling and washing shall be employed for this purpose.

The corrosion inhibiting process shall be suitable for the environmental conditions to be encountered on site and full details shall be provided at the time of tendering. Details of the chemical process employed and the method of application shall also be provided at the time of tendering.

As a minimum requirement, the finishing process shall consist of the following:

2.3 Finish

2.3.1 *Mild Steel – Baked Enamel Finish*

Immediately after cleaning, all surfaces shall be covered by a rust inhibiting, tough, broken metal-phosphate film and then thoroughly dried.

Apply two-pack wet primer to 15 microns; allow to dry in accordance with supplier's recommendations followed by two sprayed coats of high quality alkyd-based baked enamel, with a minimum paint thickness after baking of 60 microns.

2.3.2 *Mild Steel – Powder Coated Finish*

Immediately after cleaning, those metal parts shall be pre-heated and then covered by a micro structured paint powder applied electro statically, with a minimum final paint thickness of 60 microns.

2.3.3 *3CR12*

One (1) coat of suitable etch primer (15 microns).

Apply epoxy polyester powder coat (60 microns final thickness).

3CR12 steel, where specified, shall be correctly pickled and passivated prior to being painted. Pickling and passivation shall be undertaken after basic manufacture of the Enclosure is complete.

2.4 Touch-up Paint

In the case of switchboards and larger equipment enclosures, a tin of matching touch-up paint not smaller than 1 litre shall be provided.

3. BUSBARS

All busbars shall be manufactured from solid high conductivity copper and shall comply with the requirements laid down in SANS 1195. The completed busbar system shall be a standard modular system and shall have been tested to SANS approval and a certificate shall be made available confirming the full busbar technical description, current rating and fault rating together with full details of the test results. Busbars for systems up to 600V shall be designed to withstand a test voltage of 2.5kV AC for one minute.

The busbar assembly shall be rated in accordance with the specified ultimate projected fault level, which will be not less than the short-circuit stresses limited by the protective device(s) on the supply side of the busbars, as well as the specified continuous full load current, with a current density not exceeding 1,60 Amps per mm². The busbars shall withstand a fault current under test conditions of the specified fault level for 1 second. If a fault level is not specified, the busbars shall be tested at 20 times rated current for 1 second.

The fault current during tests shall be:

- between all three-phases
- any two phases
- neutral and the adjacent phase, and
- earth conductor and the nearest phase conductor.

The busbars shall be continuously rated for the specified current with a maximum temperature rise of 40°C relative to a peak ambient temperature of 40°C giving a maximum peak busbar temperature of 80°C.

Busbars shall be mounted in the top section of the assembly and shall be rigidly supported by means of approved insulated busbar clamps (at intervals not exceeding 500mm) to prevent damage resulting from the specified short circuit conditions.

The busbars shall run along the entire length of the assembly up to 76mm from either end. The phase busbars shall be identified in the phase colours red, white and blue.

The busbars shall be arranged horizontally with the longer side of the cross-sections in the vertical plane and one behind the other in the horizontal plane. The minimum clearance between live conductors and live conductors and earth shall be 40mm for systems up to 600 volts.

3.1 Earth Busbar

A solid copper earth bar shall be provided inside each assembly at the back and along the entire length, at a height of approximately 500mm above floor level, or 200 mm above the gland plates. A bar is to be provided at the top of

the assembly where top entries exist and this shall be solidly connected to the bottom earth bar.

The bar will be supported on robust spacers and will have a minimum clearance of 40mm to the sheet steel panel.

The earth bar shall have a cross-section of not less than 40mm X 6.3mm and shall be drilled with the requisite number of holes for the individual connection of all cable ECC and other earth conductors.

The earth bar, busbar joints and cable terminations must not be insulated.

High tensile phosphor bronze or cadmium plated nuts, bolts and lock washers shall be provided through the earth bar at each earthing position and at least 5 additional holes will be provided for future connections, each being fitted with nuts and bolts as above.

The earthing positions shall be evenly spaced along the length of the earth bar and the bar must be clearly identified as the earth.

3.2 Neutral Busbars

Neutral busbars in 3 phase, 4 wire supplies shall have a cross-section of at least 60% of the cross-section of the phase busbars. Where single-phase circuits (e.g. lighting and general power circuits) are protected by single-phase circuit breakers or fuses, all neutral conductors shall be connected to a separate neutral busbar mounted in a suitable position. The cross-section of the busbar shall be at least 6.3 x 25 mm and the busbar shall be long enough for the lug of each conductor to be bolted separately to the busbar. Only one neutral conductor is allowed per nut and bolt combination.

A separate neutral bar shall be provided for each earth leakage unit provided on the switchboard.

3.3 Busbar Droppers

All busbar droppers must be suitably supported (maximum spacing @ 500mm centres) and braced to suit the specified and/or projected short circuit conditions. They should be fully insulated and screened against accidental contact.

The droppers to the supply side of a single functional unit, as well as the components included in this unit, may be rated on the basis of the reduced short-circuit stresses occurring on the load side of the short-circuit protective device in this unit provided that these conductors are arranged such that under normal operating conditions an internal short-circuit between phases and/or between phases and earth is only a remote possibility, for example by being provided with adequate insulation or shrouding.

Particular attention shall be paid to the provision of adequate facilities for making off the main power supply cables. Attention must be paid to the vermin proofing of single core cabling.

Bunched cable connections will not be accepted between busbars and outgoing power circuit breakers, fuses or isolators.

3.4 Busbar Connections

All connections and extensions to busbars shall be effected by means of high tensile phosphor bronze nuts, bolts and washers or cadmium plated, high tensile steel bolts and nuts which shall also be provided for future extensions. The minimum diameter of any hole will be 10 mm.

In exceptional cases a relaxation of SANS 1473 may be permitted to allow the drilling of holes, in which case the cross-sectional area as measured is to be reduced by the area of the holes.

4. EQUIPMENT

Unless otherwise stated on the drawings the latest version of the following minimum specifications shall be assumed for equipment to be installed in the switchboards:

| | |
|--|--------------------------------|
| Busbars | SANS 1195 |
| Circuit breakers | SANS 60947 Part 2 and SANS 156 |
| Switches, disconnectors and fuse combination units | SANS 60947 Part 3 |
| Contactors and motor starters | SANS 60947 Part 4 |
| Control circuit devices and switching elements | SANS 60947 Part 5 |
| Multi-function switching devices | SANS 60947 Part 6 |
| Ancillary equipment | SANS 60947 Part 7 |
| HRC fuses and fuse switches | SANS 60269/1& 2 & SANS 172 |

SANS 60947 relates specifically to equipment for use at voltages up to 1000V AC. Where a voltage in excess of 1000 Volts is specified, the manufacturer must confirm that the equipment is suitable and has been tested to that higher voltage.

The equipment to be mounted in the panels will be detailed in the drawings and schedules provided.

All contactors and/or starters shall be protected with suitable back-up HRC fuses or current limiting circuit breakers to protect the equipment against abnormally high currents or short circuits developing in the system.

The manufacturer will be required to ensure the correct co-ordination between circuit breakers, contactors and overload relays to comply fully with SANS 60947 Part 4, in order to achieve 'Type 2' co-ordination.

Unless otherwise stated, contactors and/or starters shall be rated for 10 million operations for making and breaking no-load currents to category AC3 as laid down in SANS 60158. Note that SANS 60947 requires equipment and wiring to be suitable for 7.2 X FLC for DOL starters.

Each switchboard shall be provided with a means to isolate the incoming supply. This may be achieved by the use of an isolator, circuit breaker (fixed or draw-out) or fuse switch, rated to make against the full system fault at the point and break the full load current. The incoming supply section containing switchgear, protection equipment, controls and instrumentation shall form a clearly labelled, self-contained unit behind one or more hinged panels. The operating handle of the isolator, circuit-breaker or fuse switch controlling the incoming supply shall protrude through the panel and shall be interlocked to ensure that the panel can only be opened when the supply is off.

Equipment that cannot be flush mounted on the panel, shall be mounted on a suitable metal chassis and shall protrude through a close fitting cutout in the panel. All protection relays contained in enclosed units with glass fronts shall be flush mounted on the hinged panels, contactors, thermal overload relays, etc. shall be mounted on a chassis behind the panel.

Access to the various starters shall be possible without isolation of the entire MCC, but the hinged front panels corresponding to each compartment shall be inter-locked with a local isolator in order that any compartment must be isolated before access to the equipment can be obtained. A mechanical device shall be incorporated in each isolation in the off position to provide a locking out facility during maintenance periods.

All over current reset buttons (22mm diameter) shall be mounted on the front panel enabling operators to reset the unit without having to open the panel.

Timers and relays controlling a starter shall be mounted in the compartment with the starter. All timers and relays must be clearly labelled with the identity given on the schematic diagrams.

Equipment to be supplied under this contract must be identical in all respects and it shall be possible to interchange such equipment should it become necessary.

All material and equipment must be suitable for 415/240V-supply voltage, 50 Hz supply frequency and must be approved by Bosch Projects. In addition all

equipment shall be designed, manufactured and tested in accordance with the relevant IEC Standard Specification and the necessary precautions shall be taken against corrosion, i.e. all metal shall be galvanised.

4.1 Derating of Equipment

Full cognisance must be taken of manufacturers derating tables for equipment located in enclosures and the rating of that equipment must be increased accordingly. In all such cases labels must be provided on the front of the associated cubicle stating the maximum permitted circuit loading.

Where high ambient temperatures and/or continual high loading are anticipated, the assembly must incorporate adequate ventilation systems to eliminate the possible build-up of excessive temperatures. Where specified, renewable filter elements must be incorporated.

4.2 Cable Terminations

Due to the continuing miniaturisation of equipment, difficulties can be experienced in terminating power cables onto equipment terminals, particularly where more than one cable has to be terminated. The manufacturer shall ensure that suitably designed and rigidly braced copper stubs are extended from such terminals to facilitate the termination of all cables. Flash barriers must be used between the phase terminals of circuit breaker equipment.

5. INSTRUMENTATION

All instruments shall be of a matching flush pattern, preferably with a 96mm X 96mm square dial. The single line diagram will indicate the ratio of CTs where required. The instruments shall be suitable for the environment in which they are installed. All instruments shall withstand a test voltage of 2kV for 1 minute and the terminals of all instruments mounted on hinged panels shall be shrouded.

All main incoming panels shall be provided with three combined maximum demand/instantaneous ammeters, a voltmeter and selector switch as well as any additional instrumentation detailed on the single line diagrams.

5.1 Ammeters

Each Incomer shall have three combined maximum demand type instruments will comprise a moving iron ammeter showing the instantaneous current value, combined with an ambient corrected, manually reset, thermal maximum indicating ammeter which will indicate the mean current reached during any 15 minute period. The maximum demand ammeter shall be in accordance with IEC 60051.

Each starter cubicle for all motors and all motor driven pumps irrespective of size shall be provided with an ammeter, which shall incorporate an adjustable red pointer and an extended starting characteristic. Allowance must be made for the full load current of all motors to be checked and for all red pointers to be set accordingly. The motor FLA shall be 50 to 70% of full scale. The ammeter shall be in accordance with IEC 60051-1.

5.2 Current Transformers

Where applicable, the current transformers shall generally be of the ring type complying with the requirements of SANS 60044-1, as amended. The current transformers shall have a Class 3 or 5 accuracy. The CT's shall have 1 Ampere secondary.

5.3 Voltmeters

Voltmeters shall be of the moving iron, suppressed zero type, having a full scale deflection of not less than 480 Volts, unless otherwise specified. The voltmeter shall have Class 1,5 accuracy in accordance with IEC 60051-1

5.4 Hour Meters

These shall be provided on each motor starter if specified in the Detailed Specification.

Running hour meters shall be in accordance with IEC 60051-1 suitable for operation on a three phase 50 Hz AC system with Industrial Grade accuracy. The meter shall have seven digits and need not have a reset facility.

5.5 Kilowatt Meters

These shall be provided on the MCC incomer if specified in the Detailed Specification.

Kilowatt meters shall be in accordance with IEC 60051-1 suitable for operation on a three phase 50 Hz AC system with Class 2 accuracy and shall be driven by 1A CTs.

5.6 Power Factor Meters

These shall be provided on the MCC incomer if specified in the Detailed Specification.

Power factor meters shall be in accordance with IEC 60051-1 suitable for operation on a three phase 50 Hz AC system with Class 2 accuracy.

5.7 Instrumentation Fuses

All instrument fuses shall be mounted in the panel onto or next to the busbars. 6mm² wiring shall be used between the busbars and the fuses and shall be kept as short as possible.

HRC cartridge fuse links to SANS 172 shall be used and shall incorporate a visual indication device to facilitate the location of blown fuses on visual inspection. They shall be designed to clip into the fuse carrier contacts without the use of fixing screws.

Wiring from fuse bases to instruments may be bunched but must be suitably supported in Bowthorpe Hellerman trunking or lacing.

Each fuse shall be separately labelled stating the instrument circuit, phase and rating.

6. PROTECTIVE DEVICES AND PROTECTION SETTINGS

The switchgear shall be provided with the specified protection and auxiliary relays, which must be of a modular pattern, readily accessible, replaceable and extensible.

The thermal overload releases and instantaneous magnetic short circuit trips are to be adjustable over the trip ranges as specified by Bosch Projects.

The Contractor must allow to grade, set and test the protection devices for the main switch, bus section switches and each motor circuit.

The following minimum motor protection shall be provided unless otherwise specified in the Detailed Specification:

| TYPE OF PROTECTION | APPLICATION |
|---------------------------|---|
| Short Circuit | All motor starters |
| Thermal Overload | Motors 7.5kW and Below |
| Electronic Overload | Motors greater than 7.5kW |
| Unbalanced/Single Phasing | All three phase motors |
| Earth Fault | All three phase motors |
| Phase Reversal | All three phase motors |
| Undervoltage | All motors |
| Overvoltage | All motors |
| Undercurrent | All motors |
| Thermistor | All motors greater than 22 kW and motors supplied via a VSD |
| Anti-condensation heaters | All motors greater than 22 kW |
| Bearing Temperature | All motors fitted with sensors |
| | |

7. ELECTRONIC SOFT STARTERS

The soft starter will satisfy all CE directives UL, cUL, Lloyds ENV1,2 manufactured under ISO 9002 and will start the motor by means of smooth and stepless increase of motor voltage while maintaining current limit. Control of internal routines will be digital and microprocessor controlled from the latest model manufactured.

The digital control system will include pump control software to eliminate high pressure during starting and water hammer effect during stopping. Advanced current feedback closed loop Torque and Current control as well as linear Tacho generator or encoder control input.

The adjustments of pump control system will allow the adoption eight starting and stopping characteristics to the system installed at the site. The Soft-Starter will also include optional capabilities for adding Motor Insulation controller, RS485 communication with MODBUS, protocol, Profibus or TCP/IP cards and Analogue I/O card with PTC Thermistor input and 4-20mA, 0-20mA, 0-10Vdc.

7.1 Start and Stopping Parameters

| | |
|------------------------------------|--|
| Pump control | Special starting and stopping characteristics for pump. Three starting and stopping curves for optimal adjustment to the system. |
| Starting Torque / Voltage | 10 – 50 % of nominal voltage (10-80% extended range) |
| Current Limit (Starting) | 100 -400 %of nominal current. (100 – 500 % extended range) |
| Ramp up time (Soft start time) | 2- 30 sec (2-240 sec. extended range) |
| Ramp down time (soft stop time) | 2 – 30 sec (2-90sec extended range) |
| Dual adjustments | Two start/stop characteristics and two Overload protection characteristics (externally controlled) |
| Linear acceleration (Tacho. Input) | RPM feedback from Tacho generator or optional digital encoder, uniquely developed for large conveyors and pumps (0-10Vdc) |
| Torque control | Enhanced torque control of the motor's shaft. Intelligently eliminates motor's torque fluctuation within the starting process and overrides any non linear motor behavior. |
| Current Control | Unique voltage control increase to the motor through a real, closed loop current ramp |

7.2 Applications Assistance

| | |
|--|---|
| Pulse/Kick start | Short high torque 80 % Un for starting and releasing clogged sewage pumps. |
| Reverse motor rotation at slow speed | Electronic switching of rotation direction at slow speed without contactors. For sewage pumps release, positioning of large mills and pocket elevators maintenance. |
| Shear-Pin Detection at no fault | Unique programming allows for "Immediate Relay" to close without the "Fault Relay" announcing a fault. |
| Energy save | Reducing voltage upon detection of light loads. |
| Analog card – Analogue output (4-20mA, 0-20mA or 0-10V) and Thermistor input | Analogue output corresponding to motor current and Analogue input for Thermistors from the motor. |
| RS485 Modbus (Modbus + addressing), Profibus or TCP/IP communication | For programming, controlling, display and real time high speed data acquisition. |

7.3 Motor and Starter Protection

| | |
|---------------------------------------|--|
| Electronic overload | Adjustable Inverse Time Electronic Overload |
| Electronic fuse (Shear-Pin) | Immediate trip (under 0.02 sec) when current exceeds to $9 \times I_n$ at all times (Adjustable) |
| Electronic Fuse (Starting Conditions) | Adjustable trip when current exceeds a preset value while Starting |
| Electronic Fuse (Running Conditions) | Adjustable trip when current exceeds a preset value while Running |
| Under current | Adjustable to 20 – 90 % of nominal current with 1 – 40 Sec delay. |
| Long Start Time | Stall protection with adjustable time delay |
| Phase loss | Immediate disconnection in case of voltage difference or missing one/two phases. |
| Phase sequence | Avoiding start in wrong phase sequence |
| Under voltage | Adjustable to 50 – 100 % of nominal voltage with 1 – 10 sec. |

| | |
|-----------------------------|--|
| | Delay or off |
| No Voltage | Nonadjustable protection saves fault data into memory within 15ms. When voltage is restored does not permit starting before fault was reset. |
| Over voltage | Adjustable to 100 – 150 % of nominal voltage with 1 – 10 sec delay. |
| Wrong connections | Disable starting upon wrong connection at the motor side or disconnection in the motor winding. |
| External fault | N/O input terminal for connection to an external device (PLC etc). Closing the contact will trip the starter. |
| Too many starts | Set the maximum allowed number of starts in a preset period, and the time which starts can be disabled to allow motor cool down. |
| Shorted SCR protection | Avoids start in case of one or more shorted SCR |
| SCR over voltage protection | MOV (Metal Oxide Varistors) protecting the SCR's against voltage spikes |
| Heatstink over temperature | Protecting the SCR's from over heating |
| Motor Insulation | Measures the motor insulation before start signal. Strongly recommended when large motors are used with long off-time periods. |
| Self Test | Upon startup, selected components in the soft starter are tested, upon OK, the Green ON led will be lit. |

7.4 Display and Adjustments

| | |
|---------------------------------|--|
| LED Display | Eight LED's for status display, On (starter OK), Start, Run, Operation, Soft-Stop, Stop, Fault, Dual adjust, Slow-speed, reversing |
| LCD Display | Adjustments, Fault description, Starting and Operating Current, Insulation level (Ohms) on a 2 x 16 character clearly viewed and lit LCD screen. |
| Statistical information | Run Time counter, Peak Current, Last starting time, Number of starts, Number of Faults, Last Fault, Last Fault Current. |
| Language Selection | Easy selection one of Four Languages: English, Spanish, French, German |
| Soft Touch Push-Buttons | Soft Touch Push-buttons, including soft – lock |
| Reset | Front Panel (Local) and Remote resetting |
| Remote door installation option | Door installation Display and keyboard (1.5m) |

7.5 Inputs and Outputs

| | |
|--|---|
| Operating Voltage | Selectable 110, 220VAC with automatic selection for fan operation with EMI & RFI protections, Lloyd's CE, UL and cUL approved |
| Control Voltage | Optically isolated digital control inputs, two analogue control input (Tacho & Thermistor). Two programmable inputs allowing sophisticated starting procedures, generator-starting characteristics, hardware and software controlled etc. |
| Outputs | Four 8A/250 V C/O for immediate end of acceleration fault and insulation alarms (fault or fault fail safe), all relays will have hold and release timers. |
| RS 485 Communication | Up to 32 units on a single twisted shielded pair, allowing adjustments control and full statistics with fault information. |
| Profibus Communication | Full data reading and parameter modification is performed via the advanced Profibus port. |
| TCP/IP Communication | Advanced port connection with PNP network plug and single step configuration |
| Insulation Card | Check through ground operation, unique testing to prevent stator damage with alarm fail-safe operation and adjustable set points. |
| Analog card – Analogue output and Thermistor input | Analog output (4-20mA, 0-20mA or 0-10V) corresponding to motor current and Analog input for PTC Thermistors from the motor. |

7.6 Operating Conditions and Starter Construction

| |
|---|
| The Soft Starter will be designed for continuous operation in In at 50° C |
| The Soft Starter will allow starting conditions of 300 % In for 30 sec at 50° C for at least twelve times within one hour. |
| The Soft Starter will allow full operation at service factor of 115 % (SF 1.15) |
| The Soft Starter will combine a by-pass option, allowing operation of all current and voltage protections when by-pass contactor is closed. |
| The digital control panel will be of the plug-in type (inputs and outputs) module identical to starter sized B-G |
| Soft-Starters size A will be IP20 protection |
| All electronic circuits will have the option to be fungus and corrosion protected. |

| |
|---|
| The Starter will include a special diesel generator starting characteristics, controlled via external programmable input. |
| The Soft Starter will allow Power Factor Correction Capacitors to be connected directly at the input side. |
| The Soft-Starter Voltage range will be 230 - 1000 VAC |
| The Soft-Starter current range will be 8A – 2700 A |
| The Soft-Starters will be Lloyds, UL, cUL; CE tested and approved under ISO 9002 manufacturing standards. |

8. VARIABLE FREQUENCY DRIVE (VSD/VFD)

This section provides specification requirements for variable frequency drives (VF Drives) for use with design AC squirrel cage induction motors. Contractor shall provide the following:

Provide Bosch Projects with the VF Drive manufacturer's written concurrence that the output of the Drive is compatible with the design and construction of the associated motor to be supplied by the Drive

A VF drive manufacturer's representative to field test, adjust and certify all installed VF Drives for satisfactory operation with motor load running under all design conditions.

8.1 8.1 Warranty

Provide a 3 year parts warranty, on materials and workmanship, and 1 year labour warranty from the date of field certification by manufacturer's representative of satisfactory operation. The manufacturer's turn around period to repair or replace the VF Drive shall be no more than 48 hours.

8.2 8.2 Quality Assurance

The manufacturer of the VF Drive shall be a certified ISO 9001 facility. The VF Drive and all associated optional equipment shall be UL listed according to Power Conversion Equipment UL 508C. A UL label shall be attached inside each enclosure as verification. Every Power Converter (component of the VF Drive) shall be tested with an actual AC Induction Motor 100 % loaded and temperature cycled to the full range of the VF Drive. All VF Drive door mounted pilot devices shall be tested to verify successful operation.

The VF Drive shall be submitted to a HI-Pot test with all enclosed devices mounted and wired, prior to delivery. Documentation shall be furnished to verify successful completion of all the above, upon request of Bosch Projects.

8.3 General Description

Alternate control techniques other than pulse width modulated (PWM) are not acceptable. The VF Drive shall convert the input AC mains power to an adjustable frequency and voltage as defined in the following sub-paragraphs. The input power section shall utilise a full wave bridge design incorporating diode rectifiers. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage. This power section shall be insensitive to phase rotation of the AC line. The DC bus shall have external connections for standby battery back-up or for linking multiple VF Drives with DC buses for management of regeneration power. The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall utilise the Insulated Gate Bipolar Transistors (IGBTs) or Intelligent Power Modules (IPM's) as required by the current rating of the motor.

8.4 Construction

The VF Drive shall be mounted in an enclosure with an external operated disconnecting device. A mechanical interlock shall prevent an operator from opening the VF Drive door when the disconnect is in the on position. Another mechanical interlock shall prevent an operator from placing the disconnect in the on position while the VF Drive door is open. It shall be possible for authorised personnel to defeat these interlocks.

Provisions shall be provided for locking all disconnects in the off position with up to three padlocks.

Current limiting fuses shall be installed and wired to the AC Drive input

Provisions shall be made for accepting a padlock to lock the VF Drive enclosure door.

8.5 Motor Data

The VF Drive should always be sized per the motor's maximum current requirements under breakaway torque demands, since the maximum demands placed on the motor by its connected load also must be met by the VF Drive. "Motors connected to VF Drives shall have a 1.15 service factor, but the connected load shall be sized to not exceed the 1.0 service factor of the motor. Provide motor winding thermal sensing thermistors (PTC) in motors to be connected to VF Drives."

The Contractor shall ultimately be responsible for obtaining all necessary motor's technical data from the motor or equipment manufacturer, to properly size the VF Drive. The VF Drive shall be sized per the motor's maximum current requirements under breakaway torque demands, not per the motor power rating. Size the Drive to operate the AC motors of the following equipment.

- Equipment name (_____) shown on the Mechanical and Electrical drawings.
- Motor Power: (_____) or as provided by the manufacturer Motor maximum current at breakway torque: (____Amps) unless otherwise indicated by manufacturer.
- Motor full load amperes: (____Amps) or as provided by the manufacturer.
- Motor RPM: 1500 @ 50 Hz, unless otherwise indicated.
- Motor voltage : 400 V (_____)
- Motor service factor : 1:15

8.6 Application Data

Variable Torque motors are used to operate fans and centrifugal pumps,

Constant Torque motors are used on conveyors, positive displacement pumps, and compressors, Constant power motors are used on machine tools and winches.

The VF Drive shall be sized to operate a Variable Torque, Variable Torque Low Noise, Constant Torque, Constant power, Impact Load. The speed range shall be from a minimum speed of 0.5 Hertz to a maximum speed of 400 Hertz.

8.7 Environmental Ratings

The VF Drive shall be of construction that allows operation in a pollution Degree 2 environment, minimum

The VF Drive shall be designed to operate in an ambient temperature from 0 to +40 degrees Celsius

The Storage temperature range shall be – 25 to +70 degrees Celsius. The maximum relative humidity shall be 95 % at 40 degrees Celsius, non-condensing.

The VF Drive shall be rated to operate at altitudes less than or equal to 1000m. For altitudes above 1000m de-rate the VF Drive by 1.2 % for every 100m.

8.8 Ratings

The VF Drive shall be designed to operate from an input voltage of 380 to 420 VAC +- 10 % or 230 to 240 VAC +- 10 %. Output voltage shall be 0 to maximum voltage, equal to input line voltage.

The VF Drive shall operate from an input voltage frequency range from 47.5 to 52.5 hertz.

The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.

The efficiency of the VF Drive shall not be less than 96 % at 100 % speed and load.

The overload current rating for variable torque (VT) shall be minimum 110% for 1 minute, for constant torque (CT) shall be 150 % for 1 minute.

The output carrier frequency of the VF Drive shall be selectable at steps of 2kHz up to 10kHz for A frame, 8kHz for B frame and 6kHz for C frame, depending on VF Drive rating for low noise operation. No VF Drive with an operable carrier frequency above 10kHz shall be allowed. Or, the VF Drive shall have a switching frequency dependent on load in the 2 to 4 kHz range without a fixed carrier.

The output frequency shall be from 0.1 to 400 Hertz for VF Drives up to 55kW. At powers above 55 kW, the maximum output frequency will be 200 Hertz.

The VF drive will be able to develop rated motor torque at 0.5 Hertz (50 Hz base) or at zero base, in a Sensorless Flux Vector mode using a standard induction motor without an encoder feedback signal.

For motor thermal protection function when the motor is operating at slow speed for extended times, the VF drive shall have a protection function that detects a motor over temperature by wiring a motor thermistor

8.9 Protection

Upon power-up the VF Drive shall automatically test for valid operation of memory, option module, loss of analogue reference input, loss of communication (dynamic brake failure) DC to DC power supply, control power and the pre-charge circuit.

The VF Drive shall be UL 508C listed for use on distribution systems with (10 000A RMS) (22,000A RMS) (65,000A RMS) available fault current. The Power Converter shall meet short circuit withstand ability of 65 000 RMS symmetrical amperes as defined by NEMA ICS 7.1.09 and have the value listed on the VF Drive nameplate.

The Power Converter shall be protected against short circuits, between output phases and ground and between the logic and analogue control outputs.

The VF drive shall have a minimum AC under voltage power loss ride-through of 200mS. The VF drive shall have the user defined option of frequency fold-back to allow motor torque production to continue to increase the duration of the powerloss ride –through.

The VF drive shall have a selectable ride through function which will allow the logic to maintain control for a minimum of one second without faulting.

For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 5 programmable restart attempts. The programmable time delay before restart attempts will range from 1 second to 30 seconds minimum.

The deceleration mode of the VF Drive shall be programmable for normal and fault conditions. The stop modes shall be free-wheel stop (coast to stop), DC injection brake, Ramp-to-Stop/Hold.

Upon loss of the analogue process follower reference signal the VF Drive shall be User programmable to do the following: Fault and stop, Alarm and maintain last reference (within 10 %); Alarm and go to preset speed, which would be programmed to be minimum speed or maximum speed.

Motor overload protection: The VF Drive shall have solid state I_{2t} protection that is UL listed and meets UL 508C as a Class 10 overload protection. The minimum adjustment range shall be from 0.45 to 1.05 percent of the current output of the VF Drive.

The VF Drive shall provide a motor phase loss function that monitors the status of the motor cable connection. During startup if any of the motor phases are not connected the Drive shall refuse to start. The Drive shall have a user defined operation, during motor phase loss, of either a fault indication and stop, or no reaction.

The VF Drive shall have a thermal switch with a user selectable prealarm that will provide a minimum of 60 seconds delay before over temperature fault. Or, the drive shall provide access to the heatsink temperature parameter such that the user can monitor it.

The VF Drive shall be provided with cooling air fan(s) and/or may utilise bonded or cast fin heatsink construction for maximum heat transfer. The cooling air must be clean and free from corrosive materials.

The VF Drive shall have a programmable fold-back function that will anticipate a controller overload condition and fold back the frequency to avoid a fault condition.

The output frequency shall be software enabled to fold back when the motor is overloaded. There shall be 3 skip frequency ranges that can each be programmed with a selectable bandwidth of 2 or 5 Hz. The skip frequencies shall be programmed independently, back to back or overlapping.

The VF drive shall include phase to phase and phase to ground transient voltage surge protection wired to the incoming AC mains.

8.10 Factory Settings, Field Adjustments and Configurations

The VF Drive shall self-configure to the main operating supply voltage and frequency. No operator adjustments shall be required. The VF Drive shall be insensitive to incoming power phase sequence.

The VF Drive shall be capable of determining the speed and direction of a spinning motor and adjusting its output to engage the motor at the rotating speed.

Upon power-up, the VFD will automatically send a signal to the connected motor and store the resulting resistance data into memory. The inductance data will be measured during no-load operation when operating at a frequency between 20 – 40 Hz. The VFD will automatically optimise the operating characteristics according to the stored data.

The VF drive will be factory pre-set to operate most common applications.

A choice of three types of acceleration and deceleration ramps will be available in the AC Drive software, Linear S Curve and U curve (or Linear, S1 curve, S2 curve and S3 curve)

The acceleration and deceleration ramp times shall be adjustable from .1 to 999.9 seconds.

The volts per frequency (V/Hz) ratios shall be user selectable to meet variable torque loads, normal and high torque machine applications.

The Drive shall retain and record operating frequency, Drive status, power mode, and fault type of the past 4 faults, minimum. Information shall be maintained in memory in the event of a power loss.

Slip compensation shall be a software enabled function, if required.

The software shall have no load function that will reduce the voltage to the motor when selected for variable torque loads. A constant Volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load.

The AC drive shall offer programmable DC injection braking that will brake the AC motor by injecting DC current and creating a stationary magnetic pole in the stator. The level of current will be adjustable between 50 – 150 % of rated current and available from 0.0-30 seconds continuously. For continuous operation after 30 seconds, the current shall be automatically reduced to 50 % of the nameplate current of the motor.

Sequencing logic will co-ordinate the engage and release thresholds and time delays for the sequencing of the VFD output, mechanical actuation and DC injection braking in order to accomplish smooth starting and stopping of a mechanical process. Time delay can be an external option.

8.11 Operator Interface Terminal

The operator interface terminal will offer the modification of VFD adjustments via a touch keypad. All electrical valves, configuration parameters, I/O assignments, application and activity function access, faults, local control, adjustment storage, self-test and diagnostics will be in plain English.

The display will be a high resolution; LCD backlighted screen capable of displaying operating parameters in percentages, and alphanumeric characters.

The VFD model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall all be listed on the drive identification display as viewed on the LCD display.

The display shall be configured to display numeric data that is selectable and scalable by the operator. A user defined label function shall be available. As a minimum the selectable outputs shall consist of speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, elapsed time, motor speed, machine speed reference and machine speed.

A single keystroke scrolling function shall allow dynamic switching between display variables.

The terminal keypad will consist of predefined menus or programmable function keys. The functions will allow both predefined menus or operating commands and programming options to be preset by the operator. A hardware selector switch or programmed password will allow the terminal keypad to be locked out from unauthorised personnel.

The operator terminal will offer a general menu consisting of parameter setting, I/O map, fault history, and drive configuration. A software lock will limit access to the main menu. The main menu will consist of keypad configuration, drive configuration, general configuration, diagnostic mode and drive initialisation screens.

There will be arrow keys that will provide the ability to scroll through menus and screens, select or activate functions or increase the value of a selected parameter.

A data entry key will allow the user to confirm a selected menu, numeric value or allow selection between multiple choices.

An escape key will allow a parameter to return the existing value if adjustment is not required and the value is displayed. The escape function will also return to a previous menu display.

A RUN key and STOP key will command a normal starting and stopping as programmed when the VFD is in keypad control mode. Local STOP is not

active in the remote control mode. Keypad will first have to be placed on local control mode for the VFD to be stopped locally.

The VFD shall come with 3 LEDs mounted on the front panel to indicate functional status. A Green LED will verify that the VFD power supply is ON. A red LED indicator will indicate an VFD FAULT. A yellow LED indicator will designate a PENDING FAULT condition.

A user interface shall be available that is a Windows 3.1 based personal computer, serial communication link or detachable operator interface.

The Keypad and all door mounted controls shall be type 1 (Type 12) rated.

All adjustments made on the user interface shall be stored in non-volatile memory. The user interface shall provide memory for factory default values as well as programmed user defaults.

8.12 Control

External pilot devices shall be able to connect to a terminal strip for starting / stopping the VFD, speed control and displaying operating status. All control inputs and outputs will be software assignable.

2 wire or 3-wire control strategy shall be defined within the software. External relays or logic devices will not be allowed.

The control power for the digital inputs and outputs shall be 24Vdc.

The internal power supply shall incorporate an automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and not be damaged if shorted or excess current is pulled.

All control logic connections shall be furnished on a terminal strip separate from power wiring.

There will be 2 software assignable analogue inputs. The analogue inputs will be software selectable and consist of the following configurations: 0-20mA, 4-20 mA, 20-4mA x-20mA (where x is user defined) or 0-10V. There will be 4 software assignable logic inputs that will be selected and assigned in the software. The selection of assignments shall consist of run/reverse, jog plus/minus speed, setpoint memory, preset speeds, auto/manual control, controlled stop, terminal or keypad control, by-pass, motor switching, and fault reset.

There will be two software assignable analogue outputs that can be selected and assigned in the software. The analogue output assignments shall be proportional to the following motor characteristics: Frequency, current, power torque, voltage and thermal state. The output signal will be selectable from 0 – 20mA or 4-20mA.

A minimum of two Form C relay output contacts will be provided. One of the contacts will indicate AC drive fault status. The other contract will be user assignable. There shall be a hardware input/output extension module which also provides interlocking and sequencing capabilities. The module shall be fully isolated and house din an enclosure with terminal strips. The module will add 4 logic inputs, 2 analogue inputs, 2 relay outputs and one analogue output. All of the I/O will be user assignable in the software as previously defined.

The VF Drive door mounted control area shall include a power ON, Drive RUN, Drive Fault Light and Hand-Off-Auto selector switch with Manual Speed Potentiometer.

The VFD control island shall accept (% indicating analogue meters) (obsolete indicating digital) meters to display (Power, Amperes,) (Voltage) (Hertz)

8.13 Braking (Application Dependent Option)

When braking certain types of loads, there is the conversion of kinematic energy into electrical energy by the motor which is returned to the VF Drive. Dynamic braking can be chosen to absorb this energy and avoid causing the VF Drive to inadvertently shut down. The energy is dissipated across a resistor that is connected to the Drive. For constant torque VF Drive controllers, the dynamic braking unit must be capable of stopping 1.5 per unit motor torque from base frequency to 0.5 Hz with sensor less flux vector control mode.

A dynamic brake resistor shall be provided and connected to existing terminals on the VF Drive. The resistor shall mount externally to the VF Drive enclosure. An IGBT will be provided in the Drive to switch excess regenerative energy to the braking resistor. The braking resistor will be of a size calculated to stop 6 times motor inertia at 1.5 per unit motor torque.

Provisions shall be provided to protect the Dynamic Braking Resistor against overload and overcurrent due to Dynamic Brake switch failure. This protection must be resetable without replacement of fuses or other devices.

8.14 Isolation / Bypass Contactors (Automatic)

The VFD shall include an isolation and bypass contactors complete with thermal overload relay, circuit breaker disconnecter interlocked with the door, control circuit transformer, motor flux decay timer and VFD-OFF-BYPASS selector switch. The operator may select for manual bypass by setting the switch in the BYPASS position or automatic bypass by setting the switch in the

VFD position. In the VFD position the VF Drive will provide variable frequency/speed control of the motor under non-fault conditions of the Drive. When the Drive is under a fault condition the bypass contactor will be automatically energised upon Drive shutdown (Drive fault contact operation) to operate the motor, across the line, on 50 Hertz line power and on a full voltage non-reversing starter with overload relay.

8.15 Harmonic Current Filtering

The distortion factor must not exceed 3 percent for individual phases and 5 percent for the power system used to supply the VFDs and other loads. A study will be required if the combination of harmonics on the power system and those generated by the VF Drives could produce unacceptable aberrations on the power system. Provide either an isolation transformer of adequate size or reactors of minimum 3 % per unit impedance, on the primary of the VF Drive to act as a buffer and reduce the current harmonics that are fed back into the electrical supply power system.

A harmonic analysis shall be performed by the VF Drive manufacturer base upon system documentation consisting of but not limited to one-line diagrams and specific distribution transformer information consisting of KVA, %Z and X/R data. The analysis data shall consist of but not be limited to total harmonic voltage distortion and total current.

(Line reactors) (an isolation transformer) shall be provided in a stand-alone enclosure for mounting separately from the VF Drive. (Line reactors shall be of minimum 3% per unit impedance, and may be provided integral to the VF Drive. All line reactors, integral or external type, shall be provided by the VF Drive manufacturer as a part of the VFD package.

The isolation transformer shall be of adequate size with full capacity taps 4-2.5% 2+ 2- to provide voltage change if necessary to match the motor drive voltage requirements. The isolation transformer shall provide an isolated secondary winding which shall be grounded to a separate isolated building ground point, in order to insure that AC Drive “noise” is not coupled back into the Line side of the service primary system and affects other equipment connected on the Line side. The isolation transformer shall provide reactive buffer to ease the rate of current change in the solid state switching elements contained in the VF Drive. The windings shall allow for additional heating as a result of eddy current loss in the transformer windings carrying harmonic currents. Core design shall feature reduced flux density to prevent core saturation effects as a result of voltage waveform distortion caused by harmonic currents.

8.16 Execution

The Contractor shall not install the VF drive (s) until the building environment can be maintained within the service conditions required by the manufacturer. Before and during the installation, the VF drive equipment shall be protected

from site contaminants. Installation shall be in compliance with manufacturer's instructions, drawings and recommendations.

The Contractor shall provide a manufacturer's certified technical representative to supervise the Contractor's installation, testing and start-up of the VF Drive (s) furnished under this specification for the minimum number of days required for the technical representative to approve the installation and operation of the AC Drive. In addition, the manufacturer's technical representative shall provide training to the User's personnel.

Six months after start-up, the Contractor shall provide a manufacturer's certified technical representative to make a one-day site visit to inspect the VF Drive (s) and accessories.

8.17 Training

A certified representative of the VF DRIVE manufacturer shall provide an on-site training course of 3 training days to the User's plant and / or maintenance personnel. The training course shall include VF Drive model brochures, and troubleshooting manuals that describe accurate procedures to follow for maintenance personnel to quickly isolate a cause for Drive failure.

8.18 Ventilation

In self-contained cabinet units integrated cooling fan(s) are to be used to cool power section of the frequency converter.

Air intake and outlets are not to be restricted and clearance between the upper side of the cabinet unit is to be at least 450mm.

Filters are to be provided for air intakes in dusty environments. These must be removable for maintenance.

Chassis units are to have built-in fans(s).

A minimum clearance of 450mm to the floor, ceiling or other equipment, should be retained above and below the chassis unit.

9. PUSH BUTTONS AND INDICATING LIGHTS

These shall be 22mm diameter unless otherwise specified and shall be suitable for the environment conditions. Emergency Stop push-buttons shall be 40mm diameter "Twist to Release"

Unless otherwise specified, the following is the minimum requirement for illuminated push buttons and indicating lights: Illuminated Push buttons may be offered.

| PUSH BUTTON / LABEL | INDICATION / LABEL | COLOUR |
|---------------------|--------------------|--------|
| MOTOR START | MOTOR RUN | GREEN |
| MOTOR STOP | MOTOR STOPPED | RED |
| | MOTOR TRIPPED | AMBER |
| TRIP RESET | | BLACK |
| LAMP TEST | | WHITE |
| | MOTOR HEATER ON | WHITE |
| | OTHER | BLUE |

Indicator lamps may only be of the Cluster LED types. Where LED's are specified as indicators on main supply voltages, a suitable current limiting capacitor and reverse voltage protection diode must be used. For low AC or D.C. voltages ($\pm 24V$) a current limiting resistor will suffice.

10. CONTROL VOLTAGE SUPPLY

Control Voltage transformers will be required if the control voltage can not be obtained via a four wire system i.e. between neutral and white phase.

The control voltage shall be provided by a single phase, double wound transformer supplied from the Red and White phases of the main busbars, with the secondary voltage as specified on the schematic diagrams.

The primary and secondary connections are to be provided by suitably rated and labelled HRC fuses.

Unless otherwise specified, the transformer shall be rated at 0,8 X (total hold-on VA of all contactors plus VA of all lights and relays plus pull-in VA of largest device) with a further allowance of 50% for future extensions.

Should the main busbar system incorporate a buscoupler, 2 control transformers shall be provided. Supplies to the 2 transformers shall be controlled by contactors interlocked to ensure that only one transformer supplies the control circuits at any one time.

Where suitable, a control voltage busbar shall be provided along the length of the MCC.

One normally open auxiliary contact for control circuit isolation, which shall be interlocked with the main circuit breaker/isolator.

One normally closed auxiliary contact for test purposes shall be provided with an emergency stop button mounted on the inside of the hinged front panel for testing of the control circuitry and interlocks while the hinged front panel is open.

One Control Circuit mcb/fuse with fuse holder and one Control Link shall be provided for each motor starter.

11. SWITCHES

11.1 Voltmeter Selector Switch

All voltmeter selector switches shall be wired to connect the voltmeter between all phases and each phase and neutral and shall disconnect it in the OFF position. The switch shall have a positive located switching mechanism.

11.1 Control Selector Switches

All other selector switches specified e.g. control by-pass switches, ON/OFF, Duty Standby, Field/Off/PLC switches shall provide the required switching functions. Rotary switches shall have roll and wipe contacts to ensure low resistance. Rocker arm or toggle switches shall have bifurcated contacts.

11.2 Time Switches

Time switches shall be of single-pole type, suitable for 220/250V systems, with contacts rated for the duty to be performed, with a minimum rating of 15 A. Contacts shall be of high quality material, e.g. silver-plated or solid silver.

The clock shall be driven by a self-starting hysteresis synchronous motor, keeping accurate mains time. All clocks shall be controlled by an electrically wound escapement providing the main spring with a minimum of 15 hours reserve in case of a power failure. The main spring shall be kept fully wound without the use of slipping clutch devices that may wear and fall out of adjustment.

The main spring shall have a minimum of 15 hours reserve under full load and if fully discharged, shall be completed rewound with 15 minutes of the restoration of power.

An external manual bypass switch shall be provided to permit the circuit to be switched "ON" or "OFF" manually without affecting the timing of the time switch.

The time switch shall have a 24-hour dial with day and night indication that can be set to switch in 30-minute steps. The dial shall be fitted with 48 tappets corresponding to 48 change over operations in a 24-hour period. Alternatively, electronic time switches with 30-day battery timing back up may be offered.

The time switch shall be fitted with a day omission dial comprising a total of 14 tappets, which can be set to switch in 12-hour steps.

The time switch shall be housed in a dust tight moulded plastic or metal case consisting of a plastic clip-on front cover and a moulded plastic or metal base. The time switch shall have a transparent face to enable an operator to determine the time and settings without having to remove any covers. Time

switches to be used for surface mounting on walls shall be provided with a suitably positioned 20mm conduit knockout.

11.3 Sequence Time Switches

Sequence time switches suitable for starting a group of machines in a predetermined sequence, shall be provided as required. The switches shall provide the number of steps indicated and minimum time intervals of 15 seconds between starts.

Sequence time switches shall have normally open contacts unless specified to the contrary. The contacts shall be of silver-to-silver or other approved type with a minimum rating of 10 A.

Sequence time switches shall be of the reversible type, i.e. switching the machines on in the reverse sequence when rotating backwards.

Sequence time switches or time-delay switches shall be provided to prevent the simultaneous starting of major or multiple items of equipment. The sequence shall not be reversible.

The switches shall be constructed so that the driving motor of the unit shall switch off when forward rotation is complete while the controlled machines run on uninterrupted. When the machinery is to be switched off, the drive motor on the unit shall rotate backwards and switch the machinery off in the reverse sequence. An ON/OFF switch shall control the sequence time switch from a remote position, where "ON" denotes the starting sequence and "OFF" denotes the stopping sequence. Switch positions shall be indelibly labelled.

The switches shall return automatically to the start-up position when a power failure occurs.

The switches shall be suitable for operation at the system voltage.

Sequence time switches controlled by an electronic control unit providing the above functions are acceptable.

12. ANTI-CONDENSATION HEATERS

One 22,5mm diameter white LED HEATER ON indication with neon lamp with label for motors greater than 22kW.

One motor heater circuit mcb/ fuse + fuse-holder for motors greater than 22kW.

One N/C auxiliary contact on contactor for motor heaters rated at 400V for motors greater than 22kW

13. SUPPLIES TO HEATER BANKS

Switchgear, control and instrumentation for heater banks shall be grouped together in the switchboard. Equipment for the control and protection of heater banks shall be provided. Ammeters and indicator lights shall be flush mounted on a hinged front panel.

All circuit breakers shall be flush mounted on a chassis behind the hinged panels with punched cutouts. It is essential that the fault level at the output to each heater unit does not exceed the rupturing capacity of the circuit breaker. Where necessary, heater circuits shall be subdivided into groups and protected by HRC fuses and circuit breakers to limit the fault level. High-speed current limiting breakers are not acceptable. The above provisions are also applicable in cases where separate switchboards are provided to supply heater banks only.

14. CABLING, WIRING AND TERMINALS

14.1 Starter Wiring

Particular attention shall be paid to the method of wiring from busbars to the individual compartments, in order to avoid any cable crossing through a compartment with which it is unrelated.

Stranded 600/1000 V grade PVC-insulated stranded annealed copper conductors to SANS 1507 shall be used for the wiring between all starter components, isolators, fuses, contactors, overload relays and terminals is to be rated to suit the maximum capacity of the starter and shall withstand the short circuit rating of the panel but shall not be less than 2.5mm².

Three phase panels shall be wired in red, yellow and blue PVC insulated conductors for the phases, black for neutral and green for earthed circuits.

Single-phase panels shall be wired in red and black PVC insulated conductors, for phase and neutral respectively and green for earthed circuits.

Neutral connections shall be black and this colour must not be used for any other wiring.

Multi-stranded or laminated conductors shall be used between all items of equipment in preference to solid conductors. The insulation of these conductors shall not be stripped beyond the leading edge of the terminal in which it has to be accommodated. Stripping shall be carried out without damage to the conductors, preferably by means of a cable stripper.

Approved crimping lugs and ferrules or approved clamps shall be used for connection into equipment not provided with compression type terminals.

All panel wiring shall be completed and installed at the MCC manufacturing works. The wiring shall be loomed or encased in PVC cable trunking of Hellerman manufacture or equal and shall be carried out neatly along vertical and horizontal lines.

Connections between busbars and all equipment in the switchboard shall consist of heavy duty coloured PVC insulated stranded annealed copper conductors and/or solid high conductivity copper bars of ample cross-section covered with heat shrinkable material. The colours to be used in all instances shall be red, white and blue for phase connections and black for neutral connections. All circuits with a rating of 200A and more and all connections to cables larger than 70mm² shall consist of busbars only.

Flexible cords of minimum size 1mm² may be used for wiring of control instrumentation.

Where heat-generating equipment is present and the internal temperature of the board is likely to exceed 50°C on occasion, silicon-rubber insulated stranded conductors shall be used.

Wiring shall be arranged in horizontal and vertical rows and shall be bound with suitable plastic straps (cable ties) or installed in PVC wiring channels. Under no circumstances may PVC adhesive tape be used for the bunching of conductors or for the colour identification of conductors.

Bunched conductors shall be neatly formed to present a uniform appearance without twisting or crossing the conductors. Conductors leaving the harnesses so formed shall be so arranged that they are adjacent to the chassis. Conductors to hinged panels and doors shall be secured on both the door and the frame and shall be looped between the two points. The loop shall be arranged to produce a twisting motion when the door is opened or closed. A flexible protection sleeve shall be installed over the conductors.

All wiring between different panels within the same switchboard shall be installed in wiring channels.

Grommets shall be installed in each hole in the metalwork through which conductors pass.

All wiring shall be installed away from terminals, clamps or other current carrying parts. Wiring shall also be kept away from exposed metal edges or shall be protected where they cross metal edges.

Conductors may be jointed at equipment terminals or numbered terminal strips only. No other connections are allowed.

Where screened cables are specified, the screening shall only be earthed in the switchboard or control board, unless clearly specified to the contrary. Screened cables entering control boxes through pressed knockouts shall terminate in compression glands. Conductors shall as far as possible remain

inside the screening at terminations. Where conductors have to separate from the screen, the braiding shall be separated and the conductors drawn through the braid without damaging the braiding. The conductors shall then be connected to their respective terminals and the screening smoothed and connected to the earth terminal. For cables controlling electro-mechanical devices, no screening is necessary. Cables controlling electronic devices shall have high voltage screening.

Where neutral or earth connections are looped between the terminals of instruments or other equipment, it is essential that the two conductor ends be inserted into a common lug and are crimped or soldered together in order that the neutral connection is not broken when the conductors are removed from one of the instruments.

Conductors terminating on meters, fuse holders and other equipment with screw terminals shall be fitted with crimped lugs.

Wiring should be confined to the front portions of switchboards as far as possible for ease of access. This requirement is important for wiring between circuit breakers with a rating of less than 60 A and the associated main circuit breakers as well as the wiring from circuits to lighting and socket-circuits.

A maximum of two conductors will be allowed per equipment terminal. Where more conductors must be connected to the same equipment terminal (e.g. a main circuit breaker feeding other circuit breakers). Stub busbars shall be provided for the various conductors.

14.2 Control and Instrumentation

Suitably protected control, supervisory and auxiliary circuits must be wired with 2,5mm² conductors. Control circuits shall be wired with red PVC insulated conductors. Instrument wiring shall be grey.

Each end of the conductor shall be terminated in a pre-insulated, spade or pin type lug, applied by means of the recommended colour coded crimping tool. All control wiring shall be clearly marked by interlocking plastic ferrules, the numbers corresponding to wire numbers on the schematic diagrams.

If control and/or supervisory wiring is required for equipment which is installed on the hinged front panels of the panel the wiring shall be bunched together and suitably strapped with spiral binding in the form of a vertical "U" loop between the hinged front panel and the panel, to ensure that there is no tension on the wiring when the hinged front panel is rotated along its vertical axis. Approved wiring supports shall be fixed onto the hinged panels, to relieve the weight of the cables off the equipment terminals. Each hinged front panel shall be suitably earthed.

14.3 Power Cable Terminations

Sufficient space must be allowed for the connection of all known and future incoming and outgoing cables.

Outgoing cables shall be glanded off on galvanised gland plates at the bottom or top of the vertical cableways. Where top access is required, it will be specified in the tender document.

Approved shrouded and shielded terminals shall be provided for the outgoing connections to each motor for conductors up to and including 35mm², **rated at least 50% in excess of the conductor rating**. The terminals shall be fixed in the vertical cableway of the assembly and shall have ample space for making off the outgoing cable terminations.

Conductors of 50mm² and above shall be terminated directly onto the starter equipment, but the cables must be adequately supported to ensure that no strain is imposed on the equipment.

14.4 Gland Plates

A strong and robust hot dipped galvanised cable gland plate shall be provided along the entire length of the assembly at a minimum height of 300mm above floor level. The thickness of the gland plate shall be suitable for the required gland size but shall not be less than 3mm thick. The gland plate shall be constructed in sections and bolted in position to take the load of the cables being glanded to it.

When cables enter/exit from the top of the board, the top cover plate will act as the cable gland plate and shall also be 3mm thick. It shall be bolted to the frame so that it can be removed if necessary. The terminals associated with these cables will be mounted not less than 200mm below the top cover plate.

All gland plates shall be machine punched in the factory to suit each and every cable gland required. Under no circumstances will any drilling or filing be allowed on site.

14.5 Outgoing Power Circuits

All cables shall be terminated with approved glands to suit the application. Particular attention shall be paid to the termination of ECC cabling to ensure the continuity of all earth conductors.

Every termination of a power cable shall be provided with an approved numbered Bowthorpe Hellerman tag identifying its size and destination, fixed below the cable gland plate in a position which is easily observed from the front to the board. This procedure must also be incorporated at the motor termination box.

All outgoing power cables shall terminate within 300mm of the gland plate to avoid long leads. Where this is not possible, each lead must be separately braced.

Power cable sizes up to and including 70 mm² may terminate on clamp type terminals where the clamping screws are not in direct contact with the conductor, but bears upon a clamping plate. Connection to the equipment can then be made with cables that are similarly connected to the terminal. All power cable sizes larger than 70 mm² shall terminate on busbars that are connected to the associated equipment. Conductors shall have lugs that are sweated or crimped. Looping of incoming supply wiring to large circuit breakers and contactors, etc. is not acceptable. Each device shall be individually connected to the supply busbar.

15. MARSHALLING COMPARTMENTS

When specified, marshalling compartments shall be provided for control circuit wiring.

The marshalling compartment shall be adequately sized to accommodate all the required terminals PLUS provision for a further 50% spare terminals.

Where a motor control centre is to be broken down for transportation to site, each section shall be provided with a marshalling compartment to the above requirement so that the associated wiring is not disturbed.

Where such control circuits are unavoidable and control wiring has to cross a break, it shall be suitably identified and disconnected at one end during transportation.

Terminals for each starter should be grouped together and clearly identified by a permanently affixed label. Terminals shall be mounted on rails and space shall be provided for spare terminals after each group of terminals.

A suitable gland plate shall be provided for terminating the control cables and adequately sized cable way shall be provided for running the cable ends to the terminals in the marshalling compartment.

A 240 Volt switched socket outlet shall be provided in each marshalling cubicle. Where specified, a switched light shall also be provided.

16. PLC HARDWARE

When specified in the tender document, provision shall be made for mounting the PLC hardware in the motor control centre. All PLC components will normally be supplied as "Free Issue" to the manufacturer unless specified otherwise in the detailed project specific specification and bill of quantities.

Details of the equipment to be installed and the required arrangement of such equipment will be included in the tender document. In general, the manufacturer shall allow 1 or more compartments or tiers in the MCC for rack assemblies which shall accommodate ONLY the PLC hardware, including the input and output modules.

Where special power supplies such as a CVT, UPS or DC supply are specified, these shall be regarded as part of the hardware and shall be mounted in the same compartment as the other equipment. Ventilation fans and renewable filter elements shall be provided to ensure that temperature limits are not exceeded.

The power circuit drawings and the control schematics relating to each MCC, will include all connections to the PLC hardware. All such connections shall be made by the MCC manufacturer via the marshalling compartment.

In addition to the general power earth bar specified elsewhere, an 'Instrument Earth (0) Volts Bar' and an 'Instrument Screen Earth Bar' shall be provided in each compartment housing PLC Hardware and these shall be used only for instrumentation earthing connections. They shall be electrically isolated from the power earth.

Particular attention shall be paid to the provision of cabling facilities to the modules. Adequate PVC cable trunking shall be installed and separate trunking shall be provided for analogue and digital circuits.

Wiring to and from analogue input and output modules shall be carried out using cables equal to Contronics DEKORON control cable Type 1751, with 0,5mm² conductors.

Each analogue control cable shall be individually earthed to the instrument earth bar by means of its tinned copper drain wire AT ONE END ONLY.

The wiring between each starter panel and the digital input and output modules in the PLC panel shall be as indicated on the circuit diagrams and shall be installed in adequately sized PVC trunking with provision for 50% spare capacity. With the exception of the PLC output to the starter or relay coil, no power circuits may be run in this PVC trunking.

Each end of each core shall be terminated in a spade or pin type pre-insulated lug and marked with its respective wire number by means of interlocking plastic ferrules, as detailed in the circuit diagram or termination schedule.

Where connections are to be made between the PLC I/O modules and field cabling, the MCC manufacturer shall wire the I/O module terminals to the marshalling compartment.

17. SURGE DIVERTERS

Where specified, the MCC is to be equipped with surge diverters of approved manufacture and bearing the SANS mark.

The arrestors or diverters shall be mounted inside the panel on the incoming unit. The supply side connections shall be made in the factory to the three phase busbars, whilst the earth side connections shall be made to the earth bar of the board.

18. EARTHING OF METAL PARTS

All non-current carrying metal parts of the switchboard including the framework, metal enclosures of equipment, iron cores of contactors and transformer etc. shall be solidly earthed to the earth busbar. All hinged panels shall have a 4 mm² flexible copper braid connection which is bolted onto the panel and frame. Screw connections on finished surfaces shall be made with tooth washers.

19. SPARE FUSE CARTRIDGES

Where HRC or other cartridge type fuses are specified or used to protect instruments or circuits, the MCC shall be suitably equipped with a compartment for housing one third of all fuse cartridges specified, having a minimum of 1 set (i.e. 3 phase) of fuses of each size specified and all such spare fuses shall be provided inside this compartment on handing over. The compartment shall be clearly labelled: "Spare fuse cartridges: replace used-up fuses".

20. LABELS

The requirements of SANS 10142-1 must be complied with.

All boards or panels shall be fully labelled using ENGRAVED TRAFFOLITE labels, fixed to the board or panel by means of either screws or rivets, or by gluing into metal label holders which are bolted to the board. The Starter Equipment Description, Equipment Tag Number and kW Rating shall be labelled.

Labels should be black lettering on a white background, not less than 5mm in height and mounted centrally below each respective starter unit, in an approved position. A centrally mounted label shall be provided to indicate the manufacturers details, the design busbar rating and asymmetrical fault level.

A label indicating where the board is 'Fed From' shall also be fixed to each MCC.

All relays and wiring terminal blocks inside the MCC shall be labelled to clearly identify the control gear and wiring to equipment.

Danger or Warning Labels shall have red letters on a white background.

21. WORKS TESTS

The MCC shall be fully assembled and wired before being despatched from the works. The Contractor and the switchboard manufacturer will carry out a full functional test to prove the correct operation of the entire MCC, including interlocking, remote control and the simulation of all protection devices. Polarity and primary current injection tests shall be undertaken. All other circuits external to the switchboard will be simulated and will be tested accordingly. All MCC's with a fault level of 10 kA or more shall be type tested by an accredited person and a signed certificate issued with the MCC. The costs of all these tests shall be borne by the Contractor. The tests shall be witnessed by Bosch Projects.

Unless otherwise specified, the correct functioning of the PLC hardware will not be the responsibility of the MCC manufacturer, but the Contractor will be expected to have an artisan standing by during these tests in order to observe the MCC operations and carry out any remedial work required.

The tests shall be witnessed by Bosch Projects and shall be recorded in triplicate on approved test forms.

22. SITE TESTS

After completion of erection, cabling and field wiring, the Contractor shall set all overloads, protection devices etc. and shall again carry out a full functional test to prove the correct operation of the entire MCC, including the simulation of all remote devices. A signed compliance certificate by the Contractor's accredited person for the MCC and its installation shall be handed over to Bosch Projects on Completion.

The tests shall be witnessed by Bosch Projects and shall be recorded in triplicate on approved test forms.

23. INSTALLATION OF MOTOR CONTROL CENTRES

The Contractor shall make it his responsibility to furnish the switchboard manufacturer with all the relevant information in respect of the accommodation to be provided, including cable trenches, ducts, plinths and raised flooring.

Where possible, the largest number of cubicles or panels should be installed intact, to avoid assembly on site, provided space and handling facilities and conditions do not lead to damage of the unit. All floor mounted motor control centre must be bolted securely to the floor.

The Contractor will advise the manufacturer which of the cables enter or leave from the top or bottom of the MCC.

During transport to site and installation, the boards shall be protected against mechanical damage and vibration.

Boards shall not be moved onto site nor installed until all building services and finishing trade work has been completed in the room or vicinity of where the boards are to be installed.

The boards shall be installed in such a manner as to facilitate extensions, maintenance , testing and repair work with easy access to cable entries terminations, current transformers, potential transformers, small wiring terminal boards and relays, and busbar connections.

Prior to the on-site tests, all screws, bolts, joints and cable terminations shall be checked for tightness. Busbar joints and cable terminations must be torqued to the correct tension.

All suitable galvanised angle iron, holding down bolts and other fixing accessories shall be provided.

24. DRAWINGS, BOSCH PROJECTS'S APPROVAL, GUARANTEES

CAD generated drawings of the equipment showing full details of layout and proposed wiring system and equipment offered shall be submitted for approval to Bosch Projects prior to manufacture.

Bosch Projects shall also be advised when the boards are being manufactured and when they will be ready for inspection at the works. Equipment which is despatched to the site without the authorisation of Bosch Projects may be rejected and all costs incurred in having it returned to the factory, where necessary, and any liability for delays, will be for the Contractors account.

The Contractor will issue to Bosch Projects the following:

- Dimensioned general arrangement layout plans of the MCC and sections through the board.
- Busbar and dropper bracing and support details. Where the system fault level exceeds 15kA specimen calculations or test reports of the busbar supports in substantiation of short circuit capacity of the system.
- Busbar section and size including selection/sizing criteria and calculations in substantiation of the full load rating.

- All labelling information of components and circuit wiring cross referenced on a separate sheet.
- Wiring Schematics;
- System and component descriptions;
- Component data and calibration sheets if applicable;
- Operation & Maintenance instructions with recommended preventative maintenance programme;
- Fault finding analysis;
- Adjustment and calibration settings of all protection devices;
- Priced spare parts list with names of local suppliers and list of spares recommended to be kept in stock.

CD ROM of Autocad or DXF drawing files and 3 paper print copies of drawings of the "as built" equipment which has been installed and connected on site.

A 12 month guarantee shall cover the sheet metal enclosures and all the equipment installed therein against faulty workmanship and materials. The guarantee period shall begin from the date the MCCs are completely installed and accepted by Bosch Projects. Fair wear and tear of equipment will be excluded from the guarantee.

25. COMPLETION

Prior to the handing over of the boards or panels, they shall be rendered completely free of all dust or rubbish that may have collected during installation and building operations, and finished surfaces shall be made good where necessary, using the identical paint finishes from the same batch, as at the time of manufacture.

The MCCs shall be vermin proofed. Similarly, all cable trenches will be thoroughly cleaned out and all covers fitted before the work will be considered as complete.

All labels will be correctly engraved and fixed to panels and cables as specified before the work can be considered complete.

26. SUGGESTED SUPPLIERS

The following list of approved manufacturers and suppliers of electrical equipment is provided for the convenience of tenderers. Other makes and suppliers of electrical equipment may be considered by Bosch Projects, but the tenderer is presumed to have included the following equipment in his original offer:

Air circuit breakers (ACB)

Mitsubishi
Schneider
Siemens
Unelec

Moulded case breakers (MCB)

C B Industries
Mitsubishi
Moëller
Schneider
Siemens

Combination fuse switches (CFS)

Alstom
Stromberg
Siemens

HRC fuses and cartridges

Alstom
Hager
Hazemeyer
Siemens

Contactors and overload relays

Allen Bradley
Cutler Hammer
Moëller
Schneider
Siemens

Relays and timers

Mitsubishi
Omron
Rhomberg-Bräsler
Schneider
Siemens

Terminal blocks

Allen Bradley
Klippon
Phoenix
Pratley
Schneider

**Push buttons, selector switches
pilot lights**

Allen Bradley

Cutler Hammer
Moëller
Omron
Schneider

Surge diverters

Dehn
Phoenix
Yelland

PLC

AEG/Modicon
Allen Bradley
Schneider
Siemens

Instruments

ABB
PCI

Electronic Soft Starters

ABB
Solcon
Siemens
Telemecanique

Variable Speed Drives

ABB
Danfoss
Moeller
Siemens
Telemecanique
Yaskawa

27. MANUFACTURERS

The following list of approved South African manufacturers is enclosed for the convenience of tenderers. Other manufacturers may be considered by Bosch Projects, but only if they have a proven track record of manufacture to SANS 1473/SANS 60439.

The tenderer shall ensure that copies of these Standard Specifications, Detailed Specifications, layout drawings and single line diagrams shall be provided to the manufacturers to ensure that they make full allowance for all requirements in their pricing.

ABB

Cutler Hammer

Gamma Panels

Electron

Magnol Panels

Moeller

Magnol Panels

RBF

Siemens Limited

Switchboard Manufacturer's

PROJECT SPECIFICATION

PORTION 3: PARTICULAR SPECIFICATION

C1DG **SUPPLY AND INSTALL DIESEL GENERATOR (10969-001-2040-R-0004)**

10969/001/2040/R/0004 – RevT1

**SAFDA MKHUZE RAIL SIDING
PROJECT**

**ENGINEERING SPECIFICATION
DIESEL GENERATOR**

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TECHNICAL SPECIFICATION

1. ABBREVIATIONS, TERMS AND DEFINITIONS

The following abbreviations, terms and definitions shall apply for this contact:

1.1 Abbreviations

| | |
|-----|---|
| dc | Direct Current |
| DB | Distribution Board |
| DOL | Electrical Direct On-line Starting of Electric Motors |
| I/O | Input / Output |
| ISO | International Standards Organisation |
| LV | Low Voltage |
| mA | Milliamps |
| MCC | Motor Control Centre |
| NDT | Non Destructive Testing |
| OEM | Original Equipment Manufacturers |
| PLC | Programmable Logic Controllers |
| VFD | Variable Frequency Drive |

1.2 Terms and Definitions

In interpreting this specification, the following words shall have the meanings herein assigned:

| | |
|---|---|
| 3PH | means 3 phase |
| CT | means Current Transformer |
| Codes and Standards | means the design and construction codes and standards that are applicable to the Works and which are listed as Project Standards, National Standards, Local Standards and International Codes and Standards in the Codes and Standards section of the Specification |
| Company | means South African Farmers Development Association |
| Connection elements | means all holding down, anchor or connection bolts including all washers, nuts, screws, spacers, shims etc. |
| Contractor | means the natural or juristic person supplying the Goods and/or services as indicated in the contract. |
| Contractor's Data Book for the Works | means the Contractor's record of all Goods certifications, and all other statutory tests and |

CONFIDENTIAL Any information contained herein is to be treated as confidential and may not be divulged to any other party without the prior written approval of Bosch Projects (Pty) Ltd and South African Farmers Development Association.

| | |
|------------------------------------|--|
| | certifications required in terms of the Laws and/or the Codes and Standards |
| Drive Assemblies | means all motors, gearboxes, couplings, bearings, torque arms, guards and base plates |
| Facility | means the Company's sugarcane transloading facility at Mkhuze, KwaZulu-Natal, South Africa |
| Goods | includes all equipment, materials, plant and temporary works |
| Hz | means Hertz |
| kA | means kilo Amps |
| kV | means kilo Volt |
| kVA | means kilovolts ampere – apparent power |
| LV | means Low Voltage |
| MVA | means mega volt amperes |
| ONAN | means natural oil and natural air cooled |
| Punch List Category A Items | These items effect the safe operation of the Goods |
| Punch List Category B items | These items effect the completeness of the Goods |
| Punch List Category C items | These items effect the aesthetics of the Goods only |
| QCP | means Quality Control Plan |
| R, W & B | means Red, White and Blue |
| Shall | is mandatory |
| Should | is strongly recommended |
| V | means Volts |
| VT | means Voltage Transformer; andd |

2. INTRODUCTION

The project entails construction of a transloading facility at Mkhuze Rail siding, where cane will be transferred from road trucks to rail wagons and transported by Transnet Freight Rails to the mill, a total journey length of 350kms.

2.1 Background and Overview

The cane grown in the Makhathini region currently being transported to the Felixton mill by road requires a more economically, sustainable, and efficient way of transporting the cane to the mill as of March 2021.

3. SCOPE OF WORK

The scope of work includes the design, manufacture, supply, delivery, offloading into position testing and commissioning, of the new 180kVA diesel generator set complete with all ancillary equipment.

Also included in this specification is the design, supply, delivery, offloading and installation.

The technical specification is to be read in conjunction with all of its Annexures in order to obtain a complete view of the scope of work. The Equipment to be supplied by the Contractor shall include but is not limited to the following:

- a) A 180 kVA diesel generator with all ancillary equipment necessary to comply with the requirements of this specification. The plant generally shall comprise a diesel engine directly coupled to an alternator mounted on a common base with fuel tank, a set of starting batteries, automatic charging unit, interconnecting cables, a control panel housing the generator control and management system. Water cooled engine directly coupled to an alternator will be preferred, for operation at 400/230 volts 50 Hz at 1500 RPM. The diesel generator plant shall comply with the requirements of BS 5514.
- b) The manufacture and supply of a wall-mounted change over panel, to be installed in the Electrical Room of the facility building;
- c) The diesel generating set shall be mounted on a concrete slab (installed by others) to be located alongside the facility building. Detailed requirements of the reinforced concrete slab and bund wall shall be supplied by the contractor to the Engineer for the civil contractor to install;
- d) Tenderers are advised to acquaint themselves with the site conditions including access, as no claim on the grounds of want of knowledge will be entertained;
- e) Supply of layout drawings and wiring diagrams of the electrical panels for review by the Employer's representative. A service log book shall be fixed to the inside of the canopy;
- f) Assembling the generator and change-over panel to conduct full load acceptance tests in the supplier's workshops. Provision of fuel for 1-hour test;
- g) Supply of diesel fuel to fill the 16hr skid mount fuel tank;
- h) Testing and commissioning of the entire generator installation after the cables have been connected and the submission of all test results, test reports and certificate of compliance to the Engineer;
- i) The supply of 3 sets operating and maintenance manuals and spare parts lists;
- j) Quality assurance and control (in accordance with ISO 9000);
- k) Safety and health requirements (in accordance with the OHS Act);
- l) Statuary safety and fire notices –to be mounted inside the hinged doors;
- m) Health and Safety plan;
- n) Risk analysis reports, etc; and
- o) Any other item not specifically mentioned above but deemed necessary for the satisfactory performance of the equipment to be supplied.

Note the information supplied in this Technical Specification in the form of data, drawings, descriptions, and Equipment sizes, etc, is intended to serve as a guide to the requirements of the Purchaser. The Contractor shall however be responsible for the performance of the Equipment and shall verify and confirm all size selections. Should the Contractor not be in agreement with the concepts presented, alternative concepts and designs shall be offered with full justification for the change.

It is preferred that only proven technologies be incorporated into the design of all Equipment. However, if the Contractor believes that there are significant savings to be made by offering alternative technologies, it is encouraged to include details of these alternatives clearly outlining their advantages and cost implications in the tender submission, in addition to the proven/requested technology option.

The acceptance of the information in this Technical Specification shall in no way relieve the Contractor of its responsibilities and obligations in terms of the design and engineering performance of the Works.

3.1 Scope Inclusions

- a) Project management of this Contract's scope of work including planning, scheduling and reporting to the Purchaser and the Engineer;
- b) Implementation of an appropriate quality system and quality control;
- c) Submission of all documentation, drawings and technical data as outlined in the schedule of Documents and Drawings included in this Technical Specification as well as those required for statutory regulation and project control;
- d) Selection of suitable materials of construction and appropriate codes of practice, standards and specifications applicable to the Works where not already specified herein;
- e) Supply of all related software and licences if applicable;
- f) Surface preparation, protection coatings, painting and finishing of all Equipment and Materials;
- g) Workshop and Site inspections including NDT and factory acceptance testing of electrical equipment as per the relevant codes and standards;
- h) Packing, marking and protection of all Equipment for shipping/transport including loading supervision where necessary;
- i) Supervise the positioning, assembly, alignment, and installation of all Equipment;
- j) Training of the Purchaser's/Purchaser's staff during first year of operations;
- k) Pre-commissioning, commissioning, trial operation, performance testing and punch listing activities;
- l) The supply of any special Equipment required for erection, commissioning and performance testing of the Equipment as required;
- m) Performance Guarantee and Warranty;
- n) A programme indicating manufacturing and delivery schedule; and
- o) Supply of all equipment and personnel required to comply with all local regulations;

3.2 Scope Exclusions

The following nominated items are specifically excluded from the scope of supply:

- a) Overall project management of this project;
- b) Construction power and water;
- c) Environmental impact assessments;
- d) Environmental impact management plans;
- e) Civil Works – foundations, grouting, concrete floors and earth works;
- f) Supply and installation of the power cable from the alternator to the change over switch mounted in the electrical room; and
- g) Supply and installation of cabling for power supply to the generator control panel and remote status indication.

3.3 Terminal Points

The terminal points of this scope of supply shall be as follows:

- a) The outgoing terminals on the alternator;
- b) The power supply and status signal terminals in the generator control panel; and
- c) The incoming and outgoing terminals of the changeover panel provided in this scope of works.

3.4 Plant Duties

The diesel generating set and its ancillary equipment shall normally operate as a standby mains failure unit, although it shall be capable of operating continuously for up to a week between service stops as the mains supply connection may be delayed for the first few months of operation. It shall be capable of delivering its full rated output at any time and any ambient conditions likely to occur at the site. The generating set will not be required to be synchronized back with the main supply. The generator will supply power to a changeover panel in the facility building electrical room which will supply power to the full back up board during a mains failure.

The principal load on site is a 110 kW hoist motor driven by a VFD which operates at full load for approximately two minutes every 10 minutes. The balance of the site load is continuous at approximately 30 kVA.

3.5 Rating

- a) The unit shall be capable of delivering 180 kVA at 400volts, 0.85 power factor at a speed of 1500 rpm – Prime Power.
- b) The unit shall be capable of meeting the projected load profile on a continuous basis for a period of up to one week.
- c) The rating of the diesel generating set shall be based on operation of the set being enclosed in a canopy, fully equipped with all necessary accessories such as radiator fan, air cleaners, lubricating oil pump, fuel transfer pump, fuel injection pump, water circulating pump, and battery charging alternator.

- d) The generator set shall be capable of delivering the specified output continuously under the site conditions without overheating. The engine shall be capable of delivering an output of 110% of the specified output for one hour in any period of 12 hours consecutive running in accordance with BS5514.

4. TECHNICAL SPECIFICATION

4.1 Electrical Parameters

| | |
|------------------------------|---------------------------|
| System voltages | 400 V AC 3PH and 230 V AC |
| LV fault level at Main LV DB | 10 kA |
| Lighting impulse withstand | 8 kV |
| Power frequency withstand | 2 kV |
| Phase rotation and colours | R, W and B |
| Site supplies | 400 V 3PH and 230 V 1PH |
| Frequency | 50 Hz |

4.2 General Specification and Codes

Listed below are the specifications and codes that shall be complied with:

4.2.1 Codes of Practice

| | |
|------------------------|---|
| SANS 10142 | Wiring of Premises (Part 1 and 2) |
| IEC 60204 | Safety of Machinery |
| OHS Act No. 85 of 1993 | Occupational Health and Safety (OHS) Act No. 85 of 1993 (RSA) |
| NOSA | N.O.S.A. Safety Guidelines |

4.2.2 National and International Standards

| | |
|--------------|--|
| SANS 1091 | SA National Colour standards for paint |
| SANS 61439 | Low voltage switchgear and control gear assemblies |
| SANS 1195 | Standard specification for busbars |
| SANS 1973-1 | Low-voltage switchgear and control assemblies Part 1: Type tested, partially type tested and specially type tested assemblies with a rated short-circuit withstand strength above 10kA |
| SANS 60044 | Instrument transformers |
| SANS 60269 | Low Voltage Fuses |
| SANS 156/556 | Moulded-case circuit breakers |
| SANS 60529 | Degrees of protection provided by enclosures (IP Code) |
| SANS 60947 | Low voltage switchgear and control gear |
| SANS 61000-1 | Electromagnetic compatibility (EMC) Part 1: General |
| SANS 10064 | The preparation of steel surfaces for coating |
| SANS 1274 | Coatings applied by the powder-coating process |
| SANS 10142-1 | Low Voltage Electrical installation |
| VC 8003 | Manually operated switches for fixed installations |
| VC 8035 | Compulsory specification for earth leakage units |
| VC 8036 | Compulsory specification for circuit breakers $\leq 125A$ and $\leq 10kA$ |
| SANS 1632-2 | Batteries |

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| | |
|---------------|--|
| SANS 1652 | Battery Chargers |
| SANS ISO 8528 | Reciprocating internal combustion engines |
| SANS 61312 | Protection against lightning and electromagnetic impulse |

4.3 Diesel Generator: Technical Specification

4.3.1 Diesel Engine

4.3.1.1 Type

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

4.3.1.2 Cooling System

The engine shall be of the water cooled type and the cooling system shall be of sufficient capacity to cool the engine when the set is delivering its full rated load in the ambient conditions specified in Clause 3.

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

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

The heater shall be so fitted that it can easily be withdrawn without having to drain the system. The heater shall be suitable for a 220-volt 50 Hz supply.

A low coolant level shutdown sensor switch shall be fitted in the radiator header tank. A separate temperature sensor must be fitted on the block for the normal high engine temperature shutdown and gauge

4.3.1.3 Speed

The engine speed shall not exceed 1500rpm at normal full load conditions.

4.3.1.4 Fuel

The engine shall be capable of satisfactory performance on a commercial grade of distilled petroleum fuel oil such as Number 2 fuel oil. (Commercial grade diesel fuel).

4.3.1.5 Rating

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

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

The engine shall within 120 seconds from being called to run, supply the full rated load at the specified voltages and frequency.

4.3.1.6 Governor

The engine shall be of the latest electronic type or controlled by a governor to maintain governed speed for 50 Hz operation. Class A1 governing in accordance with B.S. 5514 as amended is required.

4.3.1.7 Day Tank

The fuel tank shall be an integral part of the base frame of the generator set. The tank shall have sufficient capacity to run the engine on 100% load for a minimum period of 16 hours.

The tank shall be made of painted mild steel and fitted with a suitable filter, level gauge, removable inspection cover, drain, filler cap, low level alarm and extra low shutdown alarm sensors. These shall supply an audible and visible signal on the control panel. The fuel line shall also be fitted with a Duvalco in line water separator/fuel filter combination unit. Pump start and pump stop sensors will not be required for the control the automatic filling of the day tank from a remote free-standing farm tank or from a mobile trailer tank.

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

4.3.1.8 Lubrication

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

Full flow replaceable element type oil filters, conveniently located for servicing, shall be provided. Filters shall be provided with a spring-loaded by-pass valve to ensure circulation if the filters become clogged.

4.3.1.9 Cylinder Liners

The engine shall be provided with removable wet or dry type cylinder liners of close-grained alloy iron.

4.3.1.10 Exhaust System

The engine shall be fitted with an efficient Stainless-Steel exhaust system. Flexible bellows shall be fitted between the exhaust outlet and the silencer. The flexible piping must on no account be used to form a bend or compensate for misalignment. The silencer shall be located inside the canopy and the discharge pipe run from the silencer out through the wall of the canopy.

The silencer and discharge piping shall be firmly supported

The exhaust piping and silencer shall be suitably lagged.

Openings through the canopy are to be neatly drilled and stainless-steel flashing plates must be fitted both sides.

4.3.1.11 Flywheel

The flywheel shall be designed to limit the cyclic irregularities to within the limits laid down in B.S. 5514 as amended.

4.3.1.12 Engine Starting

The engine shall be equipped with a 12/24 volt starting system of sufficient capacity to crank the engine at a speed, which will allow starting of the engine.

The starting equipment shall include a 12/24 volt D.C. starter motor engaging directly on the flywheel ring gear. A heavy duty battery charging alternator and maintenance free batteries of the Delco/Deltec type shall be supplied. The batteries shall be mounted in a lockable battery box.

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

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

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

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

4.3.1.13 Engine Instruments

The following instruments with suitable limit markings shall be provided on the generator panel:-

- a) Water temperature gauge. The gauge shall be calibrated at the lower part of the temperature range, so that when the engine is inoperative the temperature of the water is readable when heated by the immersion heater only. The temperature range shall extend beyond the operating range of the engine.
- b) Lubricating oil pressure gauge.

4.3.1.14 Safety Controls

The engine shall be equipped with the safety controls as specified in clause 4.3.4.

4.3.1.15 Engine/Alternator Coupling and Base

The engine and alternator shall be direct coupled and arranged for operation at 400/230 volt, 50Hz and 1500 RPM.

The plant base shall be manufactured from mild steel painted black and fixed to a concrete base. Concrete base by civil contractor. The steel fabricated duplex base-frame (incorporating the day fuel tank) with anti-vibration mounts installed between the engine / alternator combination and base frame. Teeco pads are also to be installed between the base frame and the floor.

4.3.1.16 Radiator Extract Ducting

A painted mild sheet metal duct shall be provided and installed between the radiator face and outlet louver to positively duct the hot expelled air out of the canopy.

4.3.2 A.C. Alternator

4.3.2.1 Rating

The generator shall be a 400/230 volt, 3 phase, and 4 wire 50 Hz machine. The generator rating shall be applicable for continuous service application.

4.3.2.2 Construction and Manufacture

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

The generator shall be of heavy duty compact design. Insulation shall be Class H as recognised by B.S.5514.

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

4.3.2.3 Performance

The generator shall be capable of continuously delivering the full rated load specified in Clause 11.1.0 and of providing a 10 % overload for the period and in the manner specified for the engine in Clause 9.5.

4.3.2.4 Wave Form

The shape for the voltage and current wave shall be within the limits laid down by B.S. 5000.

4.3.2.5 Voltage Regulation and Response

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

The voltage regulation shall not exceed $\pm 2\frac{1}{2}\%$, from no load to full load, including cold to hot variations at any power factor between 0,8 lagging and unity and inclusive of speed variations within the limits stated in Clause 7.6.

Upon application of full load at a power factor of 0,8 lagging the alternator voltage shall recover to within $2\frac{1}{2}\%$ of the steady state value within approximately 300 milliseconds.

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

4.3.2.6 Windings

The generator stator windings shall be star connected with the star point brought out and connected to the neutral terminal in the terminal box on the generator to provide a 400/230 volt supply.

4.3.2.7 Terminal Box

The terminal box shall be fitted to suit the cable route and it shall be large enough to allow for glanding and connecting cables up to 120 mm² in size.

4.3.2.8 Radio and T.V. Interference

The generating set shall be suitably suppressed within the limits of B.S. 800 against radio and television interference.

4.3.3 Diesel Generator Control Panel and change over panel

The diesel generator change over panel shall be installed in a standalone wall mounted panel which shall be situated in the Electrical Room of the facility building.

The generator control panel equipped with a suitable controller and engine management system may be housed within the enclosure of the diesel generator or installed in the Electrical Room of the facility building. The generator control panel shall also come complete with auxiliaries and CT's for the generator control functions as required by the controller.

The control panel shall be of robust construction, mounted on the base frame and totally enclosed and dust proof. It shall be of manufactured mild sheet steel construction suitable for front entry through hinged doors and have a minimum ingress protection of IP54. Special attention shall be given to vermin proofing and dust sealing. All hinged doors shall have suitable bracing to ensure rigidity and door handles.

The changeover panel shall conform to the standards and specifications as set in the IEC/SANS 61439 as a minimum. All other IEC/SANS standards and specifications for equipment not specified in 61439 shall also apply.

The change over panel shall be a wall mounted, front access only panel with wire ways as required. The panels shall also be designed for bottom cable entry and have a minimum ingress protection of IP54. The panel shall be rated to withstand a 10kA fault for 1 second.

All doors, rear wall and covers shall be put through a 5-stage iron phosphate cleaning process thereafter epoxy powder painted to a thickness of 60-80 microns.

The panel shall be painted signal red – RAL 3001.

All bolts, nuts, washers etc. shall be rust proof and adhere to ISO metric standards.

All removable covers protecting 415V/240V equipment shall be fitted with warning labels.

The overall outside dimensions of the assemblies shall be suitable for easy installation of the switchgear in the electrical room. The height of the assemblies shall not exceed 2.3m above floor level

4.3.3.1 Bus-Bars, Wiring, Switchgear, Etc.

All bus-bars and wiring shall be adequately rated and suitably supported, and control wiring shall be neatly laced and numbered with durable plastic ferrules, for easy tracing. Suitable terminals are to be provided for incoming and outgoing cables. Suitably sized holes shall be punched in the gland plates for the required number of cable terminations for both incoming and outgoing cables. The cables shall be secured to the gland plate by means of cable glands as Pratley, C.C.G. or other approved. The gland plate shall be suitably braced to prevent distortion after the cables are glanded thereto.

4.3.3.2 Change over panel

The changeover shall comprise of two 4 pole (3L + N) moulded case circuit breakers (MCCB). The circuit breakers supplied shall be Schneider Electric or equivalent MCCB's. The breakers shall be rated at the generator full load current or 300A, whichever is the greater, and shall be able to withstand a 10kA fault level for one second. The two moulded case circuit breakers shall be mechanically and electrically interlocked, and shall be locally operated by a suitable physical or motorised operator mechanism. The change over switch shall allow the operator to select operating positions as "ESKOM", "OFF", or "DG".

4.3.3.3 Generator control panel

- a) 1 x generator controller
- b) 1 x Power Monitor
- c) 1 x Flush mounted voltmeter 0 -30VDC - Battery volts (Digital display)
- d) 1 x Flush mounted running hour meter.
- e) 1 x Manual start push button.
- f) 1 x Manual stop push button.
- g) 1 x Emergency stop push button - "Latching type".
- h) 1 x Engine alternator charge indication.

- i) Off/Reset, Auto, Manual, Test toggle/push button switches
- j) Alarm Mute push button switch

4.3.4 Specification of Controller

4.3.4.1 Front Panel Indicators and Displayed Messages

The controller status including Warning and Shutdown/ Critical alarms shall be indicated by a combination of LEDs and messages on the LCD display.

| CONDITION | LED | DISPLAY MESSAGE | WARNING | SHUTDOWN |
|---------------------------------|-----|-----------------|---------|----------|
| TEMPERATURE HIGH | | X | X | |
| HIGH TEMPERATURE | | X | | X |
| OIL PRESSURE LOW | | X | X | |
| LOW OIL PRESSURE | | X | | X |
| OVER SPEED | | X | | X |
| UNDER SPEED | | X | | X |
| LOW FUEL | | X | X | |
| NO FUEL | | X | | X |
| LOW BULK TANK | | X | X | |
| LOW WATER | | X | | X |
| START FAIL | | X | | X |
| EMERGENCY STOP | X | X | | X |
| WARNING | X | X | X | |
| SHUTDOWN/ CRITICAL | X | X | | X |
| MAINS PHASE ROTATION FAULT | | X | | |
| HIGH MAINS VOLTS | | X | | |
| LOW MAINS VOLTS | | X | | |
| MAINS ON | X | | | |
| MAINS ON LOAD | X | | | |
| ALTERNATOR ON | X | | | |
| ALTERNATOR ON LOAD | X | | | |
| ALTERNATOR PHASE ROTATION FAULT | | X | | X |
| HIGH ALTERNATOR VOLTS | | X | | X |
| CONDITION | LED | DISPLAY MESSAGE | WARNING | SHUTDOWN |
| LOW ALTERNATOR VOLTS | | X | | X |
| BATTERY VOLTS FAULT | | X | X | |
| ALTERNATOR CHARGE FAULT | | X | X | |
| AUTO | X | | | |
| TEST | X | | | |
| MANUAL | X | | | |
| MANUAL START | X | | | |
| MANUAL STOP | X | | | |
| MANUAL OR TEST (NOT IN AUTO) | X | | | |

4.3.4.2 Plant Operation

The mode selector switch functions shall be as follows

| | |
|-----------|--|
| OFF/RESET | Control system off and alarm condition reset. |
| MANUAL | Starting and stopping activated manually (two controller mount push-buttons) for operating and maintenance purposes. |

4.3.4.3 Logging Of Events

All events relating to the status of the generator set shall be logged with date and time in a non-volatile memory (which can retain information for a period of 6 months in the absence of power to the controller).

The controller must have sufficient memory to log at least three months of typical generator set operation.

4.3.4.4 User Programmable

The controller shall be user programmable on site via a menu system with an access code and clear prompts for the required data and shall incorporate the following parameters:

HIGH battery volts
LOW battery volts
HIGH Mains volts
LOW Mains volts
HIGH Alternator volts
LOW Alternator volts
OVER-SPEED
UNDER-SPEED
Crank Release RPM
Start delay
Run-up delay
Mains return delay
Cool down time
Low Oil Pressure gauge - Warning level
High Temperature gauge - Warning level
Alternator CT Ratio

4.3.4.5 Remote status indication

Potential free contacts shall be provided and wired to terminals for cabling of alarm indications in the facility Control Room of the following signals:

- Running status;
- Warning status; and
- Shutdown/Critical status.

4.3.5 Installation

The contractor shall provide all necessary power, control cables, cable terminations and racking as required for the installation between the terminal points specified above. All

cables shall be suitably rated and shall be installed as per SANS 10142 standards. All cables shall be glanded with CCG or Pratley IP65 cable glands.

4.3.5.1 Earthing

The generator shall be provided with its own earth system in terms of the regulations and bonded to the main earthbar in the Electrical Room. The neutral point of the generator shall be solidly connected, by means of an appropriate size of insulated earth conductor, to the earth bar in alternator and in the control panel. All plant, ancillary equipment and steel work in the canopy enclosure shall be suitably bonded together with an appropriate size of insulated copper tape which shall also be connected to the earth bar.

4.3.5.2 Phase Rotation

The Contractor shall ensure that the mains and generator phase rotations are identical.

4.3.6 Canopy Enclosure

The generator set is to be installed outdoors. The canopy enclosure shall be prefabricated from mild steel, at least 2mm thick and painted according to the painting specification. Suitable lockable hinged doors shall be provided for access and maintenance purposes to the engine, and electrical components. All door hinges and latches shall be made of stainless steel. All canopy bolts shall be made of stainless steel or yellow cadmium plated.

4.3.7 Painting

The engine and alternator colours shall remain as supplied by the manufactures. The base and fuel tanks shall be painted Signal Black RAL 9004, in accordance with the SANS standards and specifications.

The canopy and control panel shall be put through a 5-stage iron phosphate cleaning process thereafter epoxy powder painted to a thickness of 60-80 microns.

The control panel shall be painted signal red – RAL 3001

The canopy shall be painted blue – VEP 5308

5. GENERAL REQUIREMENTS

5.1 Units

The metric system of units shall be adopted for this project.

5.2 Built in items

The Contractor must establish the full requirements relating to all built-in items (i.e. electrical conduits, steel platework, bolts, cast in items, etc), and arrange for their earliest delivery to Site to suit the programme.

5.3 Materials and Finishing

Materials of construction and finishes shall be selected to withstand all environmental exposure conditions, internally and externally. All inside and outside surfaces shall be

painted in accordance with the Project Specific Standards but excluding final coat on structural steel work and mechanical vessels unless otherwise approved by the Purchaser and the Engineer. All materials, where applicable, shall conform to the Project Specific Standards in respect to quality, manufacture, testing and performance.

5.4 Life Span

All Equipment shall be designed for a minimum lifespan of 25 years.

5.5 Corrosion Allowance

A corrosion allowance on steel work shall be made were necessary to ensure the life span period is achieved.

The Contractor shall submit Painting and Corrosion Protection specification, with the tender, for approval by the Engineer.

5.6 Ease of Operation and Maintenance

The Equipment shall be designed and constructed for ease of operation and maintenance to ensure the availability, reliability, operating requirements and time efficiencies stated in this Technical Specification are achieved and maintained throughout the lifetime of the Equipment.

The Contractor shall provide as part of the operation and maintenances manual, a specification and procedure for the safest and most efficient way to carry out maintenance and cleaning of all Equipment. In addition, the Contractor shall supply all specialised tools and facilities (fixed and mobile) to enable safe access and efficient maintenance of the Equipment.

5.7 Post Installation Support and Breakdown Response

The ability of the Contractor to provide post installation support, servicing and response to breakdowns will be an important consideration in the adjudication of bids. The Contractor is to indicate the nearest location to the site and capability of his support centres and give a guarantee of response time in the event of a breakdown call-out

5.8 Marking, Packing and Shipping

All Equipment shall be suitably marked and correctly packed to prevent damage during loading, transportation and offloading as well as to ensure ease of storage, retrieval and unpacking on Site. The Contractor shall be required to make good all loading damage.

The Contractor shall ensure that they are fully conversant with all packing and shipping requirements.

All invoices and shipping documentation (Bills of Lading and packing lists) shall strictly match in terms of detail.

Certificates of compliance shall also be included in the shipping documentation i.e. electric cables supplied from EU, UK, RSA and shall have the appropriate certificate accompanying the shipment.

5.9 Spare Parts

The Contractor shall make allowance for the supply of all necessary spares, which will be required during the start-up, commissioning and trial operation of the Works and until the Works are suitable for commercial operation.

The Contractor will indicate the essential spares he will hold in stock in his local agency/support premises.

5.10 Codes and Standards

Unless specified otherwise, all materials and workmanship shall be of a standard recognised within the industry generally as being the most appropriate standard for the type of work concerned and completely fit and suitable for the duties required of the Equipment.

5.11 Quality Control

The Contractor shall be required to submit to the Engineer for approval a Quality Control Plan (QCP) that shall conform to the requirements of ISO 9001 (2000).

5.12 Inspection and Inspection Authorities

The Contractor shall give the Engineer and the Purchaser full opportunity to inspect progress, measurements, materials and workmanship associated with the Works.

5.13 Installation Supervision

The Contractor shall provide an experienced and skilled installation supervisor/s as required to monitor, advise and assist the main contractor where necessary in all aspects of the mechanical, structural, electrical and instrumentation installation.

The Contractor's Installation Supervisor/s in consultation with the Purchaser's Site Manager and the Engineer shall be required to make such adjustments as are necessary to enable construction to proceed safely and efficiently.

The Contractor's Installation Supervisor/s will not directly control any personal associated with the Installation Contractor except in a situation where specialist knowledge of the supplied Equipment is required.

The Contractor's Installation Supervisor/s shall be fluent in the English language.

5.14 Training

The Contractor shall develop and submit to the Purchaser and the Engineer a comprehensive training manual in English for all Equipment to be supplied

In addition, the Contractor shall lead, direct and implement all training activities up to the point of Provisional Acceptance by the Purchaser/Purchaser. Training shall be carried out using the Contractor's own resources, the resources of the Installation Contractor and the Purchaser's/Purchaser's future operating, maintenance and supervisory personnel, as selected.

6. INSPECTION

The accredited representative of the Purchaser shall have access to the Contractor's works at any time during working hours for the purpose of inspection of manufacture or test on the plant and selection of samples of the materials going into the equipment. The Contractor shall provide necessary facilities for such inspection or test.

All the type / special / routine tests on the generator as per SANS / IEC of latest issue and indicated below will be witnessed by the Engineer and all necessary facilities for inspection and testing shall be provided by the Contractor. The generator shall be completely assembled and tested at the Contractor's factory.

The Contractor shall ensure that the test instruments have calibration certificate issued by an approved standard laboratory, not earlier than six months from the date of testing.

7. TESTING

7.1 Factory acceptance tests

An acceptance test shall be carried out at the Contractor's works to establish that the diesel generating plant and its ancillary equipment meets with the requirements of the specification. All costs for the fuel and other associated costs for the factory tests shall be borne by the contractor. The Contractor shall give the Purchaser at least seven days' notice prior to testing the plant. In the event of the plant failing the test and having to be re-tested, at some future date, all expenses (including travelling) incurred by the Purchaser in attending the second test will be to the Contractor's account.

- a) Manually start the plant from cold to test its ability to attain full rated speed and voltage and assume the full load in the specified time of 120 seconds.
- b) Test run the plant at full load for a period of one hour, measuring and recording every 10 minutes the voltage over the 3 phases, the current drawn, the kW output, the frequency and the engine temperature.
- c) Immediately after the above specified run, without stopping the plant, run it for a further hour at 110 % load.
- d) Test the plant with regards to voltage dip, voltage and frequency recovery, with a sudden application of various loads. Clause 9.5
- e) Test and demonstrate (by simulation only where actual conditions could damage the plant and its ancillary equipment) the correct operation of the engine safety controls and alarms together with other alarms as specified.
- f) Any other tests the Purchaser may consider necessary to establish that the diesel generator and its ancillary equipment as a whole is functioning correctly and in accordance with the specification.
- g) The Contractor shall provide necessary instruments and equipment for carrying out the tests. The test equipment shall be capable of producing 100 % load for one hour and 110 % load for a further hour continuously without interruption. The test load shall be adjustable and balanced over three phases.

- h) The test equipment shall be capable of recording and producing printed data pertaining to transient voltage dips, recovery time, applied load, etc, as specified in Clause 9.5.

7.2 Site acceptance tests

7.2.1 On completion of the installation of the plant, the following test shall be carried out.

- a) Manual starting and stopping with manual load change over. The load in this instance will be provided by the Purchaser;
- b) Test by simulation only of the operation of the engine protection and alarm devices; and
- c) Any other tests which the Purchaser may require on site.

7.2.2 The Contractor shall ensure the safe transportation and offloading of the generator on Site. It is the responsibility of the Contractor to ensure the generator integrity has not been compromised during transportation and offloading and shall ensure the generator is free of any damage.

Shock/Impact (G-force) indicators shall be installed on all transformers prior to transportation. Handover of the transformers shall only be accepted if all indicators are clear and don't show any signs of mishandling.

7.2.3 Test Certificates

Two copies of all equipment test certificates as well as manuals shall be submitted to the Purchaser on takeover of equipment. This shall include all as-build drawings. All test certification shall be in accordance with the SANS standards and regulations.

8. SCHEDULE OF DRAWINGS AND DOCUMENTS

8.1 Drawings Supplied with Purchase Order

The drawings listed in Annexure 2 are provided with this Purchase Order. Contractors should ensure that they are in possession of a full set of drawings.

8.2 Drawings and Documents to Be Supplied By Contractor

This schedule of drawings and data requirements constitutes a part of the Specification.

The Purchase Order shall not be regarded as complete unless these requirements have been complied with.

Contractor's drawings will be approved only as to arrangement, conformity to the specifications and related drawings and approval shall not relieve or mitigate the Contractor's responsibility for accuracy and suitability of materials and/or equipment represented thereon. Contractor shall note:

8.3 Tender Drawings

Shall be manufacturer's standard drawings in sufficient detail to allow appraisal of layout of equipment, drives, access for maintenance and operation and building and foundations.

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8.4 Approval Drawings

Shall be complete with equipment number(s). Approval drawings shall be stamped "DRAWINGS FOR APPROVAL" and must show all information necessary for the design of foundations and any connections to other equipment or steelwork.

8.5 Final Drawings

Shall be stamped "CERTIFIED FOR CONSTRUCTION" and signed by the Contractor's Engineer.

Certification warrants that delivered equipment shall conform to the final drawings. Should delivered equipment fail to conform, Contractor's shall furnish all materials, labour and equipment required to correct such failures to the satisfaction of the Engineer.

Document and Drawing QUANTITIES and TYPE are indicated below in the following manner:

P = Print

S = copy on computer CD either in the latest published version of AutoCad or DXF file format.

The Document / Drawing Scheduling is indicated below in the following manner:

O = Order Date
T = Take-Over Date
A = Availability Date
C = Commissioning date

e.g. O + 30 = 30 calendar days after Order date.
C - 90 = 90 calendar days before commissioning

| Document | With Tender | After Award | | |
|--|--------------------------|--------------|----------------------------|--------------------------|
| Description | | For Approval | Certified for Construction | As-Built |
| Submission of design, manufacture, procurement, erection and commissioning programme (Level 2 to 5) | | O + 5 | | |
| **Submission of equipment loadings, fixing and interface details to enable the Engineer to fully design all civil and structural works | <input type="checkbox"/> | O + 10 | | |
| **Equipment and general arrangement drawings | <input type="checkbox"/> | O + 10 | O + 15 | <input type="checkbox"/> |
| **Submission of all MCC, panel, cubicle, layout drawings and schedules, loop diagrams etc. | | O + 10 | O + 15 | <input type="checkbox"/> |
| **Submission of detailed design calculations and drawings for approval | | O + 10 | O + 15 | |
| Submission of shop run test certification | | | | A + 5 |
| Commissioning and testing manual | | | | C - 10 |
| Operations and maintenance manuals | | | | T + 0 |
| "As Built" documentation & drawings | | | | T + 0 |
| Contractor's Data Book | | | | T + 0 |
| A copy of the ISO 9001 accredited quality system certificate or international alternative. | <input type="checkbox"/> | | | |
| Quality Control Plan | <input type="checkbox"/> | | | |
| Submission of design, manufacture, procurement, delivery and erection programme | <input type="checkbox"/> | | | |
| **Critical spare parts list | <input type="checkbox"/> | | | |

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8.6 Equipment Data Sheets

See Annexure 1 to be completed in full by the Contractor:

ANNEXURE 1 – EQUIPMENT DATA SHEET

180kVA Diesel Generator Set

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|----------|--|---------------------------------|------------|
| 1 | ENGINE INFORMATION | | |
| 1.1 | Manufacturers name | Volvo, Cummins, Scania, Perkins | |
| 1.2 | Country of origin and year of manufacture | Specify | |
| 1.3 | Manufacturers type No. | Specify | |
| 1.4 | Continuous sea level rating after allowing for Ancillary equipment: | | |
| | a) in b.h.p. | Specify | |
| | b) in kW | Specify | |
| 1.5 | Percentage de-rating for site conditions, in accordance With BS 5514 | | |
| | a) for altitude | Specify | |
| | b) for temperature | Specify | |
| | c) for humidity | Specify | |
| | d) Total derating | Specify | |
| 1.6 | Nett output on site in kVA | 125 kVA | |
| 1.7 | Nominal speed in r.p.m. | 1500 rpm | |
| 1.8 | Number of cylinders | Specify | |
| 1.9 | Strokes per working cycle | 4 | |
| 1.10 | Strokes in mm | Specify | |
| 1.11 | Initial one step load capability in kW | Specify | |
| 1.12 | Cylinder bore in mm | Specify | |
| 1.13 | Swept volume in cm ³ | Specify | |
| 1.14 | Mean piston speed in m/min | Specify | |
| 1.15 | Compression ratio | Specify | |

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| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|------|---|--|------------|
| 1.17 | Fuel consumption of the complete generating set on site in 1/h. ("Load" is the specified nominal KVA rating): | | |
| | a) 100% Load | Specify | |
| | b) 50% Load | Specify | |
| | c) 25% Load | Specify | |
| 1.18 | Make of fuel injection system | Direct injection, Turbo charged | |
| 1.19 | Capacity of fuel tank in litres | To last 8 hours. Specify in Litres | |
| 1.20 | Gauge glass fitted to tank | Yes | |
| 1.21 | What method for filling the fuel tank is included? | Specify | |
| 1.22 | Method of starting the engine | Electric Motor | |
| 1.23 | Voltage of starting system | 12/24V | |
| 1.24 | Method of cooling | Liquid Cooled with 50% of anti-freeze | |
| 1.25 | Type of radiator if water-cooled | Pressurised Heavy Duty Tropical | |
| 1.26 | Type of heater for warming cylinder heads | 220V Electric Heater | |
| 1.27 | Capacity of water heater in kW | Specify | |
| 1.28 | Method of protection against high temperature | Specify | |
| 1.29 | Method of protection against low oil pressure | Specify | |
| 1.30 | Method of protection against low water level | Specify | |
| 1.31 | Type of governor | Specify | |
| 1.32 | Speed variation in % | As per BS 5514 | |
| | a) temporary | 10% | |
| | b) permanent | 0.5% | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|------------|------------|
| 1.33 | Minimum time required for assumption of full load in seconds | Specify | |
| 1.34 | Recommended interval in running hours for: | | |
| | a) Lubricating oil change | Specify | |
| | b) Oil filter element change | Specify | |
| | c) Air filter element change | Specify | |
| 1.35 | Decarbonising | Specify | |
| 1.36 | Type of base offered | Specify | |
| 1.37 | Can plant be placed on solid concrete floor? | Yes | |
| 1.38 | Are all accessories and ducts included? | Yes | |
| 1.39 | Is engine naturally aspirated? | Specify | |
| 1.40 | Are performance curves attached? | Yes | |
| 1.41 | Diameter of exhaust pipe | Specify | |
| 1.42 | Noise level at tail of exhaust pipe in dB (A) | 75dBA @ 5m | |
| 1.43 | BMEP (4 stroke) at Continuous rating (kPa) | Specify | |
| 1.44 | % Load acceptance to BS 5514 Part 4, with 10% transient speed variation | Specify | |
| | | | |
| | | | |
| | | | |
| | | | |
| Tender Number: | | | |
| Tenderer's Authorised Signature: | | | |
| Full Name of Company: | | | |

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| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|--|--|------------|
| 2 | ALTERNATOR | | |
| 2.1 | Manufacturers name | Marelli, Leroy Somers, Weg | |
| 2.2 | Country of origin and year of manufacture | Specify | |
| 2.3 | Type of enclosure | Sound attenuated to less than 75dB, weather proof enclosure | |
| 2.4 | Normal speed in r.p.m. | 1500 rpm | |
| 2.5 | Terminal voltage | 400V @ 50Hz | |
| 2.6 | Site rating kW at 0.85 power factor | 110 kW | |
| 2.7 | De-rating for site conditions in % | Specify | |
| 2.8 | Input required in kW for site KVA output required | Specify | |
| 2.9 | Method of Excitation: | Specify | |
| 2.10 | Efficiency at 0.85 p.f.: | | |
| | a) 100% Load | Specify | |
| | b) 50% Load | Specify | |
| | c) 25% Load | Specify | |
| 2.11 | Maximum permanent voltage variation in % | 1.5% | |
| 2.12 | Transient voltage dip on full load application in % | Max 15% | |
| 2.13 | Voltage recovery on full load application in milli-seconds | Within 500ms | |
| 2.14 | Is alternator brushless? | Yes | |
| 2.15 | Class of insulation of windings | Class H | |
| 2.16 | Symmetrical short circuit current at terminals in Amps | Specify | |
| 2.17 | Type of coupling | Turboflex | |
| 2.18 | Number of bearings | One/Two | |
| Tender Number: | | | |
| Tenderer's Authorised Signature: | | | |
| Full Name of Company: | | | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|--|---|------------|
| 3 | CONTROL PANEL | | |
| 3.1 | Panel installation type | Floor mount | |
| 3.2 | Finish of board | Mild steel, powder coated finish | |
| 3.3 | Power Meter | Specify | |
| 3.4 | Ratio of current transformers | Specify | |
| 3.5 | Make of hour meter | Specify | |
| 3.6 | Range of cyclometer | Specify | |
| 3.7 | Make of circuit breaker | Specify | |
| 3.8 | Type of circuit breaker | Moulded Case circuit breakers with motor operator mechanism for auto change over complete with mechanical interlock frame as well as electrically interlocked | |
| 3.9 | Rating of circuit breaker in Ampere and fault level in kA | 400A @ 50kA | |
| 3.10 | Setting range of overload trips (Back up protection) | 110%. For 1 hr after 12 hrs operation | |
| 3.11 | Setting range of instantaneous trips (Back up protection) | Specify (incorporated on the circuit breaker) | |
| 3.12 | Make of changeover equipment | Specify | |
| 3.13 | Generator controller and protection | Specify | |
| 3.14 | Is control and protection equipment mounted on a small removable panel | Specify | |
| 3.15 | Type of generator AVR | Specify | |
| Tender Number: | | | |
| Tenderer's Authorised Signature: | | | |
| Full Name of Company: | | | |

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| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|-------------------------------|------------|
| 4 | DIMENSIONS | | |
| 4.1 | Overall dimensions of set in mm | Specify L=? & W=? & H=? | |
| 4.2 | Change over and distribution panel dimensions | Specify L=? & W=? & H=? | |
| 4.3 | Overall mass [kg] | Specify | |
| 5 | BATTERY INFORMATION | | |
| 5.1 | Manufacturers name | Specify | |
| 5.2 | Country of origin | Specify | |
| 5.3 | Type of battery | maintenance free lead-calcium | |
| 5.4 | Voltage of battery | 12/24V | |
| 5.5 | Number of cells | Specify | |
| 5.6 | Capacity in A.h. | Specify | |
| 5.7 | Type of battery housing | Specify | |
| 6 | DELIVERY & COMPLETION TIME | | |
| 6.1 | a) State no. of weeks required from date of order to complete set assembly, full factory testing and delivery to site of all equipment, in weeks: | Specify | |
| 6.2 | b) State time required to install and commission set on site in weeks | Specify | |
| 6.3 | TOTAL TIME REQUIRED FOR COMPLETION (a + b) | Specify | |
| | | | |
| Tender Number: | | | |
| Tenderer's Authorised Signature: | | | |
| Full Name of Company | | | |

ANNEXURE 2 - DRAWINGS

| Drawing No. | Description |
|-------------------------|---------------------|
| 10969-001-002- GGL-0001 | Overall Site Layout |
| | |
| | |

PROJECT SPECIFICATION

PORTION 3: PARTICULAR SPECIFICATION

C1Hi **INSTAL HILO INSTALLATION (10969-001-2040-R-0006) AND SUPPLY
OTHERS**

10969/001/2040/R/0006 – RevT1

**SAFDA MKHUZE RAIL SIDING
PROJECT**

**GENERAL MECHANICAL
INSTALLATION**

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ANNEXURE 1 - DRAWINGS.....279

TECHNICAL SPECIFICATION

1. ABBREVIATIONS, TERMS AND DEFINITIONS

The following abbreviations, terms and definitions shall apply for this contact:

1.1 Abbreviations

| | |
|-----|----------------------|
| CKD | Completely knockdown |
| kW | Kilowatts |
| QCP | Quality Control Plan |

1.2 Terms and Definitions

In interpreting this specification, the following words shall have the meanings herein assigned:

| | |
|------------------------------------|--|
| Bidder | means the natural or juristic person supplying the Goods and/or services as indicated in the contract. |
| Company | means South African Farmers Development Association |
| Connection elements | means all holding down, anchor or connection bolts including all washers, nuts, screws, spacers, shims etc |
| Drive Assemblies | means all motors, gearboxes, couplings, bearings, torque arms, guards and base plates. |
| Goods | includes all equipment, materials, plant and temporary works |
| Punch List Category A items | These items effect the safe operation of the Goods. |
| Punch List Category B items | These items effect the completeness of the Goods |
| Punch List Category C items | These items effect the aesthetics of the Goods only |

2. INTRODUCTION

The project entails construction of a transloading facility at Mkhuze Rail siding, where cane will be transferred from road trucks to rail wagons and transported by Transnet Freight Rails to the mill, a total journey length of 350kms.

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2.1 Background and Overview

The cane grown in the Makhathini region currently being transported to the Felixton mill by road requires a more economically, sustainable, and efficient way of transporting the cane to the mill as of March 2021.

3. SCOPE OF WORK

The specification covers the minimum requirements for the offloading, unboxing, assembling, installation, testing and commissioning of the Hilo Unloader (Free Issue) as well as ancillaries for the Mkhuze Rail Siding project.

The specification also covers fabrication and installation of the steel spiller wall and Buffer Guide pipes.

Design, Supply and Install hydraulic power pack for the Hilo – Unloader clamp (details later).

The technical specification is to be read in conjunction with all of its Annexures in order to obtain a complete view of the scope of work. The following major items need to be completed and installed;

- a) Installation of Hilo-Unloader (Spiller) and accessories; and
- b) Steel Spiller Wall;
- c) Buffer Guide Pipes;

The Scope of work includes supply and installation of four electrical motors, couplings and all accessories as well as the hydraulic pack for the Hilo-Unloader. The motor sizes are as follows;

- d) 110kW Hoist Motor (Winch) - W22, 50hz – IR2 – 150cv 6 poles, 220/380/440V – 315S/M – B3T – IPW55.
- e) 5.5kW Retract motor (Winch) - W22, 50hz – IR2 – 7,5cv 6 poles, 220/380/440V – 132M – B3L(D) – IP55.
- f) 2.2kW Vehicle Clamp Motor - W22, 50hz – IR3 – 3cv 4 poles, 220/380/440V – L90L – IP55.
- g) 1.1kW Brakes Motor - W22, 50hz – IR2 – 1,5cv 2 poles, 220/380/440V – 80 – IP55.

Note the information supplied in this Technical Specification in the form of data, drawings, descriptions, and Equipment sizes, etc, is intended to serve as a guide to the requirements of the Purchaser. The Bidder shall however be responsible for the performance of the Equipment and shall verify and confirm all size selections. Should the Bidder not be in agreement with the concepts presented, alternative concepts and designs shall be offered with full justification for the change.

3.1 Scope Inclusions

- a) Project management of this Contract's scope of work including planning, scheduling and reporting to the Purchaser and the Engineer;
- b) Implementation of an appropriate quality system and quality control;
- c) Submission of all documentation, drawings and technical data as outlined in the schedule of Documents and Drawings included in this Technical Specification as well as those required for statutory regulation and project control;
- d) Selection of suitable materials of construction and appropriate codes of practice, standards and specifications applicable to the Works where not already specified herein;
- e) Shop detail drawings of the steel Spiller Wall;
- f) Offloading and Rigging;
- g) Surface preparation, protection coatings, painting and finishing of all Equipment and Materials;
- h) Workshop and Site inspections including NDT and factory acceptance testing;
- i) Packing, marking and protection of all Equipment for shipping/transport including loading supervision where necessary;
- j) Supervise the positioning, assembly, alignment, and installation of the Equipment;
- k) Pre-commissioning, commissioning, trial operation, performance testing and punch listing activities;
- l) The supply of any special Equipment required for erection, commissioning and performance testing of the Equipment;
- m) Performance Guarantee and Warranty;
- n) Supply of "as-built" drawings;
- o) A programme indicating manufacturing and delivery schedule; and
- p) Supply of all equipment and personnel required to comply with all local regulations;

3.2 Scope Exclusions

The following nominated items are specifically excluded from the scope of supply:

- a) Overall project management of this project;
- b) Construction power and water;
- c) Environmental impact assessments;
- d) Environmental impact management plans;
- e) Civil Works – foundations, grouting, concrete floors and earth works;
- f) Internal wiring of the equipment (drives, control panel, limit switches);
- g) Electrical works from the panel to the MCC.

3.3 Terminal Points

- Top of concrete level for the spiller foundations and structural anchor point.

4. DESCRIPTION OF EQUIPEMENT

4.1 Hilo Unloader (Spiller)

A second-hand Hilo Unloader is to be imported from Brazil for this project in completely knockdown form (CKD). Reassembly of the unloader will be via bolted connections.

The Hilo-unloader, packed in containers, will arrive in Durban harbour from where it will be collected and delivered on site. The Bidder shall allow for offloading of the equipment in Mkhuze.

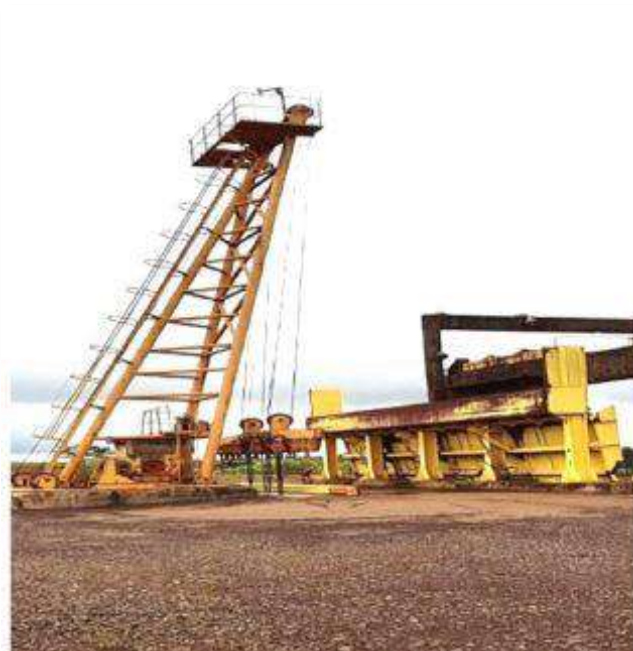


Image 4-1 – Typical Hilo-Unloader

4.2 Spiller Wall

The road rigs enter the spiller area where the hook bar engages with the trailer hook beam. The unloader then raises its hook bar and spills the load over a steel wall.

The Bidder shall manufacture the steel wall off site and deliver to site for erecting and installation on prepared concrete cane area.



Image 4-2 – Typical Steel Spiller wall

4.3 Buffer Guide Pipes

The road rigs are to be guided into position under the unloader and on to the two weighbridges by buffer guide pipes set in the concrete road. The contractor is to manufacture and supply the guide pipes, place and align them for the civil contractor to cast in.

5. GENERAL REQUIREMENTS

5.1 Units

The metric system of units shall be adopted for this project.

5.2 Materials and Finishing

Materials of construction and finishes shall be selected to withstand all environmental exposure conditions, internally and externally. Particular attention to protection of the steel structural elements.

5.3 Life Span

All Equipment shall be designed for a minimum lifespan of 25 years.

5.4 Corrosion Allowance

A corrosion allowance on steel work shall be made were necessary to ensure the life span period is achieved.

The Bidder shall submit Painting and Corrosion Protection specification, with the tender, for approval by the Engineer.

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5.5 Ease of Operation and Maintenance

The Equipment shall be designed and constructed for ease of operation and maintenance to ensure the availability, reliability, operating requirements and time efficiencies stated in this Technical Specification are achieved and maintained throughout the lifetime of the Equipment.

The Bidder shall provide as part of the operation and maintenances manual, a specification and procedure for the safest and most efficient way to carry out maintenance and cleaning of all Equipment. In addition, the Bidder shall supply all specialised tools and facilities (fixed and mobile) to enable safe access and efficient maintenance of the Equipment.

5.6 Marking, Packing and Shipping

All Equipment shall be suitably marked and correctly packed to prevent damage during loading, transportation and offloading as well as to ensure ease of storage, retrieval and unpacking on Site. The Bidder shall be required to make good all loading damage.

The Bidder shall ensure that they are fully conversant with all packing and shipping requirements.

All invoices and shipping documentation (Bills of Lading and packing lists) shall strictly match in terms of detail.

Certificates of compliance shall also be included in the shipping documentation i.e. electric cables supplied from EU, UK, RSA and shall have the appropriate certificate accompanying the shipment.

5.7 Codes and Standards

Unless specified otherwise, all materials and workmanship shall be of a standard recognised within the industry generally as being the most appropriate standard for the type of work concerned and completely fit and suitable for the duties required of the Equipment.

5.8 Quality Control

The Bidder shall be required to submit to the Engineer for approval a Quality Control Plan (QCP) that shall conform to the requirements of ISO 9001 (2000).

5.9 Inspection and Inspection Authorities

The Bidder shall give the Engineer and the Purchaser full opportunity to inspect progress, measurements, materials and workmanship associated with the Works.

5.10 Installation Supervision

The Bidder shall provide an experienced and skilled installation supervisor/s as required to monitor, advice and assist the main contractor where necessary in all aspects of the works.

The Bidders Installation Supervisor/s in consultation with the Purchaser's Site Manager and the Engineer shall be required to make such adjustments as are necessary to enable construction to proceed safely and efficiently. The Bidders Installation Supervisor/s shall be fluent in the English language.

6. TESTS ON COMPLETION AND PROVISIONAL ACCEPTANCE

The required Tests on Completion shall consist of the following:

- Pre-commissioning tests;
- Commissioning tests;
- Trial operation.

6.1 Commissioning and Testing plan

The commissioning of the Equipment will take place after the Bidder has issued a Notice of Completion Certificate and in accordance with an integrated commissioning plan for the entire project.

6.2 Commissioning and Testing manual

The Bidder shall be required to submit to the Purchaser/Purchaser's Commissioning Manager a commissioning and testing manual.

6.3 Bidder's Commissioning Supervision

The Bidder shall appoint an appropriately skilled and experienced Commissioning Supervisor/s as soon as is practicable after this Contract has been awarded to lead, co-ordinate and carry out the various commissioning activities.

Note: The Bidder/Bidders commissioning supervisor shall not be relieved of any responsibilities, obligations or liabilities under the Contract when the Purchaser's/Client personnel are operating the Equipment under the direction or supervision of the Bidder during Training or Test on Completion.

6.4 Pre-Commissioning Tests

The pre-commissioning tests shall be carried out after the Bidder has issued the Purchaser's Commissioning Manager with commissioning and testing manuals and the relevant construction drawings.

6.5 Commissioning Tests

The Bidder shall, as soon as is practicable after carrying out the pre-commissioning tests on the Equipment/Works and once all **Punch List** items have been attended to, carry out the commissioning tests.

6.6 Trial Operation

As soon as practicable after completion of the commissioning tests, a trial operation of the Equipment shall take place. During this period the Bidder/Bidder's Commissioning Supervisor shall operate the Equipment/Works with the assistance of the Installation Contractor. These tests shall demonstrate to the Purchaser and the Client that the

Equipment/Works and systems are complete, free of defects, safe for operation and operate in accordance with the Requirements outlined in this Technical Specification.

6.7 Provisional Acceptance Certificate

The Works shall be provisionally accepted when all pre-commissioning, commissioning and trial operation tests have been passed and all **Punch List** items have been attended to. Prior to Provisional Acceptance the Bidder shall demonstrate to the Purchaser and/or the Engineer, the following:

- a) That the Bidder has completed all Works, supplied all Equipment and Materials and carried out all commissioning and testing activities, except for items of an unimportant nature which do not affect the safe and reliable start-up and commercial operation of the Works and which are not required in terms of the Laws to be completed by start-up and for commercial operation of the Works
- b) That the Equipment is ready for commercial operation;
- c) That the Purchaser's Commissioning Manager has accepted that the Works have passed all pre-commissioning, commissioning and trial operation testing and checks;
- d) That the Works are safe for use and all safety devices and interlocks have been proven to function correctly and have been accepted by the Purchaser's Commissioning Manager;
- e) That the Bidder has conducted the training of the Purchaser's/Client's personnel as required to operate the Works properly and safely and in accordance with the training manuals supplied by the Bidder.
- f) The Bidder has supplied to the Client all manuals, Data books, drawings and other data required to operate, strip, maintain and reassemble the Works along with all specialised tools as required;
- g) All QCP documents have been completed and signed off by the relevant Parties;

Thereafter the Purchaser shall arrange for performance testing to be conducted as soon as practicable after a Provisional Acceptance Certificate has been issued.

7. PERFORMANCE TESTING AND FINAL ACCEPTANCE

Performance testing shall be carried out by the Client/Purchaser and the Client's/Purchaser's staff as soon as reasonably practicable after a Provisional Acceptance Certificate has been issued and as mutually agreed upon with the Bidder.

7.1 Completion and Final Acceptance

Upon the performance of the Works reaching The Guaranteed Performance Parameters as stipulated in this Technical Specification and the completion of all Punch List items, the Equipment shall be deemed to be completed. Upon successful completion the Purchaser shall execute and provide the Bidder with a Final Acceptance Certificate.

If the Purchaser does not issue the Final Acceptance Certificate within the period of ten (10) business days following the completion of the Works, then the Final Acceptance Certificate shall be deemed executed and delivered at the end of the above period of ten (10) business days.

8. PROJECT MANAGEMENT AND PROGRESS REPORTING

The Bidder shall in the tender document confirm its company's ability to implement and maintain a recognised project management, reporting and planning system, to ensure that all facets associated with this Contract are controlled from implementation through to Final Acceptance.

8.1 Two Weekly Progress Reporting

The Bidder shall maintain a system of reporting to the Purchaser and or the Engineer on a monthly basis. These reports shall include the following as a minimum:

- a) Design and Engineering progress and updates;
- b) Procurement and manufacturing progress updates;
- c) A detailed project managers report outlining current progress to date as well as any new aspects or issues which have developed that affect the project timeline and cost. These shall be accompanied by possible solutions to the problems highlighted in the report.
- d) Updated overall project plan outlining current progress against base line.

The Purchaser and the Engineer are to be notified immediately in the event that an issue, delay or potential risk arises during the execution of this Contract which may have a major effect on the project or its completion date.

9. SCHEDULE OF DRAWINGS AND DOCUMENTS

All documents, drawings and data sheets submitted by the Purchaser and Bidder throughout the course of the project including all manuals shall have the title "Mkhuze Transloading Facility". British units may be used for reference only in addition to the metric units and shall be specified in parentheses. All bolt and screw sizes and treads shall be in accordance with the International Standards Organization (ISO).

9.1 Drawings and Documents to be Supplied by Bidder

9.1.1 General

The Schedule of Drawings and Documents constitutes a part of the Technical Specification and outlines the drawings and data to be supplied as part of the Bidder's tender submission as well as those that will be required in the event that the Bidder is successfully awarded the Contract. The Bidder's submission and subsequently the Contract shall not be regarded as complete unless these requirements are fully met.

9.1.2 Drawings

Drawings submitted by the Bidder with the tender submission and those drawings (electronic and hard copy) that will be required in the event that the Bidder is successfully awarded the Contract, shall be in accordance with the relevant Project Specific Standards and the followings categories:

Tender drawings: All drawings and documents submitted with the tender submission shall be the Bidder's standard drawings and provide sufficient detail to enable the Purchaser/Engineer to comparatively adjudicate the tender. In addition these drawings shall provide enough information to allow the Purchaser to assess the overall project layout with respect to drive positions, maintenance and operational access routes and platforms, building and foundation designs, etc.

Review drawings These drawings shall be supplied by the Bidder following the successful award of this Contract. These drawings shall be in AutoCAD or compatible Format, stamped "For Review" and signed by the Bidder. These drawings shall be reviewed and approved in principle by the Purchaser/Engineer to ensure conformity to the Specifications. This review shall not relieve or mitigate the Bidder's responsibilities in any way.

Construction drawings shall be in AutoCAD or a compatible Format, stamped "For Construction" and signed by the Bidder.

As built drawings shall detail the finally constructed Works, shall be in AutoCAD or a compatible Format, be stamped "As Built" and signed by the Bidder.

9.1.3 Installation History Schedule

The Bidder's tender submission shall also include a list of locations, factories, sites, etc in which the Equipment to be supplied under this Contract has previously been supplied and/or installed.

9.1.4 Data Books

The Bidder shall be required to submit to the Purchaser individual Data Books for all Equipment covered by this Contract. These Data books shall include but may not be limited to the following:

- a) All Manufacturer's Data Books
- b) All final on-site testing certificates for all parts of the Works as per the Bidder's commissioning and testing plan.
- c) A copy of the installation and erection manual as well as all relevant drawings for the equipment.
- d) A copy of the training manual and training certifications
- e) A copy of the commissioning and testing manual (including signed off check sheets).
- f) A copy of the operation and maintenance manual where required.
- g) A full set of "As Built" drawings
- h) All QCP documentation as signed off by the relevant parties

9.1.5 Schedule of Documents and Drawings requirements (ALL DISCIPLINES)

| Description | With Tender (‘x’ days after Award) | For Approval (‘x’ days after Award) | For Construction (‘x’ days after Award) | As-Builts (‘x’ days before take over) |
|--|--|---|--|--|
| Programme level 2 (prelim), level 5 (after award) | 0 | 14 | 30 | |
| Quality control plan | | 14 | 40 | |
| Motor Frame drawings | 0 | | | |
| Material test certificates | | 30 | 40 | |
| Installation drawing and manual | | | 40 | |
| As Built documentation & drawings | | | | 30 days After Take Over |
| Data books for all equipment | | | | 30 |

Table 9-1 – Required documents

9.1.6 Clarification Period

Upon the successful award of this Contract the Bidder shall allow for a two- three-week period to spend with the Purchaser/Engineer to further clarify the scope of works, review layout drawings, identify problems, risks, develop construction methodologies, etc. The details of this period will be further discussed upon award as this may not be a continuous period.

ANNEXURE 1 - DRAWINGS

| Drawing No. | Description |
|-------------------------|---|
| 10969-001-002- GGL-0001 | Overall Site Plan |
| 10969-001-002-MEQ-0001 | Details of Spiller Wall (Typical) |
| T1250-6090-001 | Levantamento Hilo 50 T (Free Issue Hilo Unloader) |

PROJECT SPECIFICATION

PORTION 3: PARTICULAR SPECIFICATION

C1GE **GEN ELECTRICAL INSTALLATION (10969-001-2040-R-0003)**

10969/001/2040/R/0003 – RevT1

**SAFDA MKHUZE RAIL SIDING
PROJECT**

**ENGINEERING SPECIFICATION
ELECTRICAL INSTALLATION**

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TECHNICAL SPECIFICATION

1. ABBREVIATIONS, TERMS AND DEFINITIONS

The following abbreviations, terms and definitions shall apply for this contact:

1.1 Abbreviations

| | |
|----------|---|
| BOQ | Bill of Quantities |
| ISO | International Standards Organisation |
| N.O.S.A. | National Occupational Safety Association (South Africa) |
| OHSA | The Occupational Health and Safety Act (2003) |
| PVC | Polyvinyl Chloride |
| SANS | South African National Standards |
| A | Ampere |
| AC | Alternating Current |
| Cu | Copper |
| CB | Circuit Breaker |
| CT | Current Transformer |
| DC | Direct Current |
| DOL | Direct On Line |
| ECC | Earth Continuity Conductor |
| ELU | Earth Leakage Unit |
| FAT | Factory Acceptance Test |
| FLC | Full load current |
| GA | General Arrangement |
| HDHE | Hard drawn high conductivity |
| Hz | Frequency |
| IEC | International Electrotechnical Commission |
| kA | Kilo Ampere |
| kV | Kilo Volt |
| kVAr | Kilo Volt Ampere Reactive |
| LV | Low Voltage |
| MCC | Motor control center (also MCA) |
| Ms | Milliseconds |
| MCCB | Moulded Case Circuit Breaker |
| N/C | Normally Closed |
| N/O | Normally Open |
| O/C | Over Current |
| O/L | Over Load |
| PLC | Programmable Logic Controller |
| s | Seconds |
| SANS | South African National Standards |
| S/C | Short Circuit |
| S/D | Star Delta |
| S/S | Soft Starter |
| SWA | Steel Wire Armoured |
| TCH | Tons per Hour |

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| | |
|-----------|----------------------------------|
| TRF | Transformer |
| V | Volt |
| VSD / VFD | Variable Speed / Frequency Drive |
| VT | Voltage Transformer |
| XLPE | Cross Linked Polyethylene |

1.2 Terms and Definitions

In interpreting this specification, the following words shall have the meanings herein assigned:

| | |
|---|---|
| 3PH | means 3 phase |
| Codes and Standards | means the design and construction codes and standards that are applicable to the Works and which are listed as Project Standards, National Standards, Local Standards and International Codes and Standards in the Codes and Standards section of the Specification |
| Contractor | means the natural or juristic person supplying the Goods and/or services as indicated in the contract |
| Contractor's Data Book for the Works | means the Contractor's record of all Goods certifications, and all other statutory tests and certifications required in terms of the Laws and/or the Codes and Standards |
| Company | means South African Farmers Development Association |
| Connection elements | means all holding down, anchor or connection bolts including all washers, nuts, screws, spacers, shims etc. |
| CT | means Current Transformer |
| Drive Assemblies | means all motors, gearboxes, couplings, bearings, torque arms, guards and base plates. |
| Facility | means the Company's sugarcane transloading facility at Mkhuze, KwaZulu-Natal, South Africa |
| Goods | includes all equipment, materials, plant and temporary works |
| Hold Point | is an identified point that cannot be passed without the written permission of the Employer. |
| Hz | means Hertz |
| Inspection Authority | means an approved inspection authority appointed by the Supplier to independently inspect and approve the design and manufacture of the Goods as well as the certification of all welders to ensure compliance with the relevant Codes and Standards, and any applicable statutory requirements |
| kA | means kilo Amps |
| kV | means kilo Volt |
| kVA | means kilovolts ampere – apparent power |
| LV | means Low Voltage |
| MVA | means mega volt amperes |

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| | |
|------------------------------------|--|
| ONAN | means natural oil and natural air cooled |
| Punch List Category A Items | These items effect the safe operation of the Goods. |
| Punch List Category B items | These items effect the completeness of the Goods. |
| Punch List Category C items | These items effect the aesthetics of the Goods only. |
| QCP | means Quality Control Plan |
| R, W & B | means Red, White and Blue |
| Shall | is mandatory |
| Should | is strongly recommended |
| Spoil | means unsuitable or excess material removed to waste |
| Third Party Inspector | means an inspection authority appointed by the Company to independently review and approve the Supplier's Data Book for the Goods to ensure that the Supplier has complied with the applicable Codes and Standards and any applicable statutory requirements |
| V | means Volts |
| VT | means Voltage Transformer; and |
| Witness Point | is an identified point that the Employer may wish to witness but can be passed without witnessing by the Employer |

2. INTRODUCTION

The project entails construction of a transloading facility at Mkhuze Rail siding, where cane will be transferred from road trucks to rail wagons and transported by Transnet Freight Rails to the mill, a total journey length of 160kms.

2.1 Background and Overview

The cane grown in the Makhathini region currently being transported to the Felixton mill by road requires a more economically, sustainable, and efficient way of transporting the cane to the mill as of March 2021.

3. SCOPE OF WORK

The scope of work includes the design, manufacture, supply, delivery, installation, testing and commissioning of the electrical power distribution and power control systems for the new facility including Eskom supply, , main power distribution, Hilo Spiller power and controls, external lighting, protective earthing systems and power supply to the facility building and weighbridge control system.

The technical specification is to be read in conjunction with all of its Annexures in order to obtain a complete view of the scope of work. The Contractor's obligations are to install, and erect Plant and Materials for the Project as specified in the Schedules that will be supplied. All craneage and scaffolding works shall be supplied by the Contractor.

3.1 Equipment Scope of Supply

The Equipment to be supplied, delivered to site and installed by the Contractor shall include but is not limited to the following:

- a) Three new high mast light systems complete with masts, luminaires and mast mounted local distribution boards to be installed on bases provided by others;
- b) All cabling, cable supports, glands, terminations, earthing and other electrical materials as required to complete the installation works, as described in the BOQ and other sections of this specification.
- c) Supply and installation of all mounting bolts, anchors, studs or any other retaining devices as required;
- d) Supply of all equipment and personnel required to comply with the Occupational Health and Safety Act, 1993;
- e) Supply and installation of all safety equipment (guards, notices, etc.);
- f) Supply of all holding down bolts, anchors, studs or any other retaining devices as required.
- g) Any other item not specifically mentioned above but deemed necessary for the satisfactory performance of the equipment to be supplied.

Note the information supplied in this Technical Specification in the form of data, drawings, descriptions, and Equipment sizes, etc, is intended to serve as a guide to the requirements of the Purchaser. The Contractor shall however be responsible for the performance of the Equipment and shall verify and confirm all size selections. Should the Contractor not be in agreement with the concepts presented, alternative concepts and designs shall be offered with full justification for the change.

It is preferred that only proven technologies be incorporated into the design of all Equipment. However, if the Contractor believes that there are significant savings to be made by offering alternative technologies, it is encouraged to include details of these alternatives clearly outlining their advantages and cost implications in the tender submission, in addition to the proven/requested technology option.

The acceptance of the information in this Technical Specification shall in no way relieve the Contractor of its responsibilities and obligations in terms of the design and engineering performance of the Works.

3.2 Installation Work Scope of Supply

The installation work to be performed by the Contractor shall include but is not limited to the following:

- a) Assistance for the panel supplier with installation of the Main Power Distribution Board and Hilo Spiller MCC panel in the Electrical Room;
- b) Assistance for the supplier with installation of the diesel generator, auxiliary equipment and diesel generator control panel;
- c) Installation of the Change Over panel in the Electrical Room;
- d) Installation of three high masts for area lighting;

- e) Installation of the Hilo Spiller Control Panel on the Hilo Unloader (spiller) as well as cabling up of all four drives on the unloader
- f) Power supply cable installation and termination from the existing Eskom supply metering panel to the Change Over panel;
- g) Power supply cable installation and termination from the Diesel Generator to the Change Over panel;
- h) Power supply cable installation and termination from the Change Over panel to the Main Power Distribution Board and Hilo Spiller MCC panel;
- i) Power supply cable installation and termination from the Main Power Distribution Board and Hilo Spiller MCC panel to the Spiller Hoist, Retract, Clamp and Hoist Brake motors;
- j) Power supply cable installation and termination from the Main Power Distribution Board and Hilo Spiller MCC panel to the High Mast local DB's;
- k) Power supply cable installation and termination from the Main Power Distribution Board and Hilo Spiller MCC panel to the building Main DB;
- l) Power supply cable installation and termination from the Main Power Distribution Board and Hilo Spiller MCC panel to the Weighbridge Control System DB;
- m) Power supply cable installation and termination from the Main Power Distribution Board and Hilo Spiller MCC panel to the Diesel Generator Control Panel;
- n) Control and status monitoring signal cabling from the Change Over panel to the Diesel Generator Control Panel;
- o) Control and status monitoring signal cabling from the Main Power Distribution Board and Hilo Spiller MCC panel to the Hilo Spiller Control Panel;
- p) Control and status monitoring signal cabling from the Hilo Spiller Control Panel to the limit switches, actuators and other local equipment on the hilo spiller;
- q) Installation of power system earthing conductors between the Eskom supply metering panel, the Diesel Generator earthing point, and the earthing bar in the Main Power Distribution Board and Hilo Spiller MCC panel;
- r) Design, supply and installation of protective earthing conductors and earth spikes for the weighbridges, hilo spiller steelwork and High Masts;

3.3 Scope Inclusions

- a) Project management of this Contract's scope of work including planning, scheduling and reporting to the Purchaser and the Engineer;
- b) Implementation of an appropriate quality system and quality control;
- c) Submission of all documentation, drawings and technical data as outlined in the schedule of Documents and Drawings included in this Technical Specification as well as those required for statutory regulation and project control;
- d) Selection of suitable materials of construction and appropriate codes of practice, standards and specifications applicable to the Works where not already specified herein;
- e) Supply of all related software and licences if applicable;

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- f) Surface preparation, protection coatings, painting and finishing of all Equipment and Materials;
- g) Workshop and Site inspections including NDT and factory acceptance testing of electrical equipment as per the relevant codes and standards;
- h) Packing, marking and protection of all Equipment for shipping/transport including loading supervision were necessary;
- i) Supervise the positioning, assembly, alignment, and installation of all Equipment;
- j) Contractor will implement a material control procedure to adequately control equipment and materials from “off-loading to completion of installation”
- k) Contractor will provide stores facilities which will accommodate the project requirements for an open lay down area and a lockable store area.
- l) Site establishment and removal of site establishment.
- m) Supply of all scaffolding and additional crane requirements.
- n) Pre-commissioning, commissioning, trial operation, performance testing and punch listing activities;
- o) The supply of any special Equipment required for erection, commissioning and performance testing of the Equipment as required;
- p) Performance Guarantee and Warranty;
- q) A programme indicating manufacturing and delivery schedule; and
- r) Supply of all equipment and personnel required to comply with all local regulations;

3.4 Scope Exclusions

The following nominated items are specifically excluded from the scope of supply:

- a) Overall project management of this project;
- b) Construction power and water;
- c) Environmental impact assessments;
- d) Environmental impact management plans;
- e) Civil Works – foundations, grouting, concrete floors and earth works;

3.5 Terminal Points

The terminal points of this scope of supply shall be as follows:

- a) Outgoing power terminals of the Eskom supply metering cabinet;
- b) Incoming power terminals to motors;
- c) Connection terminals of Hilo Unloader (spiller) locally mounted limit switches and actuators;
- d) Incoming power terminals to distribution boards supplied by others;

4. TECHNICAL SPECIFICATION

4.1 Electrical Parameters

| | |
|------------------------------|---------------------------|
| System voltages | 400 V AC 3PH and 230 V AC |
| LV fault level at Main LV DB | 10 kA |
| Lightning impulse withstand | 8 kV |
| Power frequency withstand | 2 kV |
| Phase rotation and colours | R, W and B |
| Site supplies | 400 V 3PH and 230 V 1PH |
| Frequency | 50 Hz |

4.2 Bolts, Nuts, Washers, Brackets and Mounting Accessories

All fixing and mounting accessories shall be manufactured from 304 stainless steel unless otherwise specified.

4.3 Specification and Drawings

The specification and drawings generally show the character and extent of the proposed work, and shall not be held as showing every minute detail of the work to be executed.

Contractors must ensure that their copy of the specification is complete and that all drawings as listed have been received.

4.3.1 Contract Drawings

The layout and extent of the electrical installation are shown on the drawings which form part of this document. The positions of all equipment and cable routes which may be affected by other services, must be confirmed by the Contractor with the Engineer before placing such outlets.

4.3.2 As Built Drawings

The Contractor shall submit “As Built” drawings which shall be marked in red with all changes. The Contractor shall ensure that exact cable routes, manholes, sleeves, cable joints etc are shown and dimensioned from a building reference point.

The “As Built” drawings shall be submitted within 2 weeks of the handover of the Project.

4.4 Distribution Boards

All boards and equipment shall be designed in accordance with SANS 1473-1/SANS 61439-5 and shall be suitable for operation on supply voltages of 230/400 Volts, 50 Hertz, AC.

The following SANS standards are applicable:

| | | |
|----|--------------------------------------|----------------------|
| a) | Busbars: | SANS 1195 |
| b) | Surface-mounted Distribution Boards: | SANS 61439-5 |
| c) | Electrical terminals and Connectors: | SANS 1433-1 & 1433-2 |
| d) | Enclosure (IP): | SANS 61238-1 |
| e) | Ferrules & Lugs: | SANS 1238 |

4.4.1 Switchgear

All switchgear installed in the switchboards shall comply with the following specifications:

| | | |
|----|------------------------------------|----------------|
| a) | Miniature Circuit Breakers (MCB): | SANS 156 |
| b) | Earth Leakage Units (ELU): | SANS 767-1 |
| c) | On-Load Isolators: | SANS 152 |
| d) | Surge Arrestors: | SANS 61643-1 |
| e) | Contactors: | SANS 60497-4-1 |
| f) | HRC fuses and fuse switches (CFS): | SANS 60269-1. |
| g) | Timer Switches: | IEC 60730-2-7 |

Where surge absorbers are specified on single line diagrams, they shall be installed for the phases as well as the neutral. The Contractor shall supply and install the distribution board as indicated on the drawings. All distribution boards must be installed level at a height of 2100 mm AFFL to top of the distribution board.

4.4.2 Construction

The boards shall generally be of floor standing or wall mountable cubicle type assemblies, suitable for top and bottom cable entries. Schematic drawings will show the specific requirements applicable to each assembly.

The board shall be of sufficient dimensions to allow the installation of all equipment specified and any future equipment indicated on the drawings without unduly restricting the access to and the clearance between the various rows. (At least 25% spare space is provided if not specified elsewhere).

Single phase sections of three phase boards shall be arranged in three horizontal parallel rows, directly above one another and in the phase sequence L1-L2-L3 from top to bottom. Lighting and power circuits shall be separated by a blank space along the horizontal rows. Extra space for future circuits shall be allowed for on the right-hand side of each lighting and power row, in the ratio of one spare space for each four lighting or power circuits installed.

A minimum of 25% space shall be allowed for each lighting and power row. Dummy covers are to be provided over spare spaces.

Similar provision for future circuits shall be made on the busbars, neutral and earth bars, and terminal strips. Drawings which manufacturers submit for approval shall clearly show the proposed layout of all equipment as seen from the front of the board. These shall be submitted for approval to the Engineer before manufacture. All sizes of busbars, connections from busbars and terminal strips will be detailed on the layout drawing.

The drawings will detail all dimensions of the enclosure, busbars, earth bars and neutral bars, as well as the electrical components' make, type and rating. Positions and layout of busbars, earth bars and gland plates will be shown in front and side elevation drawings.

The assembly shall be of strong and rigid construction with suitable folded 3CR12 frame work, totally enclosed by means of removable covers and hinged doors where required. All cubicles shall be manufactured from 3CR12 sheeting of a minimum 1.6 mm thick for large panels and doors a minimum 1.6mm.

All removable covers shall be secured in position by means of patent screw locking devices approved by the Engineer. All panels shall be suitably braced to ensure rigidity. The boards shall be epoxy powder coated to suit the specified colours on the schematic drawings. The power coating process shall be in accordance with the powder coating manufacturer's specifications.

4.4.3 Hinges, Locks & Handles

Every board will be fitted with a lockable door having a suitable gasket incorporated in the frame to ensure that the arrangement is in accordance with the required degree of protection. The sealing strips and gaskets shall be made of durable, non-hardening rubber, neoprene or other synthetic material, suitably fixed to the door or frame to ensure that the seal does not become dislodged during normal operation and use. All circuit breakers except the Main Switch are to be behind the doors.

Hinges and door handles shall be of the bolted-on type and shall be manufactured from stainless steel. All hinges are to be of the lift-off type and samples shall be submitted to the Engineer for approval.

Hinges and door locks shall be of Barker and Nelson or equivalent quality to ensure satisfactory operation and a pleasant appearance, and where possible the lock and door catch shall consist of one combination unit.

Door latching and de-latching operations shall be smooth and quick, whilst ensuring proper compression of the sealing gaskets.

The repeated opening and closing of the hinged doors and the operations of the door locks and catches shall not cause chipping or scratching of the painted surfaces or any other blemishes to the finished boards.

Each lock shall have two keys and where more than one locked board is specified; the locks shall be in one master series. All keys, plus one master key, shall be handed to the Employer for which a receipt shall be obtained. One master key shall, in addition, be handed to the Engineer.

All keys submitted by the Contractor shall be suitably tagged with the board designation and location.

4.4.4 Workshop Drawings

The Contractor shall submit within 2 weeks of award, three sets of drawings to the Engineer for approval. Manufacture of boards shall only commence once the drawings

have been approved. The Contractor shall check the drawings before submitting for approval.

These checks should include physical dimensions also whether there is sufficient place for their correct mounting.

4.4.5 Inspection

The Engineer shall be advised where the equipment is being manufactured and will be given a minimum 48 hours notice (written) of when it will be ready for inspection at the works.

Equipment, which is dispatched to site without the authorisation of the Engineer, may be rejected and all costs incurred in having it returned to the factory for modification and all liability for such delays would be for the Contractor's account.

Before the switchboard is accepted by the Engineer, all tests including simulated site conditions will be carried out at the factory in the presence of the Contractor and the Engineer.

Interlocking, remote controls and all other circuits external to the switchboard will be simulated and will be tested accordingly. All costs of such tests will be included in the tender price.

A 12-month guarantee shall cover the enclosure and all the equipment installed therein, against latent and patent defects in workmanship and materials. The guarantee period shall begin from the date the boards or panels are completely installed on site, commissioned and accepted by the Engineer. Fair wear and tear of the equipment will be excluded from the guarantee.

4.4.6 Labels

Every Starter or feeder is to have its designation and Incoming cable size, and origin of supply indicated on a label on the top facing section of the panel.

Every circuit will be labelled with an engraved label showing the destination or origin of every feeder. Every cable or circuit will be marked with an approved Bowthorpe Hellerman tag showing the size and details of every cable entering or leaving the board. All identifications shall correspond with the "as-built" drawings and single-line diagrams associated with the contract.

Identification labels in accordance with the specification will be screwed to the front of each door on the panel. The label will describe the purpose of the equipment contained within each compartment.

4.5 Balancing of Load

The Contractor is required to balance the load as equally as possible over the multiphase supply.

4.6 Cable Ladder

- a) O-Line Powerspan PS75 3CR12 heavy duty cable ladder will be used.
- b) Material: unpainted 3CR12 (Minimum 2mm thick).

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- c) Span: 6m with loading of 144 kg/m including any additional 3CR12 supports.
- d) Cable ladder width: As required + 20% spare capacity
- e) Cable ladder side wall height: 75mm
- f) Cable ladder mounting height: As per site requirement. Cable ladders shall be mounted above all access openings.

Fixing: All 304 stainless steel unpainted brackets and supports, that are required to adequately support the fully loaded ladder in accordance with the manufacturer's specification, will be provided. Cable ladders shall be run vertically where possible. Care has been taken in planning the cable ladder routes, however the Contractor is still to check with other services routes to ensure that there are no clashes. Cables shall be individually strapped to the cable tray with PVC cable ties. Cables larger than 70mm² shall be individually fixed with 304 stainless steel "K" clamps.

The Contractor shall measure up and all cable ladders shall be prefabricated.

The spacing of supports shall limit the deflection of cable ladders to 10 mm at the centre of the span whilst carrying the design cable load.

Cable ladders shall be run horizontally and vertically to within tolerances that can be detected on a 1 metre spirit level.

Cables shall be individually strapped to the cable ladder with PVC cable ties. Cables larger than 70mm² shall be individually strapped with stainless steel "Bandit" straps with plastic collar.

Cable ladders shall be earthed at the point closest to the source of supply and continuity shall be maintained across joints by means of jumpers. The minimum size of the earth continuity conductor shall be 16 mm² and it shall be green PVC insulated with tinned lugs.

Separation: Power cables shall be separated from steam pipes and other hot surfaces.

Cable ladder shall be earthed at the point closest to the source of supply and continuity shall be maintained across joints by means of jumpers. The minimum size of the earth continuity conductor shall be 16 mm² and it shall be green PVC insulated with tinned lugs.

25mm or 32mm diameter stainless steel conduit with uPVC bushes on each end shall be used to support short lengths of cable from the cable ladder to the equipment.

40mm x 40mm x 5mm angle iron manufactured from 3CR12 stainless steel shall be used to support short lengths of cable from the cable ladder to the equipment.

4.7 Cables

All cables shall be in accordance with SANS 1507 and shall be PVC/SWA/PVC with stranded copper conductors. Cables shall bear the SANS mark. Four core cables shall be installed from the MCC to each three phase motor and the fourth core shall be used as the earth conductor with separate earth conductor for VSD drives. All other low voltage cables shall be of the ECC type.

Cables must be installed in accordance with SANS 0198 and the Contractor must adhere to the minimum bending radii specified.

Conductor insulation which is colour coded by a line only, will not be accepted. The total insulation must have the phase colour.

It shall be the responsibility of the Contractor to establish the correct lengths of cable on site, before placing an order. The Contractor shall not be reimbursed for any surplus cable.

4.7.1 Installation

Cables must be removed from the drums in such a manner that the cable is not subjected to mechanical damage, twisting or tension exceeding that stipulated by the cable manufacturer.

The cables must be adequately supported at intervals during the whole operation. Particular care must be exercised where it is necessary to draw cables through pipes and ducts to avoid abrasion, elongation or distortion of any kind. The ends of such pipes and ducts shall be sealed to approval after drawing in of the cables.

Each section of installed and jointed cable shall be tested in accordance with SANS 1507. The insulation resistance shall be measured with a 1000 volt Megger and the readings shall be tabulated and certified. Similarly the earth continuity resistance of each section of cable shall be measured and recorded. All low voltage cables must be tested on site prior to final terminations after glanding, in the presence of Engineer. All test results must be submitted to the Engineer.

4.7.2 Cable Glands

Cable glands shall conform to SANS 1213. All cable glands be rated at IP68 with corrosion guard and shall conform to SANS 1213. Type: Pratley or equal and approved.

4.8 Cable Junction Boxes

IP65 rated four-way orange cable boxes shall be Pratley Ezee-fit with Klippon Terminals suitable for 4mm² wire for cabling to lighting.

4.8.1 Cable Joints

Where cable joints are to be made they shall be made either by means of compound filled boxes according to the best established practice by competent cable jointers using first class materials or by means of approved epoxy-resin pressure type jointing kits such as "Scotchcast".

Epoxy resin joints must be made entirely in accordance with the manufacturer's instructions and with materials stipulated in such instructions.

Low voltage PVC cables are to be made off with sealing glands and materials designed for this purpose which must be of an approved make. Where cables are cut and not immediately made off, the ends are to be sealed without delay.

4.9 Hangers and Supports

Where provision has not been made for the fixing of luminaires, the Contractor shall supply the necessary supports, hangers, angle brackets or any other fixing method approved by the Engineer.

4.9.1 Lighting

All luminaires must be complete with lamps, diffusers and mounting brackets as required. The layout of the luminaires must be confirmed with the Engineer. Refer to the schedule in the bill of quantity.

Lighting shall be cabled 4mm² x 3core PVC/SWA/PVC Cu cable with open ended stainless steel conduit as supports. Each circuit will be protected with a 10A SP circuit breaker in the existing small power and lighting DB. Light fittings installed against steel beams shall be secured by means of suitable clamps or mounting brackets.

4.10 Earthing & Bonding

The type of main earthing must be as required by the supply authority if other than the Engineers, and in any event as directed by the Engineer, who may require additional earthing to meet test standards.

Installations shall be effectively earthed in accordance with the SANS 10142-1 and to the requirements of the supply authority. All earth conductors shall be stranded copper with or without green PVC insulation.

Connection from the main earth bar on the main board must be made to the cold water main, the incoming service earth conductor, if any and the earth mat or other local electrode by means of 70 mm² stranded (not solid) bare copper wire or such conductor as the Engineer may direct.

Main earth copper strapping where installed below 3m from ground level, must be run in 20 mm diameter PVC conduit securely fixed to the walls.

4.10.1 Sub-distribution boards

A separate earth connection shall be supplied between the earth busbar in each sub-distribution board and the earth busbar in the Main Switchboard. These connections shall consist of bare or insulated stranded copper conductors installed along the same routes as the supply cables or in the same conduit as the supply conductors.

4.10.2 Sub-Circuits

The earth conductors of all sub-circuits shall be connected to the earth busbar in the supply board in accordance with SANS 10142-1.

4.10.3 Ring Mains

Common earth conductors may be used where various circuits are installed in the same wireway in accordance with SANS 10142-1. In such instances the sizes of earth conductors shall be equivalent to that of the largest current carrying conductor installed

in the wireway, alternatively the size of the conductor shall be as directed by the Engineer.

Earth conductors for individual circuits branching from the ring main shall be connected to the common earth conductor with T-ferrules or soldered. The common earth shall not be broken.

4.10.4 Connection

Under no circumstances shall any connection points, bolts, screws, etc., used for earthing be utilised for any other purpose.

It will be the responsibility of the Contractor to supply and fit earth terminals or clamps on equipment and materials that must be earthed where these are not provided. Unless earth conductors are connected to proper terminals, the end shall be tinned and lugged.

4.11 Lightning Protection Installation

The scope of the contract is the survey, supply, installation and commissioning of the complete lightning protection system for the weighbridges, hilo spiller and high mast lighting. This part of the installation may only be undertaken by specialists. All new equipment mounted outside existing buildings shall be protected against lightning in accordance with SANS 61024 - 1. The installation shall generally consist of labelled test joints connecting 70mm² insulated copper earth wire which is then connected to 16mm diameter copper coated steel earth rods buried in the ground. The system impedance shall be better than 7 Ohms.

4.12 Project Standards

Listed below are the specifications and codes that shall be complied with:

4.12.1 Project Specific Standards

These will be the applicable Bosch Projects standards:

| | |
|-----|-----------------------------|
| E06 | Distribution Boards |
| E09 | Electrical Excavations |
| E10 | Cable Laying |
| E13 | Cabling and Wiring |
| E20 | Electrical Earthing |
| E22 | Electrical Testing |
| E24 | Lightning Protection System |
| E34 | High Mast Lighting |

4.12.2 Company Specific Standards

Not applicable.

4.12.3 Codes of Practice

| | |
|------------------------|---|
| SANS 10142 | Wiring of Premises (Part 1 and 2) |
| IEC 60204 | Safety of Machinery |
| OHS Act No. 85 of 1993 | Occupational Health and Safety (OHS) Act No. 85 of 1993 (RSA) |
| NOSA | N.O.S.A. Safety Guidelines |

4.12.4 National and International Standards

| | |
|--------------|--|
| SANS 1091 | SA National Colour standards for paint |
| SANS 61439 | Low voltage switchgear and control gear assemblies |
| SANS 1195 | Standard specification for busbars |
| SANS 1973-1 | Low-voltage switchgear and control assemblies Part 1: Type tested, partially type tested and specially type tested assemblies with a rated short-circuit withstand strength above 10kA |
| SANS 60044 | Instrument transformers |
| SANS 60269 | Low Voltage Fuses |
| SANS 156/556 | Moulded-case circuit breakers |
| SANS 60529 | Degrees of protection provided by enclosures (IP Code) |
| SANS 60947 | Low voltage switchgear and control gear |
| SANS 61000-1 | Electromagnetic compatibility (EMC) Part 1: General |
| SANS 10064 | The preparation of steel surfaces for coating |
| SANS 1274 | Coatings applied by the powder-coating process |
| SANS 10142-1 | Low Voltage Electrical installation |
| VC 8003 | Manually operated switches for fixed installations |
| VC 8035 | Compulsory specification for earth leakage units |
| VC 8036 | Compulsory specification for circuit breakers <= 125A and <= 10kA |
| SANS 61312 | Protection against lightning and electromagnetic impulse |

Note: National and International Standards must be adhered to as a minimum requirement. The Supplier may propose equivalent acceptable standards however these must be specified. In the event of differing requirements, the most stringent Code or Standard shall apply.

5. GENERAL REQUIREMENTS

5.1 Units

The metric system of units shall be adopted for this Contract.

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The Supplier is required to provide all manpower-supervision, equipment, materials, tools and services to meet the following requirements which will form part of this Contract.

5.2 Project Management

The Supplier shall be responsible for the project management of this Contract scope of work which will include planning, scheduling and reporting to the Company.

5.3 Engineering Design

The information supplied in this Contract in the form of data, drawings, etc., is intended to serve as a guide to the Company's requirements. The acceptance of this information shall in no way relieve the Supplier of its responsibilities in terms of the design, engineering and performance guarantee of the Goods. When designing and selecting equipment, the Supplier shall consider commonality between equipment to reduce spares holding. All units used in the design of the Goods shall be to the International System of Units ("SI").

5.4 Integral Components

All Connection Elements (means all holding down, anchor or connection bolts including all washers, nuts, screws, spacers, shims etc) and Integral Equipment such as local instrumentation gauges, local piping, service or supply manifolds, sight glasses, light glasses and lamps located within the terminal points is considered an integral part of the Goods and is to be provided by the Supplier. Where applicable, all integral components as well as all nozzles, are to be supplied complete with all mating flanges, connection elements, gaskets, seals and bolt sets.

5.5 Early Delivery of Built-in Items

Upon commencement of this Contract, the Supplier shall establish the full requirements relating to all built-in items and arrange for their earliest manufacture and delivery to Site to suit the overall Project programme.

5.6 Materials, painting and finishing

Materials of construction and finishes shall be selected to withstand local environmental exposure conditions with an appropriate corrosion allowance. All surfaces, where necessary, shall be painted in accordance with the Project Standards.

5.7 Name Plates

The Supplier shall provide engraved stainless steel name plates for all Goods. These name plates shall display the manufacturer's data, the relevant equipment details and the identification names and numbers in English.

5.8 Access

All areas of the Goods that require daily or frequent service access shall have permanent access facilities such as stairways, platforms, railing and cat ladders, which are wide enough for safe and easy passage. This shall include access to all manholes, inspection hatches, sample points and emergency systems.

5.9 Safety

The Supplier shall supply all the necessary safety protection equipment such as vent valves, hot surface guards, railings, notices, etc., in accordance with the latest Occupational Health and Safety Act, 85 of 1993. In addition, the plant noise level shall be less than 85 dB when measured at any point further than 3 (three) meters from the source(s) of the noise.

At all times that the Supplier is required to be on Site, the Supplier shall comply with the Company's Health and Safety Specifications

5.10 Transportation

All Goods to be delivered shall be suitably marked and correctly packaged to prevent damage during loading, transportation and offloading as well as to ensure ease of storage, retrieval and unpacking on Site. All invoices and shipping documentation (Bills of Lading and packing lists) shall strictly match in terms of detail.

5.11 Quality Control and Inspection

The Supplier shall be required to submit a quality control plan (QCP), which shall highlight all manufacturing aspects associated with the Goods and all inspection points (i.e. verification points, witness points, hold points) to be carried out by the Supplier.

The QCP shall also allow the Company to highlight any inspection points to be carried out by the Company during manufacture. The Supplier shall provide a minimum of 14 (fourteen) days' notice of when the Goods will be ready for the Company to carry out inspections. All tests, including simulated Site conditions, shall be carried out at the Supplier's factory / workshop in the presence of the Company prior to acceptance. Goods dispatched without inspection may be rejected, and all additional costs resulting from rectification or corrective action, thereafter, shall be for the Supplier's account.

5.12 Non-Destructive Testing (NDT)

The Supplier shall make allowance for all workshop/off-Site inspections and NDT as per the codes of manufacture and the Projects Standards. The Company reserves the right to review all NDT procedures and results.

5.13 Preferred Plant

The Supplier shall adhere to the Company's preferences for certain equipment and clearly state any differences in the tender. This requirement must not, however, be to the financial or technological disadvantage of the Client.

The final responsibility for the choice of suitable Goods must remain vested with the Supplier who is responsible for the performance of all Goods and associated equipment.

| | |
|-------------------------------|------------------------------|
| Operating Voltage | 400 Vac |
| Control Voltage | 220 Vac |
| Electric Motors | WEG or Siemens or equivalent |
| Motor Control Centre (panels) | IEC 61439 |

| | |
|-------------------------------|---|
| Miniature circuit breakers | Schneider Electric <u>or equivalent</u> |
| Isolators | Schneider Electric or equivalent |
| Contactors and overloads | Schneider Electric or equivalent |
| Terminal connectors | Weidmuller or equivalent |
| Panel lights | Schneider Electric or equivalent |
| Push buttons | Schneider Electric or equivalent |
| Panel Door Switches | Schneider Electric or equivalent |
| Panel Mount Current Indicator | Schneider Electric or equivalent |
| Metering CT | PCI or equivalent |
| Soft Starters | WEG or Siemens or equivalent |
| Variable Speed Drives | WEG or Siemens or equivalent |
| Timers | Schneider Electric or equivalent |
| PLC Interposing Relays | Schneider Electric or equivalent |
| General lighting | Phillips / Magnitech or equivalent |

5.14 Life Span

All Equipment shall be designed for a minimum lifespan of 25 years.

5.15 Marking, Packing and Shipping

All Equipment shall be suitably marked and correctly packed to prevent damage during loading, transportation and offloading as well as to ensure ease of storage, retrieval and unpacking on Site. The Contractor shall be required to make good all loading damage.

The Contractor shall ensure that they are fully conversant with all packing and shipping requirements.

All invoices and shipping documentation (Bills of Lading and packing lists) shall strictly match in terms of detail.

Certificates of compliance shall also be included in the shipping documentation i.e. electric cables supplied from EU, UK, RSA and shall have the appropriate certificate accompanying the shipment.

5.16 Inspection and Inspection Authorities

The Contractor shall give the Engineer and the Purchaser full opportunity to inspect progress, measurements, materials and workmanship associated with the Works.

6. INSPECTION

The accredited representative of the Purchaser shall have access to the Contractor's works at any time during working hours for the purpose of inspection of manufacture or test on the plant and selection of samples of the materials going into the equipment. The Contractor shall provide necessary facilities for such inspection or test.

All the type / special / routine tests on the generator as per SANS / IEC of latest issue and indicated below will be witnessed by the Engineer and all necessary facilities for inspection and testing shall be provided by the Contractor. The generator shall be completely assembled and tested at the Contractor's factory.

The Contractor shall ensure that the test instruments have calibration certificate issued by an approved standard laboratory, not earlier than six months from the date of testing.

7. **ELECTRICAL** Testing

The Contractor shall test the entire installation in terms of Regulation 7 of the Electrical Installation Regulations 1992 of the Occupational Health and Safety Act 1993 and shall issue a Certificate of Compliance on the official form, Annexe 1, obtainable from the Electrical Contracting Board of South Africa. All tests shall be carried out in conjunction with and to the satisfaction of the supply Authority and in the presence of the Engineer. The Contractor shall make all arrangements for testing and inspection, the costs thereof being included in the Tender Price.

The Engineer will provide the Contractor with check sheets, which must be used and completed in full. These check sheets do not relieve the Contractor from carrying out his own checks and tests. The responsibility of the installation meeting specification and statutory requirements remain with the Contractor.

The Contractor shall ensure that the installation is completed in every respect and that there are no major defects prior to notifying the Engineer (in writing) for the first delivery inspection. The certificates of compliance shall be issued to the engineer at the first delivery inspection.

The Engineer will accept zero minor defects during the final inspection. Should any defects as listed during the first delivery inspection be found not to have been corrected then the engineer will terminate that inspection and request that an additional final inspection be arranged by the Contractor.

Testing shall consist of pressure tests (where applicable), primary and secondary injection, relay tests and any tests which the Employer or the Engineer deem relevant to ensure compliance with specification and correct functionality.

The Contractor shall be responsible for arranging all the tests as specified, at the appropriate time.

The electrical installation shall be tested in accordance with the Standard Regulations for the Wiring of Premises and any applicable by-laws of Local Authorities.

The Engineer may perform similar tests at any time and the Contractor shall render all assistance and shall provide all tools and instruments, which may be required for such tests.

The Contractor shall replace any portion of the installation if it does not meet with the requirements of the Regulations of this specification, as may be found by test or inspection. Such replacement shall be done at his own cost.

"Danger " notices shall be displayed at remote ends of cables under test.

The Contractor shall advise the Engineer in writing of all results and furnish copies of all certificates.

The Contractor shall provide all the necessary instruments for the proper testing of the complete installation. If there is a reason to doubt the accuracy of such instruments, the Contractor shall take the necessary action to prove their accuracy.

| TESTING | MINIMUM REQUIREMENTS |
|---------------------------------|---|
| Insulation resistance | Whole installations: better than 1 Meg Ohms |
| LT Installation | Each sub-distribution section: better than 5 Meg Ohms. Each un-terminated cable: better than 5 Meg Ohms |
| Earth Leakage on socket outlets | Better than 30 milli amps |
| Earth continuity | Better than 0.5 Ohms |
| Earth Loop impedance | Better than 0.5 Ohms |
| Earth electrode resistance | Better than 1.0 Ohms |

8. COMMISSIONING

The commissioning activities which the Supplier is required to supervise, shall be carried out in the following sequence:

- pre-commissioning tests, which shall include the appropriate inspections and ("dry" or "cold") functional tests to demonstrate that each item of the Goods can safely undertake the next stage, (b);
- commissioning tests, which shall include the operational tests to demonstrate that the Goods can be operated safely and as specified, under all available operating conditions; and
- trial operation, which shall demonstrate that the Goods perform reliably and in accordance with the Contract.

The Supplier must develop a testing plan in MS Project format as well as a testing manual for all commissioning and performance testing activities. These documents must be submitted to the Company's Representative for review and approval prior to delivery of the Goods. The Company's Representative will integrate the Supplier's testing plan into the Company's overall commissioning and testing plan for the Project.

This overall commissioning and testing plan and the overall management of commissioning and testing thereof, shall be carried out by the Company or Company's Representative.

The Supplier's commissioning and testing manual must include the following information:

- i) the number of trained personnel required to be provided by the Company for all commissioning and testing activities as outlined in the commissioning and testing plan;
- ii) all settings, check sheets, tests procedures, etc. required for all commissioning activities (i.e. pre-commissioning, commissioning and trial operation) to ensure that the Goods are safe for operation;
- iii) all settings, check sheets, tests procedures, etc. required for all performance testing to ensure that Goods operate safely and in accordance with the requirements of the Contact; and
- iv) all punch listing forms required by the Supplier to ensure that defects are notified to the Supplier, recorded, and remedied.

The Supplier shall not be relieved of any responsibilities, obligations or liabilities under the Contract when the Company's Personnel are operating the Goods under the direction or supervision of the Supplier during training or commissioning.

8.1 Pre-Commissioning tests

The pre-commissioning tests must be carried out in the presence of the Company's Representative, the Company and a third party Inspector appointed by the Company (if required) as required and only after the Company's Representative has accepted that the Goods have been correctly installed and can operate safely.

The Supplier must actively supervise and co-ordinate all the pre-commissioning activities carried out on all Goods. In addition, the Goods shall be operated by the Supplier's personnel during this period.

The Supplier shall also be required to supervise trials as necessary to simulate operational conditions, and any tests required by the Company's Representative, the third party inspector (if required) or the Company to insure the Goods are in an acceptable and safe condition for further testing.

A punch list of items that are required to be remedied prior to the commissioning tests being undertaken ("**Punch List Category A items**") must be compiled by the Supplier and all Punch List Category A items attended to prior to the commencement of the commissioning tests.

8.2 Commissioning tests

Commissioning tests will be carried out by the Company under the Supplier's supervision and direction. The Supplier's commissioning engineer shall direct the Company's personnel to make such adjustments to the Goods as are necessary to enable commissioning to proceed safely and efficiently.

The Company shall provide all Company's Personnel required for training and assistance during this period.

Commissioning tests shall include all tests recommended by the Supplier in the commissioning and testing manuals. These tests shall include all start-up, operation, shutdown, and liquation activities as required. These tests may also include emergency operation activities as necessary.

In addition, the Supplier shall be required to direct the performance of on-load testing of the Goods (at gradually increasing loads) as necessary for the purpose of adjusting certain pieces of the Goods to ensure they are functioning properly.

A punch list of items that must be remedied prior to the Goods being operated by the Company ("**Punch List Category B items**") must be compiled during these commissioning tests and all Punch List Category B items attended to prior to the commencement of the trial operation of the Works.

9. Schedule Of **DRAWINGS** And Documents

- **Drawings Supplied With Tender**

The drawings listed in Annexure 2 are provided with this Tender. Contractors should ensure that they are in possession of a full set of drawings.

- **Drawings And Documents To Be Supplied By Contractor**

This schedule of drawings and data requirements constitutes a part of the Specification.

The Purchase Order shall not be regarded as complete unless these requirements have been complied with.

Contractor's drawings will be approved only as to arrangement, conformity to the specifications and related drawings and approval shall not relieve or mitigate the Contractor's responsibility for accuracy and suitability of materials and/or equipment represented thereon. Contractor shall note:

- **Tender Drawings**

Shall be manufacturer's standard drawings in sufficient detail to allow appraisal of layout of equipment, drives, access for maintenance and operation and building and foundations.

- **Approval Drawings**

Shall be complete with equipment number(s). Approval drawings shall be stamped "DRAWINGS FOR APPROVAL" and must show all information necessary for the design of foundations and any connections to other equipment or steelwork.

- **Final Drawings**

Shall be stamped "CERTIFIED FOR CONSTRUCTION" and signed by the Contractor's Engineer.

Certification warrants that delivered equipment shall conform to the final drawings. Should delivered equipment fail to conform, Contractor's shall furnish all materials,

labour and equipment required to correct such failures to the satisfaction of the Engineer.

Document and Drawing QUANTITIES and TYPE are indicated below in the following manner:

P = Print
S = copy on computer CD either in the latest published version of AutoCad or DXF file format.

The Document / Drawing Scheduling is indicated below in the following manner:

O = Order Date
T = Take-Over Date
A = Availability Date
C = Commissioning date

e.g. O + 30 = 30 calendar days after Order date.
C - 90 = 90 calendar days before commissioning

| Document | With Tender | After Award | | |
|--|--------------------------|--------------|----------------------------|--------------------------|
| Description | | For Approval | Certified for Construction | As-Built |
| Submission of design, manufacture, procurement, erection and commissioning programme (Level 2 to 5) | | O + 5 | | |
| **Submission of equipment loadings, fixing and interface details to enable the Engineer to fully design all civil and structural works | <input type="checkbox"/> | O + 10 | | |
| **Equipment and general arrangement drawings | <input type="checkbox"/> | O + 10 | O + 15 | <input type="checkbox"/> |
| **Submission of all MCC, panel, cubicle, layout drawings and schedules, loop diagrams etc. | | O + 10 | O + 15 | <input type="checkbox"/> |
| **Submission of detailed design calculations and drawings for approval | | O + 10 | O + 15 | |
| Submission of factory acceptance test certification | | | | A + 5 |
| Commissioning and testing manual | | | | C - 10 |
| Operations and maintenance manuals | | | | T + 0 |
| "As Built" documentation & drawings | | | | T + 0 |
| Contractor's Data Book | | | | T + 0 |
| A copy of the ISO 9001 accredited quality system certificate or international alternative. | <input type="checkbox"/> | | | |
| Quality Control Plan | <input type="checkbox"/> | | | |
| Submission of design, manufacture, procurement, delivery and erection programme | <input type="checkbox"/> | | | |

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ANNEXURE 1 - DRAWINGS

| Drawing No. | Description |
|-------------------------|--|
| 10969-001-002- GGL-0001 | Overall Site Layout |
| 10969-001-002-EED-0001 | Ground & Mezzanine Floor - Small Power & Lighting |
| 10969-001-002-ESL-0001 | Main PDB & Spiller MCC SLD |
| 10969-001-002-EED-0003 | Protective Earthing Diagram |
| S-661 | Typical Motor Cable Support Details From Cable Rack |
| S-662 | Typical Earthing Of Cable Racks |
| S-664 | Typical Earthing For Steel Structures |
| S-665 | Typical Earth Boss For Structures And Vessels |
| S-666 | Typical Earth Well |
| S-667 | Typical Lightning Protection Connection To Earth Electrode Assemble Detail |

ANNEXURE 2 – PROJECT SPECIFIC STANDARDS

| Document No. | Description |
|--------------|-----------------------------|
| E06 | Distribution Boards |
| E09 | Electrical Excavations |
| E10 | Cable Laying |
| E13 | Cabling and Wiring |
| E20 | Electrical Earthing |
| E22 | Electrical Testing |
| E24 | Lightning Protection System |
| E34 | High Mast Lighting |

PROJECT STANDARDS

DISTRIBUTION BOARDS – E06

March 2012



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SECTION 15

DISTRIBUTION BOARDS (FOR HEAVY INDUSTRIAL AND COMMERCIAL USE)

All major Distribution Boards and equipment shall be designed and manufactured in accordance with SANS 1473/60439. The equipment shall conform to SANS 60947 Parts 1 -7, unless otherwise stated, and shall be suitable for operation on supply voltages of 230/400 Volts and 500/550 Volts, 50 Hz, AC. Reference must be made to the detailed technical specification, the relevant line diagrams, as well as to the following specific requirements.

1. CONSTRUCTION OF MOTOR CONTROL CENTRE ASSEMBLIES

All Distribution Boards shall generally be of the free standing, floor mounted, with front and back access, suitable for bottom cable entries from cable trenches below the assembly. The schematic drawings show the specific requirements applicable to each assembly.

The assembly shall be constructed of electrolytically deposited zinc coated mild steel sheet similar to Zintex manufacture. Where specified the assembly enclosure may be required to be manufactured from stainless steel or 3CR-12.

The minimum thickness of 1.6mm for panels less than 0.5m wide and 2mm thick for larger panels, except for gland plates which shall be a minimum of 3mm. Thicker sheets shall be used for very large panels and where the weight of the equipment would cause buckling or vibration.

Unless otherwise specified, the metal enclosures, internal panels and all equipment support frames shall be manufactured from the same type of plate. When required, glass panels may be specified for viewing indication equipment.

The degree of protection shall not be less than IP53, for an assembly installed in an enclosed unpressurised room or IP53 for an assembly installed in a general plant area or outdoors in a semi protected area in accordance with SANS 1222 and capable of withstanding the temperature, humidity and conditions normally associated with heavy industrial applications. The assembly shall be fully vermin proofed.

A hot dipped galvanised steel base frame with predrilled holes for fixing the DB to the floor shall be provided and removable lifting eyes with blanking off plugs shall be provided for lifting heavy assemblies. All panels shall be suitably braced to ensure rigidity. The method of preparing platework, priming and painting shall be in accordance with the standard painting specification.

The DBs are to be fully assembled in the manufacturers factory for final acceptance tests. Where broken down for transportation to site, the DBs will be provided with all items required for re-assembly. Provision must be made for future extension at either side of the DB. All holes provided for such extension to be suitably plugged or covered.

The overall outside dimensions of the assembly shall be suitable for easy handling of the switchgear as indicated on the drawings. The height of the assembly shall generally not exceed 2100mm above floor level.

All hinged front panels shall be fitted with stainless steel or heavy duty rustproof hinges of Barker & Nelson or Zeus manufacture with an 180° movement and shall be secured in the closed position by means of locking devices of approved quality. Hinged front panels in excess of 450mm height shall be secured at both the top and bottom. Lockable catches are required on all hinged front panels. All hinged front panels are to be fitted with earth straps.

Covers, other than the hinged type, shall be provided with chromium plated handles to facilitate removal. Removable covers shall be secured in position by means of patent screw locking devices approved by Bosch Projects. All removable covers and hinged front covers shall have a neoprene or rubber gasket to ensure that the required IP rating of the panel is achieved.

All the equipment shall be mounted behind the hinged front panels and neat machine punched openings shall be provided for the purpose of operating handles etc. Bosch Projects's drawings will detail the instruments required which will be flush mounted. The positions of instruments shall be such that the glass cannot be broken by other equipment when the hinged front panels are in the fully open position.

Cut outs which are provided for future equipment and instruments shall be neatly blanked off by means of removable dummy frames. Back plates shall be provided in all spare cubicles for the specified future equipment.

To avoid damage to paintwork, screws, bolts, door lock, etc. must not be in direct contact with painted surfaces.

The manufacturer's detailed working drawings of the assembly **must be approved** by Bosch Projects before any fabrication commences. Any other construction or type of assembly proposed as an alternative to that specified, must have the approval of Bosch Projects in writing. The drawings will detail all dimensions of busbars, connections, electrical component make, type and rating. Positions and layout of busbars, earth bars and gland plates will be shown in front and side elevation drawings.

2. PAINT SPECIFICATION

All metal used for the fabrication of the board shall be painted, i.e. internally and externally. Baked enamel, electro statically applied powder coating or similar proven methods, other than standard enamel paint applied by brush, shall be used.

In general, the following standard colours shall be used, but the final colours are to be confirmed with Bosch Projects.

Non-essential sections Electric orange (colour B26 - SANS 1091).

Essential sections Signal red (Colour A11 - SANS 1091).

Uninterrupted power (UPS) Purple.

Instrumentation and control Blue.

2.1 Edges

Care shall be taken to ensure that all edges and corners are properly covered, after all burrs and sharp edges have been removed.

2.2 Surface Preparation

Surface preparation shall comply with SANS 10064. Prior to painting, all metal parts shall be thoroughly cleaned of rust, mill scale, grease and foreign matter to a continuous metallic finish. Sand or shot blasting or acid pickling and washing shall be employed for this purpose.

The corrosion inhibiting process shall be suitable for the environmental conditions to be encountered on site and full details shall be provided at the time of tendering. Details of the chemical process employed and the method of application shall also be provided at the time of tendering.

As a minimum requirement, the finishing process shall consist of the following:

2.3 Mild Steel – Baked Enamel Finish

Immediately after cleaning, all surfaces shall be covered by a rust inhibiting, tough, broken metal-phosphate film and then thoroughly dried.

Apply two-pack wet primer to 15 microns, allow to dry in accordance with supplier's recommendations followed by two sprayed coats of high quality alkyd-based baked enamel, with a minimum paint thickness after baking of 60 microns.

2.4 Mild Steel – Powder Coated Finish

Immediately after cleaning, those metal parts shall be pre-heated and then covered by a micro structured paint powder applied electro statically, with a minimum final paint thickness of 60 microns.

2.5 3CR12

One (1) coat of suitable etch primer (15 microns)

Apply epoxy polyester powder coat (60 microns final thickness)

3CR12 steel, where specified, shall be correctly pickled and passivated prior to being painted. Pickling and passivation shall be undertaken after basic manufacture of the Enclosure is complete.

2.6 Touch-up Paint

In the case of switchboards and larger equipment enclosures, a tin of matching touch-up paint not smaller than 1 litre shall be provided.

3. BUSBARS

All busbars shall be manufactured from solid high conductivity copper and shall comply with the requirements laid down in SANS 1195. The completed busbar system shall be a standard modular system and shall have been tested to SANS approval and a certificate shall be made available confirming the full busbar technical description, current rating and fault rating together with full details of the test results. Busbars for systems up to 600V shall be designed to withstand a test voltage of 2.5kV AC for one minute.

The busbar assembly shall be rated in accordance with the specified ultimate projected fault level, which will be not less than the short-circuit stresses limited by the protective device(s) on the supply side of the busbars, as well as the specified continuous full load current, with a current density not exceeding 1,60 Amps per mm². The busbars shall withstand a fault current under test conditions of the specified fault level for 1 second. If a fault level is not specified, the busbars shall be tested at 20 times rated current for 1 second. The fault current during tests shall be:

- between all three-phases
- any two phases
- neutral and the adjacent phase, and
- earth conductor and the nearest phase conductor.

The busbars shall be continuously rated for the specified current with a maximum temperature rise of 40°C relative to a peak ambient temperature of 40°C giving a maximum peak busbar temperature of 80°C.

Busbars shall be mounted in the top section of the assembly and shall be rigidly supported by means of approved insulated busbar clamps (at intervals not exceeding 500mm) to prevent damage resulting from the specified short circuit conditions.

The busbars shall run along the entire length of the assembly up to 76mm from either end. The phase busbars shall be identified in the phase colours red, white and blue.

The busbars shall be arranged horizontally with the longer side of the cross-sections in the vertical plane and one behind the other in the horizontal plane. The minimum clearance between live conductors and live conductors and earth shall be 40mm for systems up to 600 volts.

3.1 Earth Busbar

A solid copper earth bar shall be provided inside each assembly at the back and along the entire length, at a height of approximately 500mm above floor level, or 200 mm above the gland plates. A bar is to be provided at the top of the assembly where top entries exist and this shall be solidly connected to the bottom earth bar.

The bar will be supported on robust spacers and will have a minimum clearance of 40mm to the sheet steel panel.

The earth bar shall have a cross-section of not less than 40mm X 6.3mm and shall be drilled with the requisite number of holes for the individual connection of all cable ECC and other earth conductors.

The earth bar, and busbar joints and cable terminations must not be insulated.

High tensile phosphor bronze or cadmium plated nuts, bolts and lock washers shall be provided through the earth bar at each earthing position and at least 5 additional holes will be provided for future connections, each being fitted with nuts and bolts as above.

The earthing positions shall be evenly spaced along the length of the earth bar and the bar must be clearly identified as the earth.

3.2 Neutral Busbars

Neutral busbars in 3 phase, 4 wire supplies shall have a cross-section of at least 60% of the cross-section of the phase busbars. Where single-phase circuits (e.g. lighting and general power circuits) are protected by single-phase circuit breakers or fuses, all neutral conductors shall be connected to a separate neutral busbar mounted in a suitable position.

The cross-section of the busbar shall be at least 6.3 x 25 mm and the busbar shall be long enough for the lug of each conductor to be bolted separately to the busbar. Only one neutral conductor is allowed per nut and bolt combination.

A separate neutral bar shall be provided for each earth leakage unit provided on the switchboard.

3.3 Busbar Droppers

- All busbar droppers must be suitably supported (maximum spacing @ 500mm centres) and braced to suit the specified and/or projected short circuit conditions. They should be fully insulated and screened against accidental contact.
- The droppers to the supply side of a single functional unit, as well as the components included in this unit, may be rated on the basis of the reduced short-circuit stresses occurring on the load side of the short-circuit protective device in this unit provided that these conductors are arranged such that under normal operating conditions an internal short-circuit between phases and/or between phases and earth is only a remote possibility, for example by being provided with adequate insulation or shrouding.
- Particular attention shall be paid to the provision of adequate facilities for making off the main power supply cables. Attention must be paid to the vermin proofing of single core cabling.
- Bunched cable connections will not be accepted between busbars and outgoing power circuit breakers, fuses or isolators.

3.4 Busbar Connections

- All connections and extensions to busbars shall be effected by means of high tensile phosphor bronze nuts, bolts and washers or cadmium plated, high tensile steel bolts and nuts which shall also be provided for future extensions. The minimum diameter of any hole will be 10 mm.
- In exceptional cases a relaxation of SANS 1473 may be permitted to allow the drilling of holes, in which case the cross-sectional area as measured is to be reduced by the area of the holes.

4. EQUIPMENT

Unless otherwise stated on the drawings the latest version of the following minimum specifications shall be assumed for equipment to be installed in the switchboards:

- Busbars SANS 1195
- Circuit breakers SANS 60947 Part 2 & SANS 156
- Switches, disconnectors and fuse combination units SANS 60947 Part 3
- Contactors and motor starters SANS 60947 Part 4
- Control circuit devices and switching elements SANS 60947 Part 5
- Multi-function switching devices SANS 60947 Part 6
- Ancillary equipment SANS 60947 Part 7
- HRC fuses and fuse switches SANS 60269/1& 2 & SANS 172

SANS 60947 relates specifically to equipment for use at voltages up to 1000V AC. Where a voltage in excess of 1000 Volts is specified, the manufacturer must confirm that the equipment is suitable and has been tested to that higher voltage.

The equipment to be mounted in the panels will be detailed in the drawings and schedules provided.

All contactors shall be protected with suitable back-up HRC fuses or current limiting circuit breakers to protect the equipment against abnormally high currents or short circuits developing in the system.

Unless otherwise stated, contactors shall be rated for 10 million operations for making and breaking no-load currents to category AC3 as laid down in SANS 60158.

Each switchboard shall be provided with a means to isolate the incoming supply. This may be achieved by the use of an isolator, circuit breaker (fixed or draw-out) or fuse switch, rated to make against the full system fault at the point and break the full load current. The incoming supply section containing switchgear, protection equipment, controls and instrumentation shall form a clearly labelled, self-contained unit behind one or more hinged panels. The operating handle of the isolator, circuit-breaker or fuse switch controlling the incoming supply shall protrude through the panel and shall be interlocked to ensure that the panel can only be opened when the supply is off.

Equipment that cannot be flush mounted on the panel, shall be mounted on a suitable metal chassis and shall protrude through a close fitting cutout in the panel. All protection relays contained in enclosed units with glass fronts shall be flush mounted on the hinged panels, contactors, thermal overload relays, etc. shall be mounted on a chassis behind the panel.

Equipment to be supplied under this contract must be identical in all respects and it shall be possible to interchange such equipment should it become necessary.

All material and equipment must be suitable for 415/240V-supply voltage, 50 Hz supply frequency and must be approved by Bosch Projects. In addition all equipment shall be designed, manufactured and tested in accordance with the relevant IEC Standard Specification and the necessary precautions shall be taken against corrosion, i.e. all metal shall be galvanised.

4.1 Derating of Equipment

Full cognisance must be taken of manufacturers derating tables for equipment located in enclosures and the rating of that equipment must be increased accordingly. In all such cases labels must be provided on the front of the associated cubicle stating the maximum permitted circuit loading.

Where high ambient temperatures and/or continual high loadings are anticipated, the assembly must incorporate adequate ventilation systems to eliminate the possible build-up of excessive temperatures. Where specified, renewable filter elements must be incorporated.

4.2 Cable Terminations

Due to the continuing miniaturisation of equipment, difficulties can be experienced in terminating power cables onto equipment terminals, particularly where more than one cable has to be terminated. The manufacturer shall ensure that suitably designed and rigidly braced copper stubs are extended from such terminals to facilitate the termination of all cables. Flash barriers must be used between the phase terminals of circuit breaker equipment.

5. INSTRUMENTATION

All instruments shall be of a matching flush pattern, preferably with a 96mm X 96mm square dial. The single line diagram will indicate the ratio of CTs where required. The instruments shall be suitable for the environment in which they are installed. All instruments shall withstand a test voltage of 2kV for 1 minute and the terminals of all instruments mounted on hinged panels shall be shrouded.

All main incoming panels shall be provided with three combined maximum demand/instantaneous ammeters, a voltmeter and selector switch as well as any additional instrumentation detailed on the single line diagrams.

5.1 Ammeters

Each Incomer shall have three combined maximum demand type instruments will comprise a moving iron ammeter showing the instantaneous current value, combined with an ambient corrected, manually reset, thermal maximum

indicating ammeter which will indicate the mean current reached during any 15 minute period. The maximum demand ammeter shall be in accordance with IEC 60051 and the accuracy need not exceed 3%.

5.2 Current Transformers

Where applicable, the current transformers shall generally be of the ring type complying with the requirements of SANS 60044-1, as amended. The current transformers shall have a Class 3 or 5 accuracy. The CT's shall have 1 Ampere secondary.

5.3 Voltmeters

Voltmeters shall be of the moving iron, suppressed zero type, having a full scale deflection of not less than 480 Volts, unless otherwise specified. The voltmeter shall have Class 1,5 accuracy in accordance with IEC 60051-1

5.4 Kilowatt Meters

These shall be provided on the DB incomer if specified in the Detailed Specification.

Kilowatt meters shall be in accordance with IEC 60051-1 suitable for operation on a three phase 50 Hz AC system with Class 2 accuracy and shall be driven of 1A CTs.

5.5 Power Factor Meters

These shall be provided on the DB incomer if specified in the Detailed Specification.

Power factor meters shall be in accordance with IEC 60051-1 suitable for operation on a three phase 50 Hz AC system with Class 2 accuracy.

5.6 Instrumentation Fuses

All instrument fuses shall be mounted in the panel onto or next to the busbars. 6mm² wiring shall be used between the busbars and the fuses and shall be kept as short as possible.

HRC cartridge fuse links to SANS 172 shall be used and shall incorporate a visual indication device to facilitate the location of blown fuses on visual inspection. They shall be designed to clip into the fuse carrier contacts without the use of fixing screws.

Wiring from fuse bases to instruments may be bunched but must be suitably supported in Bowthorpe Hellerman trunking or lacing.

Each fuse shall be separately labelled stating the instrument circuit, phase and rating.

6. SWITCHES

6.1 Voltmeter Selector Switch

All voltmeter selector switches shall be wired to connect the voltmeter between all phases and each phase and neutral and shall disconnect it in the OFF position. The switch shall have a positive located switching mechanism.

6.2 Control Selector Switches

All other selector switches specified e.g. control by-pass switches, ON/OFF, Duty Standby, Field/Off/PLC switches shall provide the required switching functions. Rotary switches shall have roll and wipe contacts to ensure low resistance. Rocker arm or toggle switches shall have bifurcated contacts.

6.3 Time Switches

Time switches shall be of single-pole type, suitable for 220/250V systems, with contacts rated for the duty to be performed, with a minimum rating of 15 A. Contacts shall be of high quality material, e.g. silver-plated or solid silver.

The clock shall be driven by a self-starting hysteresis synchronous motor, keeping accurate mains time. All clocks shall be controlled by an electrically wound escapement providing the main spring with a minimum of 15 hours reserve in case of a power failure. The main spring shall be kept fully wound without the use of slipping clutch devices that may wear and fall out of adjustment.

The main spring shall have a minimum of 15 hours reserve under full load and if fully discharged, shall be completed rewound with 15 minutes of the restoration of power.

An external manual bypass switch shall be provided to permit the circuit to be switched "ON" or "OFF" manually without affecting the timing of the time switch.

The time switch shall have a 24-hour dial with day and night indication that can be set to switch in 30-minute steps. The dial shall be fitted with 48 tappets corresponding to 48 change over operations in a 24-hour period. Alternatively, electronic time switches with 30-day battery timing back up may be offered.

The time switch shall be fitted with a day omission dial comprising a total of 14 tappets, which can be set to switch in 12-hour steps.

The time switch shall be housed in a dust tight moulded plastic or metal case consisting of a plastic clip-on front cover and a moulded plastic or metal base.

The time switch shall have a transparent face to enable an operator to determine the time and settings without having to remove any covers. Time switches to be used for surface mounting on walls shall be provided with a suitably positioned 20mm conduit knockout.

6.4 Sequence Time Switches

Sequence time switches suitable for starting a group of machines in a predetermined sequence, shall be provided as required. The switches shall provide the number of steps indicated and minimum time intervals of 15 seconds between starts.

Sequence time switches shall have normally open contacts unless specified to the contrary. The contacts shall be of silver-to-silver or other approved type with a minimum rating of 10 A.

Sequence time switches shall be of the reversible type, i.e. switching the machines on in the reverse sequence when rotating backwards.

Sequence time switches or time-delay switches shall be provided to prevent the simultaneous starting of major or multiple items of equipment. The sequence shall not be reversible.

The switches shall be constructed so that the driving motor of the unit shall switch off when forward rotation is complete while the controlled machines run on uninterrupted. When the machinery is to be switched off, the drive motor on the unit shall rotate backwards and switch the machinery off in the reverse sequence. An ON/OFF switch shall control the sequence time switch from a remote position, where "ON" denotes the starting sequence and "OFF" denotes the stopping sequence. Switch positions shall be indelibly labelled.

The switches shall return automatically to the start-up position when a power failure occurs.

The switches shall be suitable for operation at the system voltage.

Sequence time switches controlled by an electronic control unit providing the above functions are acceptable.

7. ANTI-CONDENSATION HEATERS

One 22,5mm diameter white LED HEATER ON indication with neon lamp with label for motors greater than 22kW.

One motor heater circuit mcb/ fuse + fuse-holder for motors greater than 22kW.

One N/C auxiliary contact on contactor for motor heaters rated at 400W for motors greater than 22Kw.

8. SUPPLIES TO HEATER BANKS

Switchgear, control and instrumentation for heater banks shall be grouped together in the switchboard. Equipment for the control and protection of heater banks shall be provided. Ammeters and indicator lights shall be flush mounted on a hinged front panel.

All circuit breakers shall be flush mounted on a chassis behind the hinged panels with punched cutouts. It is essential that the fault level at the output to each heater unit does not exceed the rupturing capacity of the circuit breaker. Where necessary, heater circuits shall be subdivided into groups and protected by HRC fuses and circuit breakers to limit the fault level. High-speed current limiting breakers are not acceptable. The above provisions are also applicable in cases where separate switchboards are provided to supply heater banks only.

9. CABLING, WIRING AND TERMINALS

9.1 Wiring

Particular attention shall be paid to the method of wiring from busbars to the individual compartments, in order to avoid any cable crossing through a compartment with which it is unrelated.

Standard 600/1000 V grade PVC-insulated stranded annealed copper conductors to SANS 1507 shall be employed for the internal power wiring of switchboards.

The wiring between all components, isolators, fuses, contactors, overload relays and terminals is to be rated to suit the maximum capacity of the components and is to be not less than 6mm².

Three phase panels shall be wired in red, yellow and blue PVC insulated conductors for the phases, black for neutral and green for earthed circuits.

Single-phase panels shall be wired in red and black PVC insulated conductors, for phase and neutral respectively and green for earthed circuits.

Neutral connections shall be black and this colour must not be used for any other wiring.

Multi-stranded or laminated conductors shall be used between all items of equipment in preference to solid conductors. The insulation of these conductors shall not be stripped beyond the leading edge of the terminal in which it has to be accommodated. Stripping shall be carried out without damage to the conductors, preferably by means of a cable stripper.

Approved crimping lugs and ferrules or approved clamps shall be used for connection into equipment not provided with compression type terminals.

All panel wiring shall be completed and installed at the DB manufacturing works. The wiring shall be loomed or encased in PVC cable trunking of Hellerman manufacture or equal and shall be carried out neatly along vertical and horizontal lines.

Connections between busbars and all equipment in the switchboard shall consist of heavy duty coloured PVC insulated stranded annealed copper conductors and/or solid high conductivity copper bars of ample cross-section covered with heat shrinkable material. The colours to be used in all instances shall be red, white and blue for phase connections and black for neutral connections. All circuits with a rating of 200A and more and all connections to cables larger than 70mm² shall consist of busbars only.

Where heat-generating equipment is present and the internal temperature of the board is likely to exceed 50°C on occasion, silicon-rubber insulated stranded conductors shall be used.

Wiring shall be arranged in horizontal and vertical rows and shall be wound with suitable plastic straps (cable ties) or installed in PVC wiring channels. Under no circumstances may PVC adhesive tape be used for the bunching of conductors or for the colour identification of conductors.

Bunched conductors shall be neatly formed to present a uniform appearance without twisting or crossing the conductors. Conductors leaving the harnesses so formed shall be so arranged that they are adjacent to the chassis. Conductors to hinged panels and doors shall be secured on both the door and the frame and shall be looped between the two points. The loop shall be arranged to produce a twisting motion when the door is opened or closed. A flexible protection sleeve shall be installed over the conductors.

All wiring between different panels within the same switchboard shall be installed in wiring channels.

Grommets shall be installed in each hole in the metalwork through which conductors pass.

All wiring shall be installed away from terminals, clamps or other current carrying parts. Wiring shall also be kept away from exposed metal edges or shall be protected where they cross metal edges.

Conductors may be jointed at equipment terminals or numbered terminal strips only. No other connections are allowed.

Where screened cables are specified, the screening shall only be earthed in the switchboard or control board, unless clearly specified to the contrary. Screened cables entering control boxes through pressed knockouts shall terminate in compression glands. Conductors shall as far as possible remain inside the screening at terminations. Where conductors have to separate from the screen, the braiding shall be separated and the conductors drawn through the braid without damaging the braiding. The conductors shall then be

connected to their respective terminals and the screening smoothed and connected to the earth terminal. For cables controlling electro-mechanical devices, no screening is necessary. Cables controlling electronic devices shall have high voltage screening.

Where neutral or earth connections are looped between the terminals of instruments or other equipment, it is essential that the two conductor ends be inserted into a common lug and are crimped or soldered together in order that the neutral connection is not broken when the conductors are removed from one of the instruments.

Conductors terminating on meters, fuse holders and other equipment with screw terminals shall be fitted with crimped lugs.

Wiring should be confined to the front portions of switchboards as far as possible for ease of access. This requirement is important for wiring between circuit breakers with a rating of less than 60 A and the associated main circuit breakers as well as the wiring from circuits to lighting and socket-circuits.

A maximum of two conductors will be allowed per equipment terminal. Where more conductors must be connected to the same equipment terminal (e.g. a main circuit breaker feeding other circuit breakers). Stub busbars shall be provided for the various conductors.

9.2 Power Cable Terminations

Sufficient space must be allowed for the connection of all known and future incoming and outgoing cables.

Outgoing cables shall be glanded off on galvanised gland plates at the bottom or top of the vertical cableways. Where top access is required, it will be specified in the tender document.

Approved shrouded and shielded terminals shall be provided for the outgoing connections to each motor for conductors up to and including 35mm², **rated at least 50% in excess of the conductor rating**. The terminals shall be fixed in the vertical cableway of the assembly and shall have ample space for making off the outgoing cable terminations.

Conductors of 50mm² and above shall be terminated directly onto the equipment, but the cables must be adequately supported to ensure that no strain is imposed on the equipment.

9.3 Gland Plates

A strong and robust 3mm hot dipped galvanised cable gland plate shall be provided along the entire length of the assembly at a minimum height of 300mm above floor level. The gland plate shall be constructed in sections and bolted in position to take the load of the cables being glanded to it.

When cables enter/exit from the top of the board, the top cover plate will act as the cable gland plate and shall also be 3mm thick. It shall be bolted to the frame so that it can be removed if necessary. The terminals associated with these cables will be mounted not less than 200mm below the top cover plate.

All gland plates shall be machine punched in the factory to suit each and every cable gland required. Under no circumstances will any drilling or filing be allowed on site.

9.4 Outgoing Power Circuits

All cables shall be terminated with approved glands to suit the application. Particular attention shall be paid to the termination of ECC cabling to ensure the continuity of all earth conductors.

Every termination of a power cable shall be provided with an approved numbered Bowthorpe Hellerman tag identifying its size and destination, fixed below the cable gland plate in a position which is easily observed from the front to the board. This procedure must also be incorporated at the motor termination box.

All outgoing power cables shall terminate within 300mm of the gland plate to avoid long leads. Where this is not possible, each lead must be separately braced.

Power cable sizes up to and including 70 mm² may terminate on clamp type terminals where the clamping screws are not in direct contact with the conductor, but bears upon a clamping plate. Connection to the equipment can then be made with cables that are similarly connected to the terminal. All power cable sizes larger than 70 mm² shall terminate on busbars that are connected to the associated equipment. Conductors shall have lugs that are sweated or crimped. Looping of incoming supply wiring to large circuit breakers and contactors, etc. is not acceptable. Each device shall be individually connected to the supply busbar.

10. SURGE DIVERTERS

Where specified, the DB is to be equipped with surge diverters of approved manufacture and bearing the SANS mark.

The arrestors or diverters shall be mounted inside the panel on the incoming unit. The supply side connections shall be made in the factory to the three phase busbars, whilst the earth side connections shall be made to the earth bar of the board.

11. EARTHING OF METAL PARTS

All non-current carrying metal parts of the switchboard including the framework, metal enclosures of equipment, iron cores of contactors and transformer etc. shall be solidly earthed to the earth busbar. All hinged panels shall have a 4 mm² flexible copper braid connection which is bolted onto the panel and frame. Screw connections on finished surfaces shall be made with tooth washers.

12. SPARE FUSE CARTRIDGES

Where HRC or other cartridge type fuses are specified or used to protect instruments or circuits, the DB shall be suitably equipped with a compartment for housing one third of all fuse cartridges specified, having a minimum of 1 set (i.e. 3 phase) of fuses of each size specified and all such spare fuses shall be provided inside this compartment on handing over. The compartment shall be clearly labelled: "Spare fuse cartridges: replace used-up fuses".

13. LABELS

The requirements of SANS 10142-1 must be complied with.

All boards or panels shall be fully labelled using ENGRAVED TRAFFOLITE labels, fixed to the board or panel by means of either screws or rivets, or by gluing into metal label holders which are bolted to the board.

Labels should be black lettering on a white background, not less than 5mm in height and mounted centrally below each respective unit, in an approved position. A centrally mounted label shall be provided to indicate the manufacturers details, the design busbar rating and asymmetrical fault level.

A label indicating where the board is 'Fed From' shall also be fixed to each DB.

All relays and wiring terminal blocks inside the DB shall be labelled to clearly identify the control gear and wiring to equipment.

Danger or Warning Labels shall have red letters on a white background.

14. WORKS TESTS

The DB shall be fully assembled and wired before being despatched from the works. The Contractor and the switchboard manufacturer will carry out a full functional test to prove the correct operation of the entire DB, including interlocking, remote control and the simulation of all protection devices. Polarity and primary current injection tests shall be undertaken. All other circuits external to the switchboard will be simulated and will be tested accordingly. All DB's with a fault level of 10 kA or more shall be type tested by an accredited person and a signed certificate issued with the DB. The costs of all these tests shall be borne by the Contractor. The tests shall be witnessed by Bosch Projects.

Unless otherwise specified, the correct functioning of the PLC hardware will not be the responsibility of the DB manufacturer, but the Contractor will be expected to have an artisan standing by during these tests in order to observe the DB operations and carry out any remedial work required.

The tests shall be witnessed by Bosch Projects and shall be recorded in triplicate on approved test forms.

15. SITE TESTS

After completion of erection, cabling and field wiring, the Contractor shall set all overloads, protection devices etc. and shall again carry out a full functional test to prove the correct operation of the entire DB, including the simulation of all remote devices. A signed compliance certificate by the Contractor's accredited person for the DB and its installation shall be handed over to Bosch Projects on Completion.

The tests shall be witnessed by Bosch Projects and shall be recorded in triplicate on approved test forms.

16. INSTALLATION OF DISTRIBUTION BOARDS

The Engineer shall supply the switchboard manufacturer with all the relevant information in respect of the accommodation to be provided, including cable trenches, ducts, plinths and raised flooring.

Where possible, the largest number of cubicles or panels should be installed intact, to avoid assembly on site, provided space and handling facilities and conditions do not lead to damage of the unit. All floor mounted motor control centre must be bolted securely to the floor.

The Contractor will advise the manufacturer which of the cables enter or leave from the top or bottom of the DB.

During transport to site and installation, the boards shall be protected against mechanical damage and vibration.

Boards shall not be moved onto site nor installed until all building services and finishing trade work has been completed in the room or vicinity of where the boards are to be installed.

The boards shall be installed in such a manner as to facilitate extensions, maintenance, testing and repair work with easy access to cable entries terminations, current transformers, potential transformers, small wiring terminal boards and relays, and busbar connections.

Prior to the on-site tests, all screws, bolts, joints and cable terminations shall be checked for tightness. Busbar joints and cable terminations must be torqued to the correct tension.

17. DRAWINGS, BOSCH PROJECTS'S APPROVAL, GUARANTEES

CAD generated drawings of the equipment showing full details of layout and proposed wiring system and equipment offered shall be submitted for approval to Bosch Projects **prior to manufacture**.

Bosch Projects shall also be advised when the boards are being manufactured and when they will be ready for inspection at the works. Equipment which is despatched to the site without the authorisation of Bosch Projects may be rejected and all costs incurred in having it returned to the factory, where necessary, and any liability for delays, will be for the Contractors account.

The Contractor will issue to Bosch Projects the following:

- Dimensioned general arrangement layout plans of the DB and sections through the board.
- Busbar and dropper bracing and support details. Where the system fault level exceeds 15kA specimen calculations or test reports of the busbar supports in substantiation of short circuit capacity of the system.
- Busbar section and size including selection/sizing criteria and calculations in substantiation of the full load rating.
- All labelling information of components and circuit wiring cross referenced on a separate sheet.
- Wiring Schematics;
- System and component descriptions;
- Component data and calibration sheets if applicable;
- Operation & Maintenance instructions with recommended preventative maintenance programme;
- Fault finding analysis;
- Adjustment and calibration settings of all protection devices;
- Priced spare parts list with names of local suppliers and list of spares recommended to be kept in stock.

CD ROM of Autocad or DXF drawing files and 3 paper print copies of drawings of the "as built" equipment which has been installed and connected on site.

A 12 month guarantee shall cover the sheet metal enclosures and all the equipment installed therein against faulty workmanship and materials. The guarantee period shall begin from the date the DBs are completely installed

and accepted by Bosch Projects. Fair wear and tear of equipment will be excluded from the guarantee.

18. COMPLETION

Prior to the handing over of the boards or panels, they shall be rendered completely free of all dust or rubbish that may have collected during installation and building operations, and finished surfaces shall be made good where necessary, using the identical paint finishes from the same batch, as at the time of manufacture.

The DBs shall be vermin proofed. Similarly, all cable trenches will be thoroughly cleaned out and all covers fitted before the work will be considered as complete.

All labels will be correctly engraved and fixed to panels and cables as specified before the work can be considered complete.

19. SUGGESTED SUPPLIERS

The following list of approved manufacturers and suppliers of electrical equipment is provided for the convenience of tenderers. Other makes and suppliers of electrical equipment may be considered by Bosch Projects, but the tenderer is presumed to have included the following equipment in his original offer:

| | |
|---|--------------------|
| Air circuit breakers (ACB) | ABB Siemens |
| Moulded case breakers (MCB) | ABB Siemens |
| Relays and timers | ABB Siemens |
| Terminal blocks | Klippon Phoenix |
| Push buttons, selector switches pilot lights | ABB Siemens |
| Surge diverters | Dehn Phoenix |
| Instruments | ABB |

20. MANUFACTURERS

The following list of approved South African manufacturers is enclosed for the convenience of tenderers. Other manufacturers may be considered by Bosch Projects, but only if they have a proven track record of manufacture to SANS 1473/SANS 60439.

The tenderer shall ensure that copies of these Standard Specifications, Detailed Specifications, layout drawings and single line diagrams shall be provided to the manufacturers to ensure that they make full allowance for all requirements in their pricing.

ABB

Magnol Panels

Siemens Limited

Switchboard Manufacturer's

PROJECT STANDARDS

ELETRICAL EXCAVATIONS – E09

MARCH 2012



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ELECTRICAL EXCAVATIONS AND TRENCHING

1. GENERAL

The Contractor shall excavate, in all kinds of ground and to an appropriate depth and width, trenches for the laying of cables and/or the installation of cable ducts, which shall comply with the requirements of the OHS Act, SANS 1200 as well as all local bylaws and regulations.

The Contractor shall, before trenching commences, familiarise himself with the routes and site conditions and shall then plan the procedure and order of doing the work in conjunction with the general construction programme for other services and building requirements.

The Contractor shall obtain from the Employer or the relevant Local Authority full details of existing buried services along the route and shall ensure that this information is passed to the individual directly responsible for the excavation and shall be responsible for ensuring that all due care is taken when excavating in the vicinity of such existing services. In no circumstances shall mechanical excavators be used within one metre of any known existing services nor shall they be used in other open ground without the prior written permission of Bosch Projects.

The Contractor will be held responsible for damage to any existing services brought to his attention by the relevant authorities and shall be responsible for the cost of repairs.

The Contractor shall take all the necessary precautions and provide the necessary warning signs and/or lights to ensure that the public and/or employees on site are not endangered.

The Contractor shall ensure that the excavations will not endanger existing structures, roads, railways, other site constructions or other property.

The Contractor shall be responsible for the provision of all planking, shoring and strutting that may be necessary in the course of the excavations, the provision of any temporary bridging required, and the provision of all roping, warning lamps and notices and other precautions to prevent danger to persons.

2. MECHANICAL EXCAVATORS

Power-driven mechanical excavators may be used for trenching operations provided that they are not used in close proximity to other plant, services or other installations likely to be damaged by the use of such machinery.

The use of power-driven mechanical excavators shall be subject to the approval of Bosch Projects. Should the excavator produce trenches that exceed the required dimensions, payment based on volumetric excavation rates will be calculated on the required dimensions only.

3. BLASTING

No guarantee is given or implied that blasting will not be required.

Should blasting be necessary and approved by Bosch Projects, the Contractor shall obtain the necessary authority from the relevant Government Department and Local Authorities. The Contractor shall take full responsibility and observe all conditions and regulations set forth by the above authorities.

4. ROUTES

Trenches shall connect the points shown on the drawings in a straight line. Any deviations due to obstructions or existing services shall be approved by Bosch Projects beforehand.

Bosch Projects reserves the right to alter any cable route or portion thereof in advance of cable laying. Payment in respect of any additional or wasted work involved shall be at the documented rates.

The Contractor shall allow for the removal of obstructions along the cable routes including all tree roots and similar obstructions.

5. SHORING AND WATER PUMPING

The Contractor shall provide shoring for use in locations where there is a danger of the sides of the trench collapsing due to water logging or other ground conditions, to the full requirements of the OHS Act.

The strength of shoring must be adequate for site conditions prevailing and the shoring must be braced across the trench.

The Contractor shall provide all pumps and equipment required to remove accumulated water from trenches. Water or any other liquid removed shall be disposed of without any nuisance or hazard.

6. TRENCHING

Trenching shall be programmed in advance and the approved programme shall not be departed from except with the consent of Bosch Projects.

Trenches shall be as straight as possible and shall be excavated to the dimensions indicated in this specification.

The bottom of the trench shall be of smooth contour, and shall have no sharp dips or rises which may cause tensile forces in the cable during backfilling.

The excavated material shall be placed adjacent to each trench in such a manner as to prevent nuisance, interference or damage to adjacent drains, gateways, trenches, water furrows, other works, properties or traffic. Where this is not possible the excavated materials shall be removed from site and returned for backfilling on completion of cable laying.

Surplus material shall be removed from site and disposed of at the cost of the Contractor.

Trenches across roads, accessways or footpaths shall not be left open. If cables cannot be laid immediately the Contractor shall install temporary "bridges" or cover plates of sufficient strength to accommodate the traffic concerned.

In the event of there being any damage caused to existing buried services, the Contractor shall immediately notify Bosch Projects to that effect and shall take such temporary or permanent remedial measures as Bosch Projects may direct. All such measures shall be effected at the Contractor's expense.

Prior to cable laying the trench shall be inspected thoroughly and all objects likely to cause damage to the cables either during or after laying shall be removed.

Where ground conditions are likely to reduce maximum current carrying capacities of cables or where the cables are likely to be subjected to chemical or other damage or electrolytic action, Bosch Projects shall be notified before installing the cables. Bosch Projects will advise on the course of action to be taken.

Extreme care shall be taken not to disturb surveyor's pegs. These pegs shall not be covered with excavated material. If the surveyor's pegs are disturbed, they shall be replaced by a person qualified to do so.

7. DIMENSION OF TRENCHES

All cable trenches are to be sized to suit specific cable requirements. Any other combinations of cable installation will be determined by Bosch Projects on site and Variation Orders issued to the Contractor accordingly.

Cable trenches for one or two cables shall not be less than 300 mm wide and need not be more than 450 mm wide. This dimension shall be valid for the total trench depth.

The width shall be increased where more cables are installed to allow for the spacing stipulated.

Where trenches change direction or where cable slack is to be accommodated, the Contractor shall ensure that the requirements of the relevant SANS Specification regarding the bending radii of cables are met when determining trench widths.

Trench depths shall be determined in accordance with cable laying depths and bedding thickness.

Payment will be made on a volumetric excavation rate calculated on the basis of the given maximum dimensions or the actual dimensions, whichever is the lesser.

8. BEDDING

Before laying the cables, all injurious items shall be removed from the bottom of the trench. The floor of the trench shall be inspected and approved by Bosch Projects before it is evenly covered with a layer of compacted sifted backfill or fine soil to a level which is at least 75mm above the highest unevenness of the trench.

Only sandy clay or loam soil with a satisfactory thermal resistivity (not exceeding 1,5°C/W) may be used for this purpose. Sea or river sand, ash, chalk, peat, clinker or clayey soil shall not be used. The use of crusher sand is acceptable.

Where no suitable soil is available on site, the Contractor shall import fill from elsewhere and make all the necessary arrangements to do so. The cost of importing soil for bedding purposes shall be included in the unit rates for excavations.

After cable laying a further layer of bedding shall be provided to extend to 75 mm above the cables.

The bedding under joints shall be fully consolidated to prevent subsequent settling.

9. BACKFILLING

The Contractor shall not commence with the backfilling of trenches without prior notification to Bosch Projects so that the cable installation may be inspected. Should the Contractor fail to give a timeous notification, the trenches shall be re-opened at the Contractor's cost. Such an inspection will not be unreasonably delayed.

Backfilling shall be undertaken with soil suitable to ensure settling without voids. The maximum allowable diameter of stones present in the backfill material, is 26 mm and all large or sharp stones or other debris shall be removed from the fill material.

The Contractor shall have allowed in his tender for the removal of surplus material and the importation of suitable backfill material if required.

All trenches shall be backfilled in layers of thickness not exceeding 150 mm and the material shall be compacted to 93 % of modified AASHTO maximum density in the case of cohesive soil or 98 % in the case of non-cohesive soil. Care shall be taken to ensure newly laid cable is not damaged during compaction of trenches. Mechanical compactors shall be used, hand compaction will not be accepted.

The Contractor shall appoint independent experts to perform compaction tests for the compaction and provide a report to confirm that the compaction complies with the above specification. The costs of these tests and report shall be included in the contract sum.

Where trenches are in grassed or open areas sufficient allowance must be made for final settlement. For the first layer of 150mm, sifted soil of which 75mm must be below and 150mm must be above the cable, must be used. Where no suitable soil is available on site, the Contractor shall import fill from elsewhere and make all the necessary arrangements to do so.

When Bosch Projects shall adjudge that the backfilled material has fully settled and shall so advise the Contractor, the Contractor shall, within 30 days, return to the site and permanently reinstate all ground surfaces to their original condition to the satisfaction of Bosch Projects. All backfilling and temporary or permanent reinstatement shall be carried out to the satisfaction of Bosch Projects.

10. SURPLUS GROUND

All surplus ground and rocks shall be removed from the works and dumped at a site to be approved by Bosch Projects. The cost of this work shall be included in the Contractor's price for excavation of trenches etc., in the Bill.

11. COVERING AND SEALING OF CABLE TRENCHES WITHIN BUILDINGS

All open cable trenches shall be covered with steel or aluminium chequer plate.

The trench coverings shall be ridged and shall not sag more than 5mm with two normal persons standing on one section.

The trench covering shall be in sections not exceeding 1,25m.

The trench coverings shall be provided with holes or recessed handles to make it possible to remove and replace the covers easily.

The trench coverings shall be neatly cut where necessary to accommodate cables.

The covers shall overlap the trench on both sides and shall be recessed to fit flush with the surface of the floor.

The cable entrances in the trenches of the switch rooms, transformer rooms and generator rooms shall be closed and sealed after the cables have been installed to prevent the backfill material and water from entering the trenches in the building.

If the cables enter the trenches via sleeves, these sleeves shall be plugged on both sides with weak mortar, an asbestos and cement mixture or a non-hardening compound.

12. FILLED TRENCHES

Where specified, floor trenches shall be filled with sand, which shall be covered in one of the following ways :

- Reinforced concrete covers.
- Sand and cement screed.
- Removable chequer plates.

Reinforced concrete covers shall be used where vehicular traffic may be encountered over trenches. Unless otherwise specified allowance for a mass of 2 tons shall be made.

13. MEASUREMENTS

For the purpose of measurement and payment, the excavation will be classified in seven categories. The Contractor may however, use whichever method he wishes to excavate any type of material but his chosen method shall not determine the classification.

All measurements for payments shall be made jointly by Bosch Projects and the Contractor and the Contractor shall obtain the signature of Bosch Projects including approval of such measurements.

No allowance shall be made for the breaking away of the trench sides, other earth movements or for trenches excavated more than the stipulated dimensions.

All low voltage cables must be installed 600 mm to the bottom of the cable, below final ground level. Contractors must base their rates for cable trenches in soil, soft rock and hard rock on the quantities given in the Schedule of Prices. The actual quantities shall be determined on site. Adjustments to the Contract Sum shall be calculated using the rates in the Schedules of Prices, after completion of the installation.

Bosch Projects, before back filling or application of bedding material, shall classify the excavation and complete the excavation & backfill schedule.

13.1 Soft and Pickable

Shall mean hand pickable soil and includes loose gravel, clay, back-filled soil, loose or soft shale, loose literati and rocks less than 75 mm diameter.

13.2 Hard Material

Shall mean rock which is hand pickable including hard shale, dense literati and rocks exceeding 75 mm in diameter to 0,03 cubic metres volume.

13.3 Rock

Shall mean granite, quartz sandstone, slate and stone of similar hardness as well as rocks exceeding 0.03 cubic metre volume in general requiring the use of jack hammers and other mechanical means of excavations.

13.4 Hard Rock

Shall mean rock than can only be excavated by means of explosives.

Where rock and hard rock are encountered, the prior approval of Bosch Projects shall be obtained before proceeding with the excavation. This requirement is stipulated in order to afford Bosch Projects the opportunity to determine whether an alternative trench route is justified.

13.5 Asphalt Surface

Shall mean existing asphalt road surfaces and compacted sub-layers requiring the use of jackhammers and other mechanical means of excavations.

13.6 Concrete Surface

Shall mean existing concrete surfaces and compacted sub-layers requiring the use of jackhammers and other mechanical means of excavations.

13.7 Paving Blocks

Shall mean existing un-grouted concrete or clay paving and compacted sub-layers. Pavers must be carefully removed and replaced by skilled labourers after excavations are filled and sub- layers compacted to 95% MOD. A.A.S.H.T.O. density.

PROJECT STANDARDS

CABLE LAYING – E10

MARCH 2012



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CABLE LAYING AND JOINTING

This Specification must be read in conjunction with "Excavation and Trenching".

1. CABLE INSTALLATION DETAILS

This specification relates to the installation of MV and LV cables in trenches and sleeves - all of which must be undertaken in accordance with SANS 0198.

The storage, transportation, handling and laying of all underground cables shall be according to first class practice, and the Contractor shall have adequate equipment and labour to ensure that no damage is done to the cables during such operations.

2. CABLE LAYING PROCEDURES

Regarding the laying of medium voltage cable, the following requirements shall be complied with: -

Under no circumstances should a drum or reel of cable be dropped during unloading or transport to or on a site. When rolled, drums and reels must always be rolled in the direction of the arrow marked upon the flange. The protective cover and securing tie of the inner end must be removed before the cable is unwound. It is essential that cables should be installed only when both the cable and the ambient temperature are above 10°C, and have been so for the previous 24 hours, or when special precautions have been taken to maintain the cable above this temperature.

The cable shall be removed from the drum in the direction indicated in such a way that no twisting, tension or other mechanical damage is caused, and must be adequately supported at short intervals during the whole operation.

Particular care must be exercised where it is necessary to draw cables through pipes and ducts to avoid abrasion, elongation or distortion of any kind.

Suitable approved cable rollers onto which the cable shall be drawn must be placed in or alongside the cable trench. The rollers must preferably be spaced 2 metres apart, but the spacing must under no circumstances exceed 3 metres.

The maximum speed at which cables shall be drawn must not exceed 10 metres per minute.

The cable must be bent slowly and carefully and the minimum radius of curvature must not be less than "12d" where "d" is the overall diameter of the cable.

Where cables are cut and not immediately made off, the ends are to be adequately sealed without delay.

The Contractor is advised to measure actual lengths of cable required on site before ordering as he will not be compensated for redundant cable or in fact any other material over supplied.

The separation between cables of the same voltage shall be a minimum of 200mm.

3. CABLE DEPTHS AND CLEARANCES

For MV cables, the cable trench shall be 1075mm deep where 75mm bedding is required. (Cable 1000mm deep).

For LV cables only, trenches shall be 925mm deep where 75mm bedding is required. (Cable 850mm deep). Street lighting cables will be laid 600mm deep and in bedding as above.

A clearance between MV and LV cables shall be 250mm vertically or horizontally.

4. CABLE SLACK

At every termination sufficient slack shall be provided in the cable of effect future repairs to the cable end should this become necessary due to a fault or some unforeseen circumstances on site. An amount of 800mm of cable slack shall be allowed at each termination for tender pricing purposes.

5. CABLE IDENTIFICATION

Every power distribution cable, switchboard interconnecting cable, and any other cable which may not be readily identified, shall be provided at both ends of the run with aluminium labels 12mm wide x 1.5mm thick, stamped with the reference number employed in the cable schedules.

6. CABLES LAID DIRECT IN GROUND

Except where indicated on the Contract Drawings or in the Cable Schedules, and except where cables enter building or traverse railways or roads or other paved areas likely to be subject to vehicular traffic, underground cables shall be buried direct in the ground.

7. CABLES IN CONCRETE TRENCHES

In concrete trenches cables shall be laid side by side on the bottom of the trench without cross-overs. When necessary to maintain spacing factors, cables may be fixed to the walls of the trench using an approved cable rack system and the cables shall be adequately cleated to prevent movement.

8. CABLE IN DUCTS

The total cross sectional areas of any cable installed in a duct shall not exceed 50% of the internal cross sectional area of the duct. After installation of the cable, duct stoppers shall be fitted to each end of each duct run and at the entry to all buildings to effectively seal to duct from ingress of vermin etc.

9. CABLE DUCTS

Underground cable ducts shall be laid at a depth to the approval of Bosch Projects.

All underground cable ducts shall be laid on a level bed of lean mix concrete not less than 100mm in thickness.

Cable ducts passing under roads carrying heavy vehicles or under railways shall be completely surrounded with lean-mix concrete to a minimum thickness of 150mm.

Where cable ducts deviate from a straight line, the radius of curvature, in the plane of the deviation, shall be not less than 0,5metres.

Cable duct runs shall, in general, be laid level with a tolerance of $\pm 10\text{mm}$. Where the nature of the ground makes this impracticable, they shall be laid so as to drain naturally towards one or both ends, where adequate provision for drainage shall be made.

Adequate precautions shall be taken to prevent the cable duct system acting as a storm water or ground water drainage system.

10. CABLE MARKERS (SEE ATTACHED SKETCH)

All cable runs shall be marked above ground at intervals not exceeding 50 metres on straight runs, 25 metres on long continuous curves and at every other deviation and bend.

The markers shall consist of a concrete block at least 350mm deep and 150mm square at the top painted yellow and having the words "MV Cable" or "LV Cable". Embossed in the cement, the letters to be painted with black epoxy paint. (Min. 40mm high).

11. PROTECTION SLABS

Where specified, reinforced concrete cable slabs embossed as above, will be laid 150mm above the cable during installation.

12. MARKER TAPE

An approved yellow polythene marker tape 150mm wide will be laid 300mm above all cables during backfilling, showing the presence of all electrical cables.

The tape shall be yellow, with a red words "ELECTRIC CABLE ". These markings shall not be more than 1m apart from centre to centre. The marker tape is to be installed 150mm above protection slabs.

13. JOINTING INSTRUCTIONS

The Contractor will issue Bosch Projects with a copy of the jointing instructions associated with each type of termination or straight through joint, being installed on site. Where applicable, the Employer's maintenance staff will be permitted to observe the method of jointing to facilitate any repairs which may be required during the future maintenance of the installation, after the retention period has expired.

14. TESTS

Tests on completion of the laying and jointing of the various cables shall be carried out on site in the presence of Bosch Projects and the test results properly recorded and submitted in triplicate.

On each completed section of laid and jointed cable, the insulation resistance shall be tested in accordance with the Standard Specification for Testing included elsewhere in this document.

The test voltage (either a.c. or d.c.) should be applied between conductors and between each conductor and the metallic protection or earthed surroundings of the cable, as appropriate; it should be increased to the full appropriate value, and maintained at this value for 15 minutes.

PROJECT STANDARDS

CABLING AND WIRING – E13

MARCH 2012



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INDUSTRIAL INSTALLATIONS

1. GENERAL

The Contractor must allow for the supply, delivery, erection, installation, testing, commissioning and maintenance of the electrical work described in the contract documents.

Except where otherwise specified, the entire installation shall comply with the standard conditions set out hereunder and with the current edition of all SANS or IEC Standards and Codes, as well as all relevant Government and Supply Authority bylaws and provisions.

Materials and equipment used in this Contract should, where possible, be of South African manufacture.

All materials used shall be suitable for the environment and service for which the material is to be used.

Where protective coatings are damaged, these should be made good by the Contractor to the satisfaction of Bosch Projects before handover.

2. STANDARDS AND SAMPLES

The latest editions and amendments to the following Standards and Codes shall be considered a minimum requirement:

- Code of Practice for the Wiring of Premises, SANS 10142-1.
- Occupational Health and Safety Act.

National Standards and Codes must always be adhered to and shall take priority over foreign codes. Where National Codes do not yet exist BSS, VDE and IEC Standards and Codes must be followed, in that order.

Samples of equipment and materials intended for use in the installation may be requested by Bosch Projects prior to or during the course of the contract, together with relevant SANS and other test reports. The samples are returnable on completion of the contract.

Reference to the Standards and Codes shall be interpreted as meaning that all material, equipment and workmanship necessary for full compliance with those Standards and Codes.

3. UNSPECIFIED ITEMS

The Contractor shall include the supply and installation of everything necessary to ensure completion of the project to the approval of Bosch Projects.

The supply and installation of equipment required for adherence to the Standards and Codes may not be indicated in detail on the drawings or in other parts of the specification, but will nevertheless be considered to have been included.

The same make and type of apparatus shall be used for similar items throughout the installation.

4. POWER RETICULATION SYSTEM

All cables shall be in accordance with SANS 1507 and shall be PVC/SWA/PVC with stranded copper conductors. Cables shall bear the SANS mark. Four core cables shall be installed from the MCC to each three phase motor and the fourth core shall be used as the earth conductor. All other low voltage lighting cables shall be of the ECC type..

Cables should be sized in accordance with the specific requirements included on the cable schedules and full allowance shall be made for de-rating due to ambient temperature, grouping and method of installation. Specific reference must be made to SANS 10142-1 to ensure compliance.

Conductor insulation which is colour coded by a line only, will not be accepted. The total insulation must have the phase colour.

4.1 Installation

Cables must be installed in accordance with SANS 0198 and the Contractor must adhere to the minimum bending radii specified.

It shall be the responsibility of the Contractor to establish the correct lengths of cable on site, before placing an order. The Contractor shall not be reimbursed for any surplus cable. Where quantities are provided in a Schedule of Quantities, they shall not be used for the ordering of materials. The Contractor shall measure all cable lengths and shall allow for off-cuts and terminations in the unit rate. The final measurements shall be based on the net route lengths.

Particular attention must be paid to the planned sequential installation of cables to ensure that no cross-overs occur and that the final appearance of the racks and cables is of the highest standard.

Cable drums shall be supported on jacks and shall be rolled in the indicated direction. Cables must be removed from the drums in such a manner that the cable is not subjected to mechanical damage, twisting or tension exceeding that stipulated by the cable manufacturer.

Cable shall be drawn into position using sufficient rollers and labour to avoid damaging the cable by excessive bending or dragging.

Particular care must be exercised where it is necessary to draw cables through pipes and ducts to avoid abrasion, elongation or distortion of any kind. The ends of such pipes and ducts shall be sealed to approval after drawing in of the cables.

Unless otherwise specified by the cable manufacturer the minimum bending radii for cables shall be as follows:

4.1.1 Unarmoured Cables

8 times the overall outside diameter of the cable.

4.1.2 Armoured Cables

10 times the overall outside diameter of the cable.

Each section of laid and jointed cable shall be tested in accordance with SANS 1507. The insulation resistance shall be measured with a 1000 volt Megger and the readings shall be tabulated and certified. Similarly the earth continuity resistance of each section of cable shall be measured and recorded. All low voltage cables must be tested on site prior to final terminations after glanding, in the presence of Engineer. All test results must be submitted to the Engineer.

4.2 Cable Glands

Cable glands shall conform to SANS 1213/IEC 61241. All cable glands be rated at IP65 with corrosion guard. Type: Pratley or equal and approved

4.3 Cable Junction Boxes

IP65 rated four-way orange cable boxes shall be Pratley Ezee-fit with Klippon Terminals suitable for 6mm² wire for cabling to lighting.

4.4 Cable Joints

Where cable joints are to be made they shall be made either by means of compound filled boxes according to the best established practice by competent cable jointers using first class materials or by means of approved epoxy-resin pressure type jointing kits such as "Scotchcast".

Epoxy resin joints must be made entirely in accordance with the manufacturer's instructions and with materials stipulated in such instructions.

Low voltage PVC cables are to be made off with sealing glands and materials designed for this purpose which must be of an approved make. Where cables are cut and not immediately made off, the ends are to be sealed without delay.

4.5 Cable Sleeves

All sleeves indicated on the drawings will be supplied and installed by others. It shall be the responsibility of the Contractor to ensure that all the sleeves are correctly installed.

Before backfilling cable duct stoppers shall be fitted to each end of all sleeves to effectively seal it from ingress of vermin and prevent the cable sleeve from acting as a storm water or ground water drainage system.

4.6 Cabling Racking And Support Systems

The detailed technical specifications, cable schedule, layout and line drawings will indicate the overall requirements and routes for the cable racking system.

For a fully engineered project, the drawings will detail the cable rack requirements, but for lump-sum contracts the Contractor will be responsible for the detailed design of the entire system.

Where obstructions are encountered which necessitate diversions of cables due to adjacent structures, pipes drains, etc., approval for such deviations shall be obtained from Bosch Projects.

The Contractor shall allow for the supply and installation of all cable racks, ladders and trays where specified, including supporting steelwork, accessories, clamps, fixing materials, deviations, bends, angles, tees, reducers and other components required, to make the cable racks complete and ready for the laying of cables.

The cable racking system shall consist of pre-fabricated heavy duty hot dip galvanised unpainted cable racks, cable trays or angle iron, similar or equal to the "O-Line" support system.

- i) Cable racks and ladders shall be used for multiple power and control cable runs.
- ii) Cable trays shall be used for multiple control cable runs, including up to 2 x 35mm² power cables.
- iii) Angle iron droppers shall be used for single power cables and for not more than two control cables.

All supporting steelwork shall be cleaned and painted in accordance with the standard specification. Where specified, alternative cable racking systems may be offered in aluminium, 3CR12, 304 L or 316 L stainless steel or glass reinforced plastic.

Cable racks shall be installed with the minimum of changes in direction. They shall be mounted in the vertical plane and shall as far as possible be positioned so as to avoid obstruction to walkways and access routes. Racks shall not be mounted in the horizontal plane without the prior written permission of Bosch Projects.

Cable racks located in positions where they will be exposed to combustible dusts or fibres or slurry spillage shall be provided with mechanical protection in the form of a solid galvanised sheet metal cover which shall be painted in accordance with the standard specifications.

Cable racks or angle iron supports shall be secured to structures by rigid steel brackets such that there is no noticeable deflection of the rack/angle iron between support points when fully loaded. Allowance shall be made for additional loading where cable racks are not fully occupied. No welding will be permitted and all steelwork and racks must be bolted using hot dip galvanised nuts, bolts and washers.

The maximum distance between brackets for cable rack or angle iron supports shall be:

| | |
|----------------------|------------|
| Vertically mounted | 2 meters |
| Horizontally mounted | 1.5 meters |

In addition the rack shall be supported at every change in direction of the cable rack route.

Where approval is granted for supports to be welded to existing steel structures, the welding must be carried out to the full approval of Bosch Projects.

All racking shall be continuous. Any bend in the racking or angle iron support shall have a radius not less than the minimum permissible bending radius for any cable on the rack or support.

Note : No 45° angle is permissible

40mm x 40mm x 5mm angle iron manufactured from hot dipped galvanised mild steel shall be used to support short lengths of cable from the cable rack to the equipment.

Angle iron cable supports may be used under the following conditions:

- i) The size of the angle iron shall be such that in cross section, no part of any cable shall project beyond the square of which the angle iron forms two sides.
- ii) The minimum size angle iron to be used shall be 25 x 25 x 5mm and maximum size 45 x 45 x 5mm.

All cable racks and supports shall be bonded together and effectively earthed to the earth bar of the switch board to which the cables are connected at the point closest to the source of supply and continuity shall be maintained across joints by means of jumpers. The minimum size of the earth continuity conductor shall be 16 mm² and it shall be green PVC insulated stranded copper conductors with tinned lugs shall be used in accordance with SANS 10142-1. Where cable racks are routed through hazardous areas (dust or vapours), earth bonding straps shall be provided across each splice to eliminate the build up of static charges.

4.7 Installation of Cable on Racks

Power cables should be limited to a single layer on a cable rack and, wherever possible power cables should be separated from control cables. Control cables may be bunched or laid in not more than two layers on a rack. Instrumentation cables shall be on separate racks and shall be a minimum of 500mm from Power & Control Cables.

Where cables come out of the ground or a trench, or pass through a floor they shall be protected by a galvanised metal pipe or suitable mechanical protection to Bosch Projects's approval, extending from 50mm to 1000mm above floor or ground level.

All cables must be secured by clamps or approved PVC straps or strapping of correct size as specified by the manufacturer at not more than 300mm spacings. Where control cables are bunched approved clips or nylon buckle fasteners shall be used. Cables larger than 70mm² shall be individually strapped with stainless steel "Bandit" straps with plastic collar.

Saddles and clamps for securing cables shall have smooth and rounded edges and shall not damage the cable sheath or serving. The types of saddle or clamp shall be approved by Bosch Projects before installation commences.

4.8 Junction Boxes And Marshalling Cubicles

All junction boxes and marshalling cubicles shall be provided in accordance with the area classification. When used in a hazardous area, they shall be certified by the appropriate authority and shall not be modified by drilling or fixing.

All power and control cable junction boxes shall be of Pratley or CCG manufacture, complete with approved glands, locknuts, shrouds, earth continuity conductor and terminations.

All control and instrumentation marshalling cubicles shall be similarly equipped. In addition, the cabling shall be terminated on to Klippon or equivalent terminals as detailed below:-

Each conductor shall be fitted with an insulated double crimp lug of the correct size. Pin lugs shall be used for pressure type terminals. Ring or spade lugs shall be used for post type terminals.

A proprietary type of wire stripper must always be used. The stripping tool must be checked regularly and is subject to inspection by Bosch Projects. The termination of stranded conductors where one or more strands have been damaged or broken is expressly prohibited.

The crimping tool used for attaching the termination lugs shall be of the type recommended by the manufacturer of the termination.

Where spare terminals are not provided, unused pairs or cores are to be neatly laid back and strapped or tied. These cores shall be cut 150mm longer than the longest used core, and labelled with its relevant cable number.

Terminated wires shall be arranged neatly and loomed where necessary using the proprietary type plastic cable straps available for this purpose. Spiral lacing shall be used for flexible or semi flexible looms.

Each wire shall be numbered with the respective terminal number by means of interlocking slip-on plastic ferrules of the correct size. The ferrules shall be a tight or interference fit on the wire.

4.9 Terminations

With the exception of top-entry switchboards and MCCs in switchrooms not subject to moisture, hosing or dust accumulation, all cables will be terminated onto equipment, junction boxes or marshalling cubicles via bottom entries. All cables shall be labelled at each end with strap on plastic marker tags bearing the cable number as shown on the cable schedules and in accordance with the detail drawing.

All cables run on racking or angle iron supports shall be rigidly clamped and supported within 150mm from the equipment gland position.

All cables shall be mechanically anchored at their points of termination by the use of glands of the correct size and in accordance with the area classification, as follows:

4.9.1 Wire armoured cable

Non-captive cone type adjustable mechanical cable gland, complete with inner seal, neoprene waterproofing shroud and heavy duty locknut.

4.9.2 Armoured Cable

When glanding off armoured cable, care shall be taken to ensure that the cable armouring is securely gripped by the cable gland and that no armouring is visible after fitting of the gland shroud.

Fixed nipple compression gland complete with retaining washer and neoprene compression bush.

Where specialised equipment is provided with cable entries having DIN, NPT, etc., threads, the Contractor shall provide all necessary adapters to permit the use of standard threaded cable glands.

Where glands are to be used with non-threaded clearance holes a heavy duty locknut, together with suitable weatherproofing gaskets shall be provided.

The cable glands shall be of either Pratley or CCG manufacture and shall be suitable for the relevant area classification, degree of protection and/or degree of corrosion.

Samples of the cable glands shall be submitted to Bosch Projects for approval before use and to ensure that they have been issued with the relevant certificates of approval.

5. REMOTE CONTROL UNITS

Remote control units shall be provided as specified in the schedules and shall be of a robust, free standing, all welded, hot-dip galvanised pattern which shall not be subject to movement or vibration. The design shall provide protection for the associated cables.

The facilities to be provided may include stop/start buttons, illuminated where required, ammeters, variable speed indication, lock off facilities and circuit labels, as specified in the Detailed Technical Specification. The remote control units shall be shrouded to prevent accumulation of dust, the ingress of moisture when subject to water jets and accidental tripping.

6. WIRING CHANNELS AND TRUNKING SYSTEMS

Wiring channels and trunking shall be of an approved manufacture and shall be complete with end caps, internal splice plates, corner pieces and tees, snap-in covers, internal partitions, z-clips, knock-outs and all other accessories needed to complete the installation.

Wiring channels and trunking shall be of heavy duty galvanised steel construction.

Cover plates on channels up to 125mm width shall be of the snap-in type.

Cover plates on larger trays shall be fixed by means of screws which shall be permanently tapped to the cover plates and spaced at intervals suitable to prevent any warping of the plate under any circumstances. Knock-outs for conduits shall be provided in the sides of all trunking as indicated on the drawing or as required to complete the installation.

Wire trunking shall be partitioned, if required, to keep different sections of wiring apart, as indicated on drawings. Partitions shall be of perforated steel, and shall be installed to the dimensions indicated.

The Contractor shall allow for the necessary brackets, clamps, bolts and nuts, hanger supports and materials to secure the trunking to the structure, and the supports shall be spaced to avoid sagging between supports.

7. ACCESSORIES AND FITTINGS

All accessories and fittings shall be suitable for use in an industrial environment. Where specified, they shall be provided in accordance with the area classification and degree of protection.

7.1 Single Phase Standard Switch Socket Outlets

Surface mounted industrial switch-socket outlet units shall be rated 16A at 240V, and shall be housed in 100 x 75 x 50 galvanised pressed steel boxes. The shuttered socket base shall be the three pin type.

7.2 Single Phase And Three Phase Welding Socket Outlets

All industrial surface mounted wall socket outlets shall conform to SANS 60309, CEE publication 17 and SANS 1239. Unless otherwise specified, they shall be of the hose proof, switched, mechanically interlocked type and shall be supplied complete with matching plugs. It shall not be possible to interchange plugs and sockets of differing voltages and current ratings. The enclosures shall be supplied in aluminium alloy finish.

7.3 Waterproof Switch Socket Outlets

Waterproof switch socket outlets shall each be equipped with a spring-loaded, hinged, and gasketed cover, which renders the socket outlet watertight when the plug is removed. Waterproof switch socket outlets shall be supplied to IP55.

7.4 Watertight Switch Socket Outlets

Watertight switch socket outlets shall each be equipped with a screwed and gasketed cover, with a retaining chain, which renders the socket outlet watertight when the plug is removed. Plugs shall be available with threaded covers so that the socket outlet and plug combination is watertight. The watertight socket outlets and plugs shall be supplied to IP65.

7.5 Start-Up Siren

Start-up sirens shall be of weather proof construction to IP65.

Start-up sirens shall operate at 240 V, 50 Hz and be rated for a duty period of 15 min. minimum and shall have a sound frequency of approximately 800 Hz. The nominal sound range shall be 500 m minimum.

7.6 Alarm Sirens

Alarm sirens shall be of weather proof construction to IP65.

Alarm sirens shall operate at 240 V or 400 V, 50 Hz, shall be rated for continuous duty, and shall have a sound frequency of approximately 1600 Hz. The nominal sound range shall be 500 m minimum.

7.7 Limit Switches

All limit switches for cranes, tripper conveyors or similar onerous duties shall be of heavy duty construction and shall be weather proof to IP65.

Except for special applications, limit switches shall be roller lever operated and shall be equipped with one normally open and one normally closed snap action contacts suitable for 400 V and 10 A. All limit switches shall have spring return to neutral mechanisms except where otherwise specified for a particular application.

8. CONDUIT AND FITTINGS

Where permitted, conduits shall be either heavy gauge, solid drawn or welded steel conduit, hot dipped galvanised screw end or plain-end to SANS 1065 & SANS EN 10240 in part and SANS ISO 1461 in part or PVC to SANS 950, as specified.

Fittings shall be to SANS 60423 and SANS 61035 galvanised or malleable cast iron to SANS 1065 & SANS EN 10240 in part and SANS ISO 1461 in part.

The use of black enamelled conduit will not be permitted within 15km of the coast line or in areas of high humidity.

The use of PVC conduit shall NOT be permitted in industrial installations, except that approval may be given for its use in ancillary buildings, or where it is cast in concrete or chased in brickwork.

Conduit systems shall be installed in accordance with SANS 10142-1 and as further detailed in the Standard Specification for "Light Commercial and Domestic Installations".

9. INDUSTRIAL LIGHTING INSTALLATIONS

Luminaries shall be provided to give a uniform glare-free lighting level throughout the defined areas in accordance with SANS Code of Practice 10114. They shall be of a heavy duty industrial pattern and may be of fluorescent, mercury vapour, high pressure sodium or incandescent type, and shall comply with the area classification and degree of protection.

All lighting and small power equipment shall operate on 400/230 V, 3 phase, 4 wire, 50 Hz systems, due regard being given to balancing of load between phases.

In general, lighting distribution is to be arranged from one or more positions with, if necessary, two way switching on a limited number of circuits to permit essential lights to be switched on when entering a building. In small buildings, such as pump houses, switching should be from the entrance.

The loading of individual circuits should be not more than 10 A per circuit. To minimise the effect of a circuit failure, plant lighting circuits should be arranged so that the failure of one circuit will not cause a loss of more than half the lights in that particular area. Not more than 12 light fittings shall be connected to one miniature circuit breaker.

Distribution circuits to exterior area lighting or roadway lighting shall be controlled by contactors operated by photo-electric devices or time switches.

Where lighting is by means of vapour discharge lamps, other than fluorescent lamps, a sufficient number of instantaneous starting lamp fittings shall be included to ensure that reasonable illumination is available after restoration of supply following a power failure.

To reduce the effect of stroboscopic flicker to a minimum, neighbouring vapour discharge and fluorescent fittings should be connected to alternative phases. Where this is impracticable, infill lighting shall be provided using an adequate quantity of incandescent lamp fittings.

Emergency lighting and escape route lighting is to be provided in conformance with the OHS Act, including plant control rooms, substations and other vital areas. This emergency lighting should normally be supplied from a purpose design standby battery and charger equipment complete with automatic changeover switch or, in the case of small areas, emergency lights with self contained batteries and chargers.

9.1 Recommended Lighting Levels

In general the distribution of lighting points and the designed illumination levels should conform to SANS 10114. The following list is a guide to the minimum lighting levels for industrial plants:

| AREA | Minimum Average Lux Level | Maximum Glare Index |
|--|--|---------------------|
| Exterior gangways, catwalks, stairways, ladders, gantries, conveyor structures, continuously manned | 160 lux | 25 |
| Exterior gangways, catwalks, stairways, ladders, gantries, conveyor structures, Not continuously manned | 20 lux | 25 |
| Interior gangways, stairways | 160 lux | 25 |
| Conveyor tunnels | 100 lux | 25 |
| Marshalling yards, stock yards, etc | 20 lux | 25 |
| Roadways in plant areas | 10 lux | 25 |
| General outside lighting (including unactive storage areas) | 5 lux | 25 |
| Substations, switchrooms and battery charging rooms | 200 lux | 25 |
| Boiler houses, turbine basements and compressor houses, etc | 160 lux | 25 |
| Pump houses and water treatment plant | 160 lux | 25 |
| Sugar Manufacture | 300 lux | 25 |
| Control rooms- Desks - Vertical Panels - Rear of Panels | 400 lux 300 lux 160 lux | 19 |
| Offices - Entrances - Corridors/lobbies - General Offices - Drawing Offices | 200 lux 160 lux 500 lux 750 lux | 19 |
| General laboratories | 500 lux | 19 |
| Canteens, cloakrooms, washrooms and toilets | 160 lux | 25 |
| Medium bench fitting and machine shops | 400 lux | 25 |
| Warehouses | 200 lux | 25 |

All suspended luminaires shall be supported from two suspension points per fitting.

High-bay fittings shall be located in positions where they can be reached from walkways, travelling gantry cranes or mobile zip-up staging.

All other fittings shall be accessible from 5m extension and step ladders.

All luminaires shall be installed in symmetrical rows in relation to structural steel and building lines but their positions must be confirmed with Bosch Projects on site prior to their erection or the installation of the associated wiring channels or cabling.

In order to facilitate maintenance, each luminaire shall be supplied from an adjacent suitably rated socket outlet. The connecting cable shall be flexible and heat resistant.

All luminaires shall be supplied complete with lamps, the wattage of which shall not cause degradation of the diffuser.

All incandescent lamps shall be of the E.S. type and the battens shall be of the heavy brass type.

Exterior lighting shall be controlled by durable, waterproof photo-electric cells to IP 65.

Photocells shall be suitable for 240V, 50 Hz operation and shall be designed for 3 wire operation (i.e. phase, neutral and one switched line).

The illumination response shall be adjustable between 5 lux and 500 lux, suitably time delayed in order to prevent the unit from responding to momentary changes in daylight intensity.

10. EARTHING AND BONDING

The entire installation shall be earthed and bonded as detailed in Section 4.6 of SANS 10142-1. Reference should also be made to the Standard Specification for Earthing and Bonding.

Where motors, remote control units or apparatus enclosures are mounted on a concrete floor or wall or other non conducting material and are therefore insulated from plant steel work, they shall be bonded to the plant steelwork or to the main static earthing system.

If a remote control unit is mounted on a non conducting surface it must be bonded to the motor earth terminal.

All cable glands which are not screwed into a tapped cable entry must be fitted with a "star" washer in addition to the backnut to ensure good earth contact.

All cable earth connections shall be by means of a tinned lug, crimped onto the conductor by means of an approved crimping tool and the lug bolted onto a tinned section of steelwork. Soldered connections will not be accepted.

The minimum size of earth bonding conductors shall be as follows:

415 VOLT MOTORS

| | | |
|---------------|---|-------------------|
| 0 to 15 KW | - | 6mm ² |
| 18,5 to 30 KW | - | 10mm ² |
| 37 to 55 KW | - | 16mm ² |
| 75 to 132 KW | - | 50mm ² |
| 150 to 175 KW | - | 70mm ² |

FUSED APPARATUS

| | | |
|--------------------------------|---|-------------------|
| Protecting fuse up to 30 Amp | - | 4mm ² |
| Protecting fuse 35 to 60 Amp | - | 6mm ² |
| Protecting fuse 65 to 125 Amp | - | 16mm ² |
| Protecting fuse 130 to 250 Amp | - | 50mm ² |
| Protecting fuse 260 to 400 Amp | - | 70mm ² |

PROJECT STANDARDS

ELECTRICAL EARTHING – E20

MARCH 2012



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SUBSTATION EARTHING AND THE EARTHING OF INDUSTRIAL INSTALLATIONS

1. GENERAL

The entire installation shall be properly and effectively earthed as prescribed in the Standard Regulations for the Wiring of Premises SANS 10142-1 and to the requirements of the relevant supply authority.

The earthing system shall comply in all respects with the British Standard Code of Practice CP 1013 and particular attention will be given to the method of determining the number of earth electrodes and the short time current rating of same.

SANS 10200 : Neutral earthing of MV industrial power systems
SANS 10292 : Earthing of LV distribution systems
IEC/SANS 61312 : Protection against lightning electromagnetic impulse

2. SUBSTATION MAIN EARTH BARS

Each substation shall incorporate a main earth bar consisting of a high conductivity tinned copper bar having a minimum cross sectional area of 40mm x 6mm onto which all earth electrodes and earthed components will be bonded. The main earth bar shall be supported on insulators fixed to the inside wall of the substation, as close to the transformer star point as possible. A 40mm clearance shall be provided between the bar and the adjacent wall or panel.

Every earth connection will be separately bolted to the earth bar using high tensile bronze bolts, nuts and brass washers, stainless steel bolts and nuts or cadmium plated high tensile steel bolts, nuts and brass washers. The minimum diameter of these bolts will be 12mm. All connections shall be tinned.

In mini substations the earth bar described above will be fixed in the LV compartment, and shall be easily accessible from the front of the mini substation.

3. EARTH ELECTRODE SYSTEM

Earth electrode systems shall only be provided by specialist earthing contractors. Unless otherwise specified, the final resistance of substation and mini substation earth electrode systems shall not exceed 1 Ohm. Similarly, the earth electrode resistance associated with any main distribution board, metering panel or kiosk shall not exceed 10 ohms. The minimum size of any interconnecting earth conductor shall be 70mm².

A minimum of three earth rods, at least 3 metres apart, will be driven into the ground to form a triangle alongside the substation. These rods will be bonded together to form a ring using bare 70mm² stranded copper conductors, buried at least 750mm deep. The earth rod/conductor clamp connections will be at least 600mm below finished ground level. Two green PVC insulated 70mm² copper conductors shall connect the earth electrode system to the main substation earth bar.

4. TRENCH EARTH

When soil conditions prevent the installation of driven earth electrodes a trench earth system may be used, in which case at least 40 metres of bare 70mm² copper conductor may be buried alongside the medium voltage cable preferably 20 metres in each direction (i.e. one leg with incoming and one leg with outgoing feeder cables).

5. EARTH CONNECTIONS

All main earth connections, including the transformer tank and each end of the MV switchgear earth bar are to be separately bonded to the main earth bar using bare 70mm² copper conductors. In addition, a 70mm² insulated copper conductor is to bond the transformer neutral to the main earth bar. The neutral bus bar of the main LV Board will also be bonded to the earth bar, using an insulated conductor having a cross-sectional area of not less than half the size of the transformer/LV Board cables.

6. EARTH RODS

Earth rods shall comprise of one piece, 15,88mm nominal diameter, 1,8m long copper welded rod made by the molten welding process with a steel core covered by a thick layer of copper thoroughly welded thereto so that an interlocking crystalline union bonds the two metals.

The copper coating shall be continuous over the cylindrical portion of the rods except that the ends need not be covered with copper. The thickness of the copper on the cylindrical portion of the rod shall average not less than 0,5mm.

The rod when broken by successive bending shall show no seams, pits, slithers or separation of the copper from the steel.

Conductor clamps shall be made using a strong cast bronze body to provide a high pressure contact between the earth conductors and earth rods.

The clamps shall be provided with a non-ferrous set screw.

All rods will be threaded at either end so that extensions can be added where deep driven installations are required.

All connections will be taped or water-proofed to ensure that corrosion does not affect the joint during the life of the installation.
The rods shall be supplied complete with a driving bolt for protecting the ends of the coupling whilst being driven into the ground.

Earth rods should preferably be of "Copperweld" manufacture but in the event of them being unobtainable, an alternative type manufactured by I.T.T. Blackburn Company or Cadwell will be accepted. Electroplated or galvanised rods will not be considered.

7. BONDING GENERALLY (OTHER THAN SUBSTATIONS)

The ECC of all cables and the metal work of all switchgear shall be individually bonded to a tinned copper earth bar of not less than 40mm x 6mm which in turn is connected to the earth electrode system with 70mm² stranded copper conductors.

In all other respects the installation shall be as for the main earth bar. The earth bar must be located in a convenient position where occasional inspection and tests can be made without undue difficulty.

8. LOW VOLTAGE MAIN SWITCHBOARDS

In situations where a low voltage supply is provided from a supply authority, the earth bar in each main switchboard will be earthed directly to the Supply Authorities neutral earth point and, in addition, shall be provided with a separate consumers earth consisting of at least two approved earth rods driven into the ground at least 3 metres apart with their tops not less than 600mm below ground level.

9. METERING CUBICLES

Every cubicle will have a tinned copper earth bar incorporated in the cubicle where all ECC cable bonds are terminated and will require at least one approved earth rod installed and connected as for main switchboards and the earth connection will follow the route of the incoming cable where possible. The rod will be positioned in an area where other services or cables are unlikely to interfere with the earthing system.

10. SUBSTATION FENCES

In cases where outdoor substations are interconnected via overhead lines, all fences shall be earthed as follows :

A 70mm² earth wire shall be installed 400mm below ground level and 500mm from the fence on the outside of the sub-station along the entire length of the fence. This earth wire shall be earthed at each corner by means of a 1,8m

earth rod and the rod and earth wire bonded to the fence. The earth wire shall also be bonded, in at least two points, to the main earthing system.

11. ANCILLARY EQUIPMENT

Where motors, control stations, apparatus and enclosures are mounted on a concrete floor or wall or other non conducting material and are therefore insulated from plant steel work, they shall be bonded to the plant steelwork or to the main static earthing system.

All cable earth connections shall be by means of a tinned lug, crimped onto the cable by means of an approved crimping tool and the lug bolted onto a tinned section of steelwork. Soldered connections will not be accepted.

The minimum size of earth bonding conductors shall be as follows:

11.1 LV Motors

| | | | | |
|------|----|--------|---|-------------------|
| 0 | to | 15 KW | - | 6mm ² |
| 18,5 | to | 20 KW | - | 10mm ² |
| 37 | to | 55 KW | - | 16mm ² |
| 75 | to | 132 KW | - | 50mm ² |
| 150 | to | 175 KW | - | 70mm ² |

11.2 Fused Apparatus

| | | | |
|-----------------------|----------------|---|-------------------|
| Protecting fuse up to | 30 Amp | - | 4mm ² |
| Protecting fuse | 35 to 60 Amp | - | 6mm ² |
| Protecting fuse | 65 to 125 Amp | - | 16mm ² |
| Protecting fuse | 130 to 250 Amp | - | 50mm ² |
| Protecting fuse | 260 to 400 Amp | - | 70mm ² |

12. TESTING

Test certificates shall be provided, including earth resistivity readings and as-installed earth electrode system resistance. A fully dimensioned sketch shall be provided showing the positions of all earth electrodes and trench earths.

PROJECT STANDARDS

ELECTRICAL TESTING – E22

MARCH 2012



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TESTING AND COMMISSIONING

1. SCOPE

This specification relates to the following tests:

Works Tests : For all HV, MV and LV switchboards and motor control centres.

Site Tests:

- | | | |
|-----------------------|---|-------------------------------------|
| a) Cold commissioning |) | For all switchboards, transformers, |
| |) | cables, motor control centres |
| b) Hot commissioning |) | and associated equipment |

Unless otherwise specified, works and site tests shall to be carried out on all equipment at the place of manufacture and/or after installation on site. The Contractor shall provide all of the equipment and personnel necessary to perform the tests. The Contractor's representative shall be fully conversant with the operation of all the equipment on site as well as the test equipment.

Bosch Projects shall be given suitable advance notice of the date and time of each test and shall witness such tests as the Bosch Projects considers necessary. No equipment shall be despatched from the place of manufacture unless tested and approved by the Bosch Projects.

All test results shall be properly recorded and triplicate copies of the Test Certificates shall be provided to Bosch Projects within seven days of the completion of the tests. When manufacturer's type tests are carried out, copies of the Test Certificates shall be provided. The Test Certificates shall be correctly numbered and identified, and shall be signed by the Contractor's representative carrying out the tests.

All HV and MV tests are to be carried out in accordance with the Machinery and Occupational Safety Act under the direct supervision of a competent person.

Before commencing HV or MV tests on site, the relevant HV or MV system is to be isolated, earthed, locked off with suitable notices attached, and a 'Permit to Work' issued to the person testing the system.

2. CABLES

2.1 Low Voltage Cables (Up to 1kV)

Each section of laid and jointed cable shall be tested in accordance with SANS 1507 (PVC) :

The insulation resistance shall be measured with a 1000 volt Megger and the readings shall be tabulated and certified.

Similarly, the earth continuity resistance of each section of cable shall be measured and recorded.

2.2 High and Medium Voltage Cables (Up to 22 kV)

Each section of laid and jointed cable shall be tested in accordance with SANS 1339 (XLPE) or SANS 97 (PILCSWA)

An initial test shall be carried out using a 1000 volt Megger followed by the relevant pressure test.

The AC test voltage must be applied to each phase in turn for one minute or, alternatively, the DC test voltage must be applied for fifteen minutes. The leakage current shall be measured and recorded for each test.

In the event of the test being applied after the cables have been terminated onto switchgear, the Contractor must be in possession of a 'Permit to Work' and must ensure that the prescribed test voltage does not exceed the maximum rated voltage of any portion of the switchgear which will be subjected to the test voltage.

2.3 Cable Trenching

Compaction tests shall be carried out where specified by Bosch Projects.

3. TRANSFORMERS

3.1 Manufacturer's Tests : Oil Cooled Transformers

All routine tests as specified in SANS 780 shall be carried out. Type tests for 'full and chopped impulse voltage withstand tests' and 'temperature' and special tests, will only be required if specifically called for in the 'Schedule of Requirements'.

Copies of certificates of type tests performed on identical transformers and bushings must be submitted with the tender documents.

3.2 Manufacturer's Tests: Dry Type Transformers

All routine tests as specified in SANS 780 and IEC 726 shall be carried out. Type tests for 'full and chopped impulse voltage withstand tests' and 'temperature' and special tests, will only be required if specifically called for in the 'Schedule of Requirements'.

Copies of certificates of type tests performed on identical transformers and bushings must be submitted with the tender documents.

3.3 Site Tests

3.3.1 Oil Samples

Samples shall be taken from each transformer after erection and immediately prior to commissioning. The samples shall be tested for electrical strength and moisture in accordance with SANS 555. NOTE: sealed transformers shall be filled with passivated transformer oil.

Where silica gel breathers are to be fitted, the Contractor shall ensure that the breather is filled with dry silica gel and that the oil level is correct.

3.3.2 Oil Levels

The oil levels shall be checked prior to commissioning.

3.3.3 Commissioning Tests

The tap-changer shall be tested in each position and the secondary phase-earth and phase-phase voltages shall be measured and recorded, following which Bosch Projects will advise the tapping to be utilised.

Where applicable, the Buchholz, winding temperature and oil temperature alarm and trip wiring shall be checked and all functions shall be tested.

The phase rotation of the secondary voltage shall be checked and recorded.

4. HV AND MV SWITCHBOARDS

4.1 Manufacturer's Tests

The manufacturer shall provide copies of all type tests and routine tests in accordance with the relevant SANS, BSI or IEC Standard Specifications.

Bosch Projects shall be notified when the mechanical construction and the wiring is complete. The manufacturer will simulate all circuits and loads external to the switchboards in order to prove the correct operation of all equipment, protective relays, instruments, control and interlocking circuits.

All testing equipment and facilities, including any additional instruments, dummy loads, switchgear and cables shall be provided by the manufacturer at no extra cost.

4.2 Circuit Breaker Ratings (To Bs 4752 And Bs 5311)

Copies of the ASTA or equivalent, circuit breaker rating certificates shall be provided, covering mechanical endurance; temperature rise; dielectric strength;

impulse voltage withstand; making and breaking capacity; and short time current rating.

4.3 On Site Tests

The switchboard shall be mechanically and electrically tested on site after erection and prior to commissioning to ensure compliance with the technical specification. In addition the following tests shall be performed before the circuit cables are connected:

The insulation resistance of the busbars shall initially be measured between phases and between each phase and earth using a 1000 volt Megger.

If the above tests are satisfactory, the following pressure tests shall be applied to each phase in turn, with the remaining phases earthed, in accordance with BS 159.

| SWITCHGEAR NOMINAL VOLTAGE | TEST VOLTAGE | |
|-------------------------------|------------------------------|--------------------------|
| | BETWEEN | BUSBAR AND EARTH |
| | A.C. (r.m.s.) for one minute | D.C. for fifteen minutes |
| 0 - 0.6 kV | 2 kV | 3 kV |
| 3,3 kV | 8,6 kV | 5 kV |
| 6,6 kV | 15,2 kV | 10,5 kV |
| 11 kV | 24 kV | 18 kV |

NOTE:

In the event of the pressure tests being applied after the cables have been terminated on the switchgear, the tests voltages must not exceed those for high voltage cables.

The insulation resistance of the secondary wiring shall be measured at 2 kV (A.C.) for one minute.

Primary injection tests shall be conducted to check the correct operation of the protective equipment; the instruments; and the primary/secondary wiring of the current transformers, with each of the R - Y; Y - B; and B -R phases looped in turn.

Solid state relays shall be tested for tripping time/current at random plug/multiplier settings; no-plug operation; and tripping time/current at reduced battery voltage.

In addition, electro-mechanical relays shall be tested for creep.

The voltage transformer fuses and contacts shall be checked, together with the accuracy of the voltmeter reading.

5. DISTRIBUTION BOARDS AND CONTROL PANELS

5.1 General

- A visual check of all control instruments, auxiliary and test switch components shall be made.
- A physical check of all equipment shall be made against drawings and shall include operation of breakers, clearances between live electrical parts, tightness of connections etc.
- A terminal-to-terminal routing check of all panel wiring shall be made against drawings.
- Trip element ratings of all supply, distribution and branch circuit breakers shall be checked.
- Earth leakage tripping tests shall be made on all circuits.
- Check effectiveness of apparatus earth at each equipment location.

5.2 Testing

- Mechanical and electrical operational tests shall be performed on all switches, breakers, indicating devices and automatic change-over switches.
- A wire by wire check of all circuits shall be made.

6. MOTOR CONTROL CENTRES

Cold and hot commissioning of the electrical installation will be an ongoing process by the Contractor who will ensure that records of such tests are maintained.

6.1 General

- Megger test insulation between busbar phases and between each busbar and earth.
- Check all starter equipment, components, ratings, name plates, etc.
- Check for adequate earthing.
- Check terminal-to-terminal routing of all wiring against manufacturer's drawings.
- Check overload setting range for each circuit and adjust to correct setting.

6.2 Testing

- Check for tightness of all connections.

- Mechanical and electrical operational tests shall be performed on all breakers and their starters, including associated alarm and indicating devices. All interlocks must be tested operationally.
- All control cables shall be tested before final connections, in accordance with the test procedures applying to power cables.
- Check phasing rotation and load balance.
- With control circuits properly energised, check power operation of all controls and interlocks.
- Adjust overload setting to suit the recorded full load current. Check and ensure that this is less than the nameplate rating of the motor.

7. ELECTRIC MOTORS

7.1 Co-Ordinate Mechanical Checks (By Others)

- Check alignment with driven equipment.
- Check torque of holding down bolts.
- Check tension and alignment of belt drives.

7.2 Electrical Checks

- Check rating plate for correct supply voltage.
- Check that rotor turns freely.
- Check that correct starting procedure is being adopted.

7.3 Testing

- Record machine serial number and details on rating plate.
- Megger test between phases and earth - with supply cable disconnected.
- Measure resistance of all windings - with supply cable disconnected.
- Machine is only to be started on instruction from the Mechanical Bosch Projects.
- Check correct direction of rotation before connection of the driven plant.
- Check no-load current and full-load current. Check current balance of each phase.
- Observe machine performance for ventilation, temperature rise, vibration, overloading etc.
- Check operation of local start/stop buttons, remote control unit and all overload/thermistor/protection devices.

8. CONTROL DESK AND MIMIC PANEL

8.1 General

- Check that desk or panel is properly secured.
- Check that illumination allows ease of reading of all instruments.
- Check earth connections.

8.2 Testing

- Isolate all electronic equipment before carrying out insulation tests.
- Test mechanical and electrical operation of all control switches, instruments, alarms etc.

9. CABLE RACKS

9.1 General

- Check all racks are adequately supported, with allowance for future additional cables or other loads.
- Check all racks are electrically continuous.
- Check all racks are connected to the earthing system.

9.2 Testing

- All racks shall be tested for electrical continuity and connection to the earthing system.

10. POWER AND CONTROL CABLES

10.1 General

- All cables shall be checked for continuity and circuit label identification.
- Visually check for neatness of laying strapping and any mechanical damage, including excessive cable bending radii.

10.2 Testing

- Megger each conductor between phases and to earth and record all readings.
- Tests shall be made for continuity and identification of each conductor. Both ends of a given conductor shall be identified alike.

- Continuity and identification shall be checked by means of a DC test device, using a bell or buzzer to 'ring' out the wires, or with battery phones.
- If Megger readings on one or more conductors indicate damaged insulation, the cable shall be rejected and replaced.
- Check the type and method of crimping used on all termination lugs or pins.

11. PLC INSTALLATION

11.1 General

The testing of the completed PLC installation will be supervised by Bosch Projects but the contractor must make provision for the site supervisor plus at least one electrician to be available to render practical assistance and actually perform the test operations.

UNDER NO CIRCUMSTANCES MAY MEGGERS OR SIMILAR TYPES OF TESTING EQUIPMENT BE USED ON ANY PART OF THE PLC INSTALLATION.

The Contractor will be required to check and test the following

- All input loop circuits.
- All output loop circuits.
- 'Power Off' testing of all control and sequence circuits.
- 'Power On' testing of controls and correct operational function of each item of equipment which is to be operated by the PLC.

12. EARTHING

12.1 Earth Resistivity And Electrode Testing

It will be the Contractors responsibility to carry out the necessary earth resistivity tests on site where the specification calls for the installation of an earthing system. These tests will be in accordance with the requirements of BS Code of Practice 1013 as amended. Triplicate copies of the site soil resistivity tests will be submitted to the Bosch Projects, who will check the effectiveness of the proposed earthing system.

After the earth electrode and/or trench earths have been installed, an earth-megger shall be used to test the earth resistance at the earth bar and the results of the test shall be recorded. Triplicate copies of the Test Certificate shall be issued to Bosch Projects, together with a fully dimensioned drawing detailing the location and depth of each of the electrodes.

Note that all ECC connections and other binding shall be disconnected from the earth bar whilst the earth is being tested in order to eliminate the contribution from parallel earth paths.

12.2 Earth Continuity

Earth continuity readings shall be measured and recorded from the earth bar to each item of equipment, including all transformers, switchgear, cables and motors.

13. LABELS

All labels on switchboards, MCC's, junction boxes, cables and fittings shall be checked against the schedule of requirements.

14. TAKEOVER OF WORKS

All of the abovementioned items shall be taken over in accordance with the takeover clause as defined in the Project Specification.

PROJECT STANDARDS

LIGHTNING PROTECTION SYSTEM – E24

MARCH 2012



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SECTION 17

1. GENERAL

All workmanship and materials used shall be of the highest standard and shall be carried out in accordance with the best modern practice, as determined by the Engineer.

The entire installation shall comply in every respect with the latest amended publication of the following specifications or IEC equivalent:

- SANS 03A:1975 : The protection of dwelling houses against lightning
- SANS 171 : Low voltage lightning arresters
- SANS 03 : Protection of buildings against lightning
- IEC 61312 : Protection against lightning electromagnetic impulse
- IEC TS 61312 : Protection against lightning impulse (LEMP)
- IEC 61662 : Assessment of risk of damage due to lightning

The lightning protection system will consist in general of a metal strip arresters system affixed to the roof structure in grid form in the case of flat roofing or affixed to the edges of the roof structure in the case of a pitched roof. This earth equi-potential mat is then to be electrically bonded at various points by means of suitable down conductors to a vertical and/or horizontal earth mat system.

1.1 Definitions

a) Lightning Protection System

The whole system of conductors used to protect a structure from the effects of lightning.

b) Air Terminal

The part of a lightning protection system that is intended to intercept lightning discharges directly.

c) Down Conductor

A conductor that connects the air terminal (s) to the earth terminals (s).

d) Earth Terminal

The part of a lightning protection system that is intended to discharge lightning currents into the general mass of the earth.

e) Earthing Electrode

The part of an earth terminal which makes direct electrical contact with the earth.

f) Bond

A conductor that provides electrical connection between the lightning protection system and the metal work of the structure to be protected or between various parts of this metal work.

g) Joint

A mechanical junction between two conductors for purpose of providing electrical continuity between two parts of the lightning protection system.

h) Testing Joint

A joint in a down-conductor or in a bond connecting two sections of the lightning protection system so designed and situated as to enable measurements to be made of the resistance to earth or of electrical continuity of parts of the lightning protection system.

1.2 Materials

a) Air Terminals and Down-Conductors

All conductors shall be manufactured from coastal quality aluminium alloy in compliance with the requirements of BSS 1476/H/E9 or American Standards Specification 60623.

The minimum cross-sectional area of conductors shall not be less than 50mm². The preferred dimensions of flat conductor shall be 20 mm x 3 mm and the diameter of circular section conductor shall be 9,5 mm.

The lower ends of external down conductors shall be enclosed in a 2 metre length of suitable rigid insulating material and shall be bonded to a copper earth terminal. Under no circumstances shall aluminium be buried underground.

b) Earth Electrodes

Extensible earthing rods shall be used and shall be manufactured from copper clad steel which should have a molecular bond between the two metals to prevent moisture ingress. Where it is necessary to join earth rods together, a non-ferrous corrosion resistant coupling device should be used which prevents ingress of moisture into the joint.

c) Joints

Where it is necessary to join lengths of circular section conductor, a suitable ferrule should be used which is crimped securely into position. In the case of flat conductor, the joint should be made by either double riveting using aluminium rivets, two bolts and nuts, or other approved methods. Each joint made using dissimilar metals should be thoroughly

cleaned before assembly and subsequently rendered water-tight by painting or covering with an inert tenacious material.

d) Bonds

Where it is necessary to bond the aluminium conductor to any other metallic surface, this should be done by bolting or riveting. Care should be taken when attaching aluminium to a dissimilar metal to prevent electrolytic corrosion in that the joints should be thoroughly cleaned and subsequently sealed as described in paragraph 1.2 (c).

e) Conductor Guides

No part of the conductor system should come into direct contact with concrete or plaster as this may cause the aluminium to corrode. The conductor system should be supported in aluminium alloy guides so that an air gap exists at all times between the aluminium and the concrete surface, the guides being seated upon plastic or other similar insulating material. Guides should be installed to support the conductor at intervals not exceeding 1,2 metres horizontally or 1,5 metres vertically.

The aluminium alloy guides shall conform with the material specification given in paragraph 1.2 (a) and shall allow free longitudinal movement of the conductor to cater for expansion and contraction of the system due to temperature variation. The guides should be attached to the structure by screwing and plugging using two stainless steel screws.

f) Expansion Loops

Where conductors are installed horizontally without deviation from a straight line over long distances, expansion loops should be provided at distances not exceeding 30 metres. These expansion loops should have a cross- sectional area which is at least 50 mm².

2. INSTALLATION PROCEDURES

2.1 Air Terminals – Non-Metallic Pitched Roofs

Aluminium conductors are to be installed along all ridges of roofs and projections such as dormer windows, etc./ terminating at the ends with conductors running downwards over the surface of the roof and the eaves. Non-metallic chimneys should be bonded at a convenient point to the nearest component of the air terminal system.

NOTE:

This bond may run in a horizontal or downward direction but under no circumstances must any part of it run above horizontal.

Conductors may be dead-ended, i.e. have one end free and unbonded, providing that the length of such a conductor does not exceed 10 metres and that the unbonded end is either at the same level or higher than the bonded end. This technique may be used where ridge conductors are installed over dormer windows etc.

In all cases where metallic gutters have been installed along the eaves of a pitched roof, these should be bonded to the air termination system. Where metallic gutters do not exist, however, a conductor should be installed over the surface of the roof at eaves level to which the remainder of the air terminations system should be bonded, with the following exceptions.

- a) where the maximum distances from ground level to the eaves of the building is less than 4 metres and the pitch of the roof is greater than one in two (27° from horizontal).
- b) Where the maximum distances from ground level to the eaves is less than 7 metres and the pitch of the roof is greater than one in 1,5 (34° from horizontal), or
- c) Where the distances from the ground to the eaves is greater than 7 metres and the pitch of the roof is more than one in one (45° from the horizontal). Under these circumstances eaves conductors need to be installed.

On large roofs it may be necessary to install additional bonds between the ridge and eaves conductors as the maximum separating distances between these bonds should not exceed the dimensions given in paragraph 2.5 referring to down-conductors.

Any non-metallic objects which protrude above the general roof line, such as Cape Dutch gable ends, should be protected as described above with a suitable air termination system.

Any metallic objects which protrude above the general roof line, such as hot water expansion pipes, should be bonded as directly as possible to the nearest eaves conductor, gutter, or other part of the lightning protection system.

NOTE:

These bonding conductors should run in a horizontal, or preferably a downward, direction from the vent pipe etc. to the lightning protection system.

2.2 Air Terminals: Metallic Pitched Roofs

Buildings with roofs covered with electrically continuous metal sheet do not require separate air terminations but should be earthed via down-conductors generally as described in Section 2.6.

Any non-metallic objects projecting above the general roof line should be separately protected as described in paragraph 2.1 above and bonded to the metal roof covering.

2.3 Air Terminals: Non-metallic Flat or monopitched Roofs

For flat or monopitched roofs of non-metallic construction, the air termination system should consist of aluminium alloy conductors installed around the outer perimeter of each section of the roof structure. These conductors should be installed on top of parapet walls if these exist. Lift motor rooms, tank rooms, penthouses, etc., which protrude above the general roof line should have air terminal conductors installed around the outer perimeter of each roof slab or parapet wall.

Any metallic objects which protrude above the roof line, such as expansion pipes, signs, flag poles, handrails, etc., should be bonded directly to the nearest component of the lightning protection system as described in paragraph 2.1.

On large flat roofs additional air termination conductors should be installed to run perpendicularly to the long side of the building across the surface of the roof at approximately equal spacing not exceeding 15 metres.

The ends of these conductors should be bonded directly to the perimeter air termination system or to down-conductors.

NOTE:

It is not permissible for the ends of these conductors to be bonded directly to the perimeter air termination system if the latter is installed upon a parapet wall having a height exceeding 500 mm above roof slab level. In these circumstances the conductors should be bonded directly to the down-conductors. This may be achieved by passing the conductors through holes drilled into the parapet wall or by bonding the ends directly to the steel reinforcement at roof slab level. (See paragraph 2.6)

2.4 Air Terminals: Metallic Flat or Monopitched Roofs

These types of roof do not require separate air terminal conductors providing that there is electrical continuity between the metallic roofing sheets. (See paragraph 2.2.) Should the roof be surrounded by a non-metallic parapet wall, however, conductors should be installed at the top of the wall and these should be bonded to the metallic roof at intervals not exceeding 20 metres.

If the parapet wall is clad with metal over its upper surface or a handrail is installed which affords good electrical continuity, separate air terminal conductors need not be installed. Under these circumstances the metal hand rail or cladding should be bonded to the metal roof covering at intervals not exceeding 20 metres.

The metallic roof and air termination system should be bonded directly to down-conductors at intervals given in paragraph 2.5.

NOTE:

A non-metallic covering such as slates, tiles, asbestos cement sheeting etc., supported by a steel structure being electrically continuous throughout may be treated as being of a complete metal construction. In these circumstances no separate air termination system need to be installed providing that the steel roof structure is bonded to earth at intervals given in paragraph 2.5

2.5 Down-Conductors: Non-metallic Structures

Down-conductors should be installed regular intervals around structures and should run as directly as possible between the air termination and earthing systems.

They should, where practicable, be positioned at the external corner of the structure. The maximum separating distance between down-conductors around the perimeter of the structure must not exceed $30 \text{ minus } 0,4H$, where H is the maximum height of the structure above ground level measured in metres. The minimum separating distance between them, however, need not be less than 10 metres except in the case of very tall buildings having a slender base, i.e. chimney stacks, water towers, etc. in these circumstances a minimum of two down-conductors should be installed even though the distances between them may be considerably less than 10 metres.

The upper ends should be securely bonded to the air termination system and the lower ends to the earthing system. Caution should be exercised when bonding dissimilar metals together. (See paragraph 1.2)

The lower ends of down-conductors should be terminated and bonded to the earthing system at least 500 mm above finished ground level. Under no circumstances should aluminium conductor be buried underground. Test joints may be provided between the down-conductors and earthing system. Down-conductors should where possible run vertically between the air termination and earthing systems. Should this prove in some cases to be impracticable, their course may be deviated to run at any angle up to and including horizontal. They must never run, however, above horizontal.

Where it is necessary to run conductors horizontally over the upper surface of a structural protrusion such as an exposed concrete slab, the conductor may run down vertically over the edge of the slab and return to the main structure directly beneath it providing that the distance between the upper and lower conductors exceeds one third of the length of the horizontal run. Looped down-conductors are not permitted.

Down-conductors should not run over the underside of large overhangs which are less than 6 metres above ground level or other areas where people are likely to be present during a thunderstorm.

External or internal metallic rainwater pipes may be used as down-conductors providing that these are of substantial section and are jointed by screwing one length into another, or welding. Thin gauge galvanised steel pipes whose sections are held together by sweating, friction, rivets or screws, should not form part of a lightning protection system.

NOTE:

Large expanses of metalwork which are exposed on the face of a structure, such as curtain walling of cladding, etc. should be bonded together and to the down-conductor system at regular intervals. External metal staircases and fire-escapes which are electrically continuous over their complete length should be bonded to the lightning protection system at their upper and lower extremities.

2.6 Down-Conductors: Reinforced Concrete Frame Structures

The steel reinforcement of this type of structure may be used in place of down-conductors. No special provision need to be made to ensure electrical continuity through the reinforcement system, other than the normal technique of wiring the various sections together, which is considered to be adequate.

However, the reinforcing system of prefabricated concrete buildings should not be used unless special provision is made for bonding the various prefabricated sections together, or to the reinforcing steel of an in-situ cast section of the building.

Where the reinforcing system is used, the air termination system should be bonded to it at intervals described in paragraph 2.5. The bonds may be achieved by clamping a steel conductor between any one reinforcing bar and a corrosion-resistant metallic terminal mounted flush with the face of the concrete surface. An aluminium alloy tail should then be bonded between the terminal and the air terminal system.

A similar system may be used to bond the reinforcing system at ground level to the earthing system at points directly below the aforementioned air terminal bonds. In this case, however 50mm² copper conductors should be used as the external bonding material.

NOTE:

Under no circumstance should copper or other non-ferrous material be allowed to come into contact with steel reinforcing bars as this may cause severe corrosion and subsequent structural damage.

Neither should the steel reinforcing system be exposed to the atmosphere for long periods.

Care should be taken to ensure that the lightning protection system is not bonded to any part of the structure which is electrically isolated from the remainder of the building, i.e. cantilevered sections. In these circumstances or where it is otherwise impracticable to use the reinforcing system, external down-conductors should be installed as described in Section 2.6.

2.7 Down Conductors: Steel Framed Structures

Where the framework of a building is constructed of structural steel columns, these may be used in place of down-conductors providing that the separating distance between them does not exceed the maximum specified in paragraph 2.5. The upper ends of the columns should be bonded to the air termination system and the lower ends to the earthing system.

3. EARTHING

3.1 Vertically Installed Rod-Type Electrodes

Where soil conditions are favourable, rod-type electrodes should be driven into the ground at a position directly below each down-conductor. The maximum earthing resistance of each electrode or number of electrodes bonded to any one down-conductor shall not exceed $N \times 30$ Ohms where N equals the total number of down-conductors which are bonded to a common air terminal system or 200 Ohms whichever is the lower value.

Should the resistance of one electrode section prove to be too high to meet the requirements given above, its resistance to earth should be decreased by either:

- a) Extending the length of the electrode by joining on additional sections and driving them more deeply into the ground.
- Or
- b) driving additional shorter lengths individually into the ground and bonding these together underground with a 50mm² uninsulated copper conductor.

It is important that the minimum horizontal separating distance between electrodes installed in this manner should not be less than their installed depths.

The upper ends of installed rod-type electrodes should be terminated approximately 500 mm below finished surface level. A 50mm² copper bonding conductor should be installed to run between each earthing electrode system and the lower end of its adjacent down-conductor. A joint should be made between each of these bonding conductors and the down-conductors at a position approximately 500 mm above finished ground level. Where a joint is permanently exposed this should be made as a testing joint. See paragraph 1.1. (h).

Where there is the danger of these bonding conductors being damaged by traffic or gardening operations, they should be installed into PVC conduit securely affixed to the wall. The length of this conduit should be approximately 800 mm and should be installed so that approximately 400 mm protrudes above ground level, the remainder being buried into the soil.

3.2 Metallic Water Mains

The incoming metal water pipe should be bonded to the lightning protection earthing system

3.3 Trench Earth Type Electrodes

Where the soil conditions prevent the satisfactory installation of rod-type electrodes, a trench earth system should be installed.

The system should comprise of 50 mm² stranded copper conductor installed horizontally into a trench at a depth of 500 mm below finished ground level. The conductor should follow the general outline of the structure to be protected and be installed approximately 1 metre away from the outside walls.

Where the building is under construction, however, the conductor may be installed into trenches which have been prepared for the construction of the footings. Care should be taken to ensure that the conductor will remain in contact with the soil by covering it with plastic strip or pegging it to the bottom of the trench in such a way as to ensure that it does not become completely embedded in concrete when the footings are cast. Where specified the conductor shall be embedded in an electrically conductive concrete such as Marconite.

Where the building stands on rocky ground, the trench earth may be attached to the lower part of the wall in areas where rock protrudes through the soil. The conductor should, however, be buried wherever possible as described above. Each down-conductor should be bonded to the trench earth system as directly as possible by means of copper conductor as described in paragraph 2.1.

The earth resistance of a trench earth system is relatively unimportant and measurements need only be taken for record purposes providing that the system completely surrounds the structure to be protected forming a closed loop, or that the conductor follows the general contour of the building for a distance of not less than three quarters of its taut string perimeter.

Trench earth systems which do not comply with the conditions set out in the proceeding paragraph should have a maximum earth resistance of 30 Ohms.

An isolated length of trench earth should be bonded to the down-conductor system in such a way as to reduce the length of dead-ends to a minimum. A dead-ended conductor is one which has a free end not bonded to any part of the lightning protection system.

NOTE:

The maximum useful length of a dead-ended trench earth is 75 metres.

Should trench earths cross beneath pathways where people are likely to be present during a thunderstorm, a plastic pipe should be installed having a length similar to the width of the pathway to be crossed. This pipe should be buried at a depth of not less than 500mm below the pathway and the trench earth conductor run inside it.

4. COMPETENT PERSONS

The lightning arrester system as a whole is to be installed by a specialised firm primarily engaged in this type of work. Should the Contractor not comply with the above, he is to employ the services of such a specialised firm and the name of this firm is to be stated at the time of tendering by the Tenderer.

5. SABS APPROVAL

The successful Contractor is to arrange for the design drawings to be approved and certified by the S.A. Bureau of Standards and all costs associated with this approval must be included in the tender price.

6. SPECIAL NOTES

On no account is the lightning arrester system to be connected to the general electrical earthing system and the Contractor is to take special care when installation is in progress to insulate the one from the other. All installation costs, cable trenching, backfilling and the like are to be included in the tender price.

Explosives magazines, stores and manufacturing houses are not covered by this Section as special attention is called for in respect of lightning protection. Details of protection are given on the relevant section of S.A.N.S. Code 03 and the regulations issued by the Inspector of Explosives.

Special attention must also be given to the protection of buildings with thatched roofs.

PROJECT STANDARDS

HIGH MAST LIGHTING – E34

MARCH 2012



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1. GENERAL

High mast lighting is to be provided as detailed in the specifications and accompanying drawings.

The following standards apply to this specification:

| | |
|-----------|--|
| SANS 62 | Steel pipes and fittings |
| SANS 141 | Fibreglass reinforced polyester lighting columns |
| SANS 657 | Steel tubes for non-pressure purposes |
| SANS 719 | Steel pipes - low carbon steel electric welded |
| SANS 763 | Hot dipped galvanising |
| SANS 1088 | Luminaire entries and spigots |
| BS 1840 | Steel columns for street lighting |
| BS 4360 | Weldable structural sheets |
| BS 5135 | Metal-arc welding of carbon steels |

2. GALVANISED STEEL MAST CONSTRUCTION

The masts shall be of tapered section hot-dip galvanised steel to the approval of the Engineer. Where specified, steel poles shall be surmounted by a 1000mm lightning spike.

A substantial base plate shall be welded to the base of the mast and each mast shall be supplied with suitable hot-dip galvanised foundation bolts, fitted with two galvanised nuts and washers per bolt.

All steel poles/materials covered by this specification shall be hot dip galvanised on all surfaces in accordance with specification SANS 763 as amended. Before galvanising, all fabrication is to be completed. No cutting, drilling, bending, punching, forming, welding or the removal of burrs and welding slag shall be permitted after galvanising.

In the event that the Contractor cannot comply with all the provisions of specification SANS 763, details of departures are to be provided. Unless otherwise qualified, the offer will be deemed to be in full accordance with SANS 763, and a certificate to this effect may be requested before acceptance of the material.

Any damage to galvanising shall be repaired immediately on site to the satisfaction of the Engineer.

The foundations are to be cast by others and the relevant template and foundation plans are to be submitted for approval, giving details of the reinforcing required, soil pressure and over-turning safety factor. After erection the masts shall be aligned vertically.

3. FIBREGLASS REINFORCED POLYESTER MAST CONSTRUCTION

Fibreglass reinforced polyester masts shall be finished in Light Stone, smooth tapered seamless, with a weatherproof, impact resistant, fire retardant surface resin coat.

The mast shall comply with the recommendations of the European Committee for standardisation (CEN) on glassfibre lighting columns.

The pole shall be manufactured to suit the luminaires specified and shall, as a unit, comply with this Specification. The pole shall be guaranteed for at least five years.

4. ACCESS TO LUMINAIRES

Preference will be given to a simple design of mast which will provide an easy method of access to the luminaires for maintenance purposes. The masts may be of the telescopic hinged spring or hydraulic counter balance type or may be a rigid mast with external enclosed ladder or fitted with a lowering device for the luminaire assembly. Where a separate device is required for raising or lowering the masts or luminaires, the price of such equipment shall be included with the price of the masts.

5. ACCESS OPENING

An access door, properly gasketed and protected to IP32 of Specification IEC 144 unless otherwise specified shall be provided in the mast, with the bottom lintel 600mm above the base plate. The door shall be hinged and fitted with a Union lock number 1022/BE/SD, or equivalent. The opening in the mast shall be reinforced by a door frame.

Two mounting strips shall be welded opposite the door opening and shall be drilled for the mounting of a control board. An earth terminal and a support bar shall be provided below the door opening for the incoming cable.

A 50mm diameter PVC cable sleeve shall be provided centrally through the foundation plinth via a gentle bend to a point 600mm below ground level. Supply cable to masts shall be as detailed in specification.

6. LUMINAIRES

The number and type of luminaires are detailed in the specification.

7. FITTINGS

The masts shall be provided with all necessary switchgear, photocells, wiring, earth terminals, etc.

8. DRAWINGS AND DESIGN CALCULATIONS

Tenderers shall submit detailed engineering drawings with their tenders, showing full particulars of the masts offered. These drawings shall indicate the girth dimensions at each change of section as well as all wall thicknesses used in the construction. Foundation details and layouts approved by a Professional Engineer are required.

9. WORKING LOADS

9.1 Steel Masts

The design of the masts shall be adequate to resist a wind loading produced by a wind speed of 140km/h measured at a height of a 10m above ground level and acting on the projected area of the mast and luminaires.

9.2 Fibreglass Masts

The pole shall at least be designed for gale conditions (3-second gust velocity in accordance with the Standard Building Regulations) and with a load on the tip of the pole corresponding to three times the maximum windload, the pole shall not break and shall return to its initial position without any visual damage after a loading period of 1 minute.

The maximum wind load deflection at the top of the pole shall not be greater than 0,05 x (exposed height of pole).

10. GUARANTEES

The successful tenderer shall agree to guarantee the mast and fittings for a period of 12 months after erection and commissioning on site, and shall agree to make good all faults due to deficient or workmanship at no cost during this period.

PROJECT SPECIFICATION

PORTION 3: PARTICULAR SPECIFICATION

C1SPL **SMALL POWER & LIGHTING (10969-001-2040-R-0007)**

10969/001/4013/R/0007 – RevT1

**SAFD MKHUZE RAIL SIDING
PROJECT**

**ENGINEERING
SPECIFICATION ELECTRICAL
SMALL POWER & LIGHTING
IN WORKSHOP BUILDING**

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TECHNICAL SPECIFICATION

1. ABBREVIATIONS, TERMS AND DEFINITIONS

The following abbreviations, terms and definitions shall apply for this contact:

1.1 Abbreviations

| | |
|-----|---|
| dc | Direct Current |
| DB | Distribution Board |
| DOL | Electrical Direct On-line Starting of Electric Motors |
| I/O | Input / Output |
| ISO | International Standards Organisation |
| LV | Low Voltage |
| mA | Milliamps |

1.2 Terms and Definitions

In interpreting this specification, the following words shall have the meaning herein assigned to them unless there is something in the subject matter or context inconsistent with such construction.

“**Shall**” is mandatory.

“**Should**” is strongly recommended.

“**TIP**” or “Tie-In Point” is a connection to an existing system that should not require a plant shutdown or significant isolation to make the connection.

2. INTRODUCTION

The project entails construction of a transloading facility at Mkhuze Rail siding, where cane will be transferred from road trucks to rail wagons and transported by Transnet Freight Rails to the mill, a total journey length of 350kms.

2.1 Background and Overview

The cane grown in the Makhathini region currently being transported to the Felixton mill by road requires a more economically, sustainable, and efficient way of transporting the cane to the mill as of March 2021.

3. SCOPE OF WORK

CONFIDENTIAL Any information contained herein is to be treated as confidential and may not be divulged to any other party without the prior written approval of Bosch Projects (Pty) Ltd and South African Farmers Development Association.

The attention of the Contractor is drawn to the Bill of Quantities that forms an integral part of the specification and especially the following clauses.

Where the term “or other approved” is used in connection with proprietary materials or articles, it is to be understood that approval shall be at the sole discretion of the Engineer. Where brand or trade names are referred to in the Drawings and Bill of Quantities, these shall indicate the quality and type of material or fitting required and no substitution of materials so specified will be permitted, unless the authority of the Engineer has been obtained, in writing, before tenders close.

Notwithstanding the fact that the lengths of cables and trenching and lighting quantities as given in Bill of Quantities have been measured from scaled drawings, the successful Contractor shall confirm such lengths on site before ordering of such material, as he will not be paid for excess. Any allowances for off-cuts are made in the unit rates. The final measurements shall be based on the net route lengths of the cables and cable sleeves only.

The positioning of all equipment, light fittings, light switches, socket outlets etc. on the drawing, is schematic only and in some cases may not correspond to the actual layout of the buildings. The successful Contractor shall be responsible for indicating the correct position of all electrical equipment on their working drawings to enable the Client’s Representative to produce “as built” drawings.

3.1 Scope Inclusions

The successful Contractor shall provide all labour, materials, equipment, tools and supervision to transport, assemble, erect, install, connect, test and place into service the complete electrical works. The works shall consist of, but are not limited to:

- a) Removal and disposal of existing electrical installations that from LV meter room onwards
- b) The supply and installation of new supply cables and consumer unit busbar from the substation and/or main LV room to the new respective 400V or 230V switchboards complete with terminations and joints.
- c) Supply and installation of distribution boards complete terminations and joints.
- d) Supply and installation of light fittings, light switches and switched socket outlets.
- e) Supply and installation of isolators and fixed appliances.
- f) Supply and installation complete with termination of conduit, wiring earthing, etc. where required.
- g) Supply and installation of earthing and lightning protection system to building should it be deemed necessary post testing and inspection by contractor.

3.2 Scope Exclusions

The following nominated items are specifically excluded from the scope of supply:

- a) Overall project management of this project;
- b) Construction power and water;
- c) Environmental impact assessments;
- d) Environmental impact management plans;
- e) Civil Works – foundations, grouting, concrete floors and earth works;

3.3 Terminal Points

The terminal points of this scope of supply shall be as follows:

- a) Incoming power terminals of the panel provided in this scope of works;
- b) Outgoing power terminals to sockets, lighting and isolators;

4. TECHNICAL SPECIFICATION

4.1 Standards and Codes of Practice

All installation work shall comply with the following Specifications, Legal Requirements and Codes of Practice:

| LEGISLATION, STANDARDS AND CODES OF PRACTICE – ELECTRICAL RELATED | |
|---|--|
| NUMBER | TITLE |
| OHSA | Occupation Health & Safety Act (act 85 of 1993), with Regulations included |
| BS 1363-2 | 13 A plugs, socket-outlets, adaptors and connection units – Specification for 13 A switched and un-switched socket-outlets |
| ISO 9001 – 9004 | Quality Management Systems |
| NRS/IEC 048-4 | Quality of supply |
| SANS/IEC 10086-1 | The installation, inspection and maintenance of equipment used in explosives atmospheres Part 1: Installations including surface installations on mines. |
| SANS/IEC 204 | Energy efficiency in buildings |
| SANS/IEC 10108 | The classification of hazardous locations and the selection of apparatus for use in such locations. |
| SANS/IEC 1012 | Electric light dimmers |
| SANS/IEC 10142-1 | The wiring of premises. Part 1: Low-voltage installations |
| SANS/IEC 10142-2 | The wiring of premises. Part 2 Medium Voltage Installations above 1kV not exceeding 22kV |
| SANS/IEC 1019 | Standard voltages, currents and insulation levels for electricity supply |
| SANS/IEC 10198-1-14 | The selection, handling and installation of electric power cables of rating not exceeding 33 kV. Parts 1 to 13 |
| SANS/IEC 10199 | The design and installation of earth electrodes |
| SANS/IEC 1029 | Miniature substations |

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| SANS/IEC 10292 (SABS 0292) | Earthing of low-voltage (LV) distribution systems. |
| SANS/IEC 10313 | The protection of structures against lightning |
| SANS/IEC 1063 | Earth rods, couplers and connections |
| SANS/IEC 1065-1 & 2 | Metal conduits and fittings (screwed-end) |
| SANS/IEC 1085 | Wall outlet boxes for the enclosure of electrical accessories |
| SANS/IEC 1195 | Busbars. |
| SANS/IEC 10114-1 | Interior lighting Part 1: Artificial lighting of interiors |
| SANS/IEC 10114-2 | Interior lighting Part 2: Emergency lighting |
| SANS/IEC 1213 | Mechanical cable glands |
| SANS/IEC 1239 | Plugs, socket-outlets and couplers for industrial purposes |
| SANS/IEC 1339 | Electric cables – Cross-linked polyethylene (XLPE) insulated cables for voltages 3,8/6,6 kV to 19/33 kV |
| SANS/IEC 1411-1 | Materials of insulated electric cables and flexible cords – Part 1: Conductors |
| SANS/IEC 1418-1 | Aerial bundled conductor systems – Part 1: Cores. |
| SANS/IEC 1433-1 | Electrical terminals and connectors – Part 1: Terminal blocks having screw and screw less terminals. |
| SANS/IEC 1433-2 | Electrical terminals and connectors – Part 2: Flat push-on connectors. |
| SANS/IEC 1473-1 | Low-voltage switchgear and control gear assemblies – Part 1: Type-tested, partially type-tested and specially tested assemblies with a rated short-circuit withstand strength above 10 kea |
| SANS/IEC 1507-1 Parts 1-6 | Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) |
| SANS/IEC 156 | Moulded-case circuit-breakers |
| SANS/IEC 1574-3 | Electric flexible cores, cords and cables with solid extruded dielectric insulation – Part 3: PVC-insulated cores and cables. |
| SANS/IEC 1574-5 | Electric flexible cores, cords and cables with solid extruded dielectric insulation – Part 5: Rubber-insulated cores and cables. |
| SANS/IEC 1632-1 | Batteries Part 1: General Information-Definitions, abbreviations and symbols |
| SANS/IEC 164-0 parts 1 - 6 | Plug and socket-outlet systems for household and similar purposes for use in South Africa |
| SANS/IEC 1665 | Metal-clad switchgear for rated a.c. voltages above 1 kV and up to and including 36 kV – General requirements and methods of test |
| SANS/IEC 1765 | Low-voltage switchgear and control gear assemblies (distribution boards) with a rated short-circuit withstand strength up to and including 10 kA |
| SANS/IEC 1777 | Photoelectric control units for lighting (PECUs) |
| SANS/IEC 1799 | Watt-hour meters – AC electronic meters for active energy |
| SANS/IEC 1874 | Metal-enclosed ring main units for rated a.c. voltages above 1 kV and up to and including 24 kV. |
| SANS/IEC 1885/NRS 003 | Metal-clad switchgear for rated a.c. voltages above 1 kV and up to and including 36 kV – General requirements and methods of test |
| SANS/IEC 1973-1 | Part 1 Type tested Assemblies with Stated deviations and a rated short circuit withstand strength over 10kA |
| SANS/IEC 1973-3 | Low-voltage switchgear and control gear ASSEMBLIES – Part 3: Safety of ASSEMBLIES with a rated prospective short-circuit current of up to and including 10 kA |
| SANS/IEC 1973-8 | Low-voltage switchgear and control gear ASSEMBLIES – Part 8: Safety of minimally tested ASSEMBLIES (MTA) with a rated short-circuit current above 10 kA and a rated busbar current of up to and including 1 600 A a.c. and d.c |
| SANS/IEC 337 | Stove couplers |
| SANS/IEC 529 | Heat-resisting wiring cables |
| SANS/IEC 556-1 | Low-voltage switchgear – Part 1: Circuit-breakers |

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| SANS/IEC 60044-1 to 5 | Instrument transformers – Part 1 to 5 |
| SANS/IEC 60079 (all parts) | Electrical apparatus for explosive gas atmospheres |
| SANS/IEC 60137 | Insulated bushings for alternating voltages above 1 000 V |
| SANS/IEC 60265-1 | High-voltage switches – Part 1: Switches for rated voltages above 1 kV and less than 52 kV |
| SANS/IEC 60269-1 | Low-voltage fuses |
| SANS/IEC 60282-1 | High-voltage fuses – Part 1: Current-limiting fuses |
| SANS/IEC 60282-2 | High-voltage fuses – Part 2: Expulsion fuses |
| SANS/IEC 60309-1 | Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements |
| SANS/IEC 60439-1 to 5 | Low-voltage switchgear and control gear Assemblies Parts 1 to 5 |
| SANS/IEC 60502-4 | Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 4: Test requirements on accessories for cables with rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV). |
| SANS/IEC 60529 | Degrees of protection provided by enclosures (IP Code). |
| SANS/IEC 60669-1 | Switches for household and similar fixed electrical installations – Part 1: General requirements. |
| SANS/IEC 60669-2-1/ | Switches for household and similar fixed electrical installations – Part 2-1: Requirements – Electronic switches. |
| SANS/IEC 60896-21 | Stationary Lead Acid Batteries Part 21: Valve regulated types- Methods of Test |
| SANS/IEC 60896-22 | Stationary Lead Acid Batteries Part 21: Valve regulated types-Requirements |
| SANS/IEC 60947-2 | Low-voltage switchgear and control gear – Part 2: Circuit-breakers |
| SANS/IEC 60947-3 | Low-voltage switchgear and control gear – Part 3: Switches, disconnectors, switch-disconnectors and fuse combination units. |
| SANS/IEC 60947-4-1 | Low-voltage switchgear and control gear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters |
| SANS/IEC 60947-4-2 | Low-voltage switchgear and control gear – Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters. |
| SANS/IEC 60947-4-3 | Low-voltage switchgear and control gear – Part 4-3: Contactors and motor-starters – AC semiconductor controllers and contactors for non-motor loads |
| SANS/IEC 60947-5-5 | Low-voltage switchgear and control gear – Part 5-5: Control circuit devices and switching elements Electrical emergency stop device with mechanical latching function |
| SANS/IEC 60947-6-1 | Low-voltage switchgear and control gear – Part 6-1: Multiple function equipment –Transfer switching equipment. |
| SANS/IEC 61000-3-4 | Electromagnetic compatibility - Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A |
| SANS/IEC 61000-4-7 | General guide on harmonics and inter-harmonics measurements and instrumentation, for power supply systems and equipment connected thereto |
| SANS/IEC 61008-1 | Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules. |
| SANS/IEC 61084-1 | Cable trunking and ducting systems for electrical installations – Part 1: General requirements. |
| SANS/IEC 61238-1 | Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV) – Part 1: Test methods and requirements |
| SANS/IEC 61312-3 | Protection against lightning electromagnetic impulse – Part 3: Requirements of surge protective devices (SPDs). |
| SANS/IEC 61347-2-2 | Lamp control gear – Part 2-2: Requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps |
| SANS/IEC 61386-1 | Conduit systems for cable management – Part 1: General requirements. |
| SANS/IEC 61386-21 | Conduit systems for cable management – Part 21: Requirements – Rigid conduit systems |
| SANS/IEC 61386-22 | Conduit systems for cable management – Part 22: Requirements – Pliable conduit systems. |

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| SANS/IEC 61386-23 | Conduit systems for cable management – Part 23: Requirements – Flexible conduit systems |
| SANS/IEC 61558-1 | Safety of power transformers, power supplies, reactors and similar products – Part 1: General requirements and tests. |
| SANS/IEC 61641 | Arc Testing |
| SANS/IEC 61643-1 | Low-voltage surge protective devices – Part 1: Surge protective devices connected to low-voltage power distribution systems – Requirements and tests. |
| SANS/IEC 61643-12 | Low-voltage surge protective devices – Part 12: Surge protective devices connected to low-voltage power distribution systems – Selection and application principles |
| SANS/IEC 62053-11 | Electricity metering equipment (a.c.) – Requirements – Part 11: Electromechanical meters for active energy (classes 0,5, 1 and 2). |
| SANS/IEC 62053-21 | Electricity metering equipment (a.c.) – Requirements – Part 21: Static meters for active energy (classes 1 and 2). |
| SANS/IEC 62305-1 | Protection of structures against lightning Part 1: General principles |
| SANS/IEC 62305-1 | Protection against lightning – Part 1: General principles. |
| SANS/IEC 62305-2 | Protection against lightning – Part 2: Risk management. |
| SANS/IEC 62305-3 | Protection against lightning – Part 3: Physical damage to structures and life hazard |
| SANS/IEC 62305-4 | Protection against lightning – Part 4: Electrical and electronic systems within structures |
| SANS/IEC 767-1 | Earth leakage protection units – Part 1: Fixed earth leakage protection circuit-breakers. |
| SANS/IEC 780 | Distribution transformers |
| SANS/IEC 950 | Un-plasticized polyvinyl chloride rigid conduit and fittings for use in electrical installations |
| SANS/IEC 60044-1 | Instrument transformers Part 1: Current transformers |
| SANS/IEC 60044-2 | Instrument transformers Part 2: Inductive voltage transformers |
| SANS/IEC 60439-1 | Low-voltage switchgear and control gear assemblies Part 1: Type tested and partially type-tested assemblies |
| SANS/IEC 60947-1 | Low-voltage switchgear and control gear Part 1: General rules |
| SANS/IEC 60947-2 | Low-voltage switchgear and control gear Part 2: Circuit-breakers |
| SANS/IEC 60947-4 | Low-voltage switchgear and control gear Part 4: Contactors and motor-starters |
| SANS/IEC 60947-5 | Low-voltage switchgear and control gear Part 5: Control circuit devices and switching elements |
| SANS/IEC 60947-6 | Low-voltage switchgear and control gear Part 6: Multiple function equipment |
| SANS/IEC 61439-1 | LV Control-Gear and assemblies |
| SANS/IEC 10400 | Code of Practice for the Application of the National Building Regulations (as amended) |
| | |

4.2 Low Voltage PVC Insulated Cables (600-1000V)

Low voltage power cables shall be two, three or four core stranded plain annealed copper conductor, PVC insulated, PVC bedded, galvanised steel wire armoured, PVC sheathed, PVC/PVC/SWA+ECC/PVC type cable 600/1000V to SANS/IEC 1574 as amended.

All low voltage power cables shall be manufactured in strict accordance to SANS/IEC 1507 and shall bear the SABS mark on the outer sheath.

The insulation material shall comprise of PVC in accordance to SANS/IEC 1411: Part II as amended.

The bedding shall consist of a continuous impermeable of PVC extruded sheath to fit the core or cores closely and to fill the interstices between the cores of multi-core cables.

Where armouring is specified, the armouring shall consist of one layer of round galvanized steel wire in accordance with SANS/IEC 1411: Part IV. Aluminium strip or tape armouring is not acceptable.

Unless otherwise specified specifically, all multi-core cables shall include earth continuity conductor (ECC) in the armouring. Where required additional bare earth copper conductor shall be installed as specified.

All cable connections from 16mm² conductor sizes and larger shall be of the hexagonal crimp method using correct size and type of lugs, ferrule and matching crimp head dices. Smaller conductor sizes shall be done with indent crimp method with tools having the ratchet facility to ensure a full depth crimp.

All routine tests specified by SANS/IEC 1507 as amended shall be carried out on production runs of the cable. Two test certificates will be provided for each cable drum delivered to site.

Wooden cables drums shall be clearly marked on both sides in accordance with SANS/IEC 1507 as amended. Both ends of the cable on the wooden drum must be sealed to prevent penetration of moisture. Both ends of the cable shall furthermore be fixed to the flange of the drum to avoid loose coiling and mechanical damage. Cable drums shall be placed on firm, well-drained surfaces.

Cable ducting and trenches shall be in accordance with SANS/IEC 2001 PD3.

4.3 Low Voltage Cable Installation

All low voltage cables shall be in accordance with the standard and detail specifications.

Cables shall be loaded, transported and off-loaded on wooden cable drums manufactured and supplied for the purpose by the cable manufacturer.

The transportation, loading, off-loading and installation of the cables shall be in strict accordance with the requirements of the cable manufacturer, this specification and relevant standards which shall be continuously supervised and controlled by a competent person who is well experienced in the handling and installation of cables.

Cables that are not terminated shall at all times be capped and sealed to protect the ends from the ingress of moisture and dirt.

Cables shall be installed in the routes specified. Cable lengths are nominal and shall not be used for ordering purposes. The Contractor shall be remunerated on actual lengths of cable installed. All wastage shall be for the account of the successful Contractor.

All cables shall be rolled from the wooden cable drum such that the cable will not be subjected to twisting or tensions values exceeding the values specified by the manufacturer.

Cables laid in the same trench shall be laid parallel to each other and shall not cross over one another.

All cables shall be run in single un-spliced lengths and shall be drawn up and terminated in the distribution kiosk, distribution boards, plant or equipment as required. When complete, all cabling and wiring shall present a neat and tidy appearance.

No joints shall be allowed in cables unless specifically called for in the Bill of Quantities or unless the cable lengths exceed the maximum standard drum lengths supplied by the manufacturer or without the prior approval of the Engineer.

The minimum radius of bends in all cables shall be as per the manufacturer recommendation to ensure that the minimum bending radii of the cables are maintained at all times during and after installation. Failure to adhere to this requirement may result in the rejection of the particular cable.

Special care shall be taken during installation to avoid any damage to the sheaths of the cable. Rollers and pulling socks or other suitable means approved by the Engineer shall be used for installing the cables in trenches. The rollers shall be free of sharp edges and shall be spaced to prevent the cable from touching the ground during the pulling process. Corner rollers shall be used at each corner and where required bond pulling shall be used.

Where communication, instrument or signal type service cables run with power cables in the same trench, the minimum separation shall be 500mm. Where “signal” and power services cross, they shall be separated vertically by 500mm.

LV cables no less than 600mm below final ground level measured to the top of the cable.

The cables shall be laid in such a manner that the beginning of a drum shall be laid from the end of the previous drum to ensure that the lay of the cores remain the same. Low voltage cables shall overlap by at least 500mm.

All cables shall be fitted with the appropriate size lugs at the termination. Lugs and ferrules equal or greater the 16mm² shall be crimped with a hydraulic crimper only using a hexagon die.

All glands, lugs, fixers, nuts, bolts and other consumables are, where not specifically detailed in the Bill of Quantities, are to be included within the price for cable terminations.

Where cables cross under roadways, walkways, parking areas, paved areas and other services, and where cables enter buildings, the cables shall be installed in 110mm diameter Class 9 u-PVC pipes or as indicated on the drawings.

Every cable shall be marked on both ends by means of an approved type cable tag label on which the size of cable and its source or destination and cable number is punched. The label shall be installed around the outer PVC sheath immediately below the cable termination and gland.

4.4 Cables in Sleeves

Pulling socks or other suitable means approved by the Engineer shall be used for the installation of cables in sleeves. Care shall be taken to ensure that the maximum allowed mechanical forces on the cables are not exceeded and that the sheaths are not damaged during installation. Furthermore, the Contractor shall ensure that the cables are not kinked or excessively bent while maintaining the minimum bending radius as specified by the manufacturer.

The Contractor shall use necessary precautions to ensure that all cables are not damaged at the mouth of cable sleeves.

The Contractor shall inspect the sleeves before installation of the cables to ensure and confirm that there are no sharp edges present that could cause damage to the sheaths.

Cables found with scratch marks or other forms of damage will be rejected and shall be replaced at the Contractor's cost.

Should long runs of cables in sleeves be encountered, it may be required to grease the cable with petroleum jelly or other non-aggressive compound to facilitate the installation. This will however be discussed with the Engineer prior to installation.

4.5 Cables on Cable Racking

Cables to be installed on cable racking shall be secured to the cable racking at intervals not exceeding 1m.

Cables with diameters larger than 50mm and cables in trefoil arrangement shall be secured by means of stainless steel bandit straps (over a PVC strap for the protection of sheath). Smaller cables shall be secured by means of PVC cable ties.

All cables shall be individually strapped, except for cables installed in trefoil format.

4.6 Cable Numbering and Core Identification

Each cable shall be numbered by means of an approved type cable tag attached to both ends below each termination and gland. Each tag shall indicate the designation connected at the other end, cable size, number of cores, length, earth wire size and be easily readable after installation.

4.7 Distribution Boards

The successful Contractor shall be responsible for the design and installation of the distribution boards so as to ensure that they fit comfortably in the positions specified on the drawings, are easily maintained and the doors of the distribution boards can be fully opened.

The layouts and construction of all distribution boards shall be to the approval of the Engineer prior to ordering and manufacturing.

The distribution boards shall be of the flush / floor standing / surface mounting type/s. The distribution board tray shall be constructed of 2mm minimum thickness hot dip galvanised steel or folded 3CR12 sheet metal. Pre-punched knockouts for conduit shall be incorporated in the upper and lower sides of the distribution board tray prior to galvanising. The size of tray shall be determined by the number of circuits actually installed allowing for 30% additional circuit space and spare conduits installed from the distribution board to the ceiling void where the DB is built into a wall.

The architrave frame shall be constructed with square edges from minimum 2 mm thick 3CR12 steel and be powder coated. The architrave frame shall form a 25 mm border around the bonding tray and shall be fixed to the bonding tray in such a manner as to allow for adjustment for the inequalities in the wall finish. A minimum of 75 mm shall be allowed between the inside of the architrave frame and the equipment.

The distribution board cover shall be constructed of minimum 2mm thick folded 3CR12 steel and be powder coated. The distribution board cover shall have machine cut openings for the specified electrical equipment and as indicated on the single line diagrams. The distribution board cover shall furthermore be fitted with suitable handles to facilitate safe the removal of the cover.

Distribution boards shall be equipped with single/double hinged doors. The doors shall be constructed of 2 mm minimum thick 3CR12 steel and be powder coated. Where required, the doors shall be reinforced to ensure rigidity. The door shall be mounted flush in the architrave frame and will comply with the requirements detailed on the drawings.

The distribution boards shall be equipped with suitably sized tinned solid copper neutral and earth bars as required for earth leakage protected circuits and for the balancing of the circuits. Only one neutral conductor shall terminate in each clamp. 30% extra terminals shall be provided above those circuits actually installed.

Wiring shall be done by means of PVC insulated copper conductors with sizes to suit the relevant switchgear. The ends of the conductors shall be provided with suitably sized lugs, firmly crimped for connection to busbars.

The main/incoming isolator/circuit breaker shall be mounted at the left hand side of the distribution board. The isolators and circuit breakers shall comprise the list as shown on the single line diagram. Should the distribution board comprise of rows of equipment, then sufficient vertical space shall be allowed for between equipment for the bending and termination of conductors and cables. The earth leakage circuit breakers/isolators shall be 30mA sensitivity with a tolerance of +0 to -50%.

All metal doors shall be earthed bonded to the distribution board tray by means of an insulated copper strap, tooth washers, bolts and nuts.

Every circuit on each distribution board shall be clearly and legibly labelled. The legend shall be typed and circuit breaker numbering shall be of the engraved type.

All unequipped spaces in the distribution boards shall be fitted with dummy MCB's or approved cover plates.

uPVC sleeves installed shall cater for the cable size and the minimum bending radius on the sleeve with minimum 6 times the diameter of the sleeve.

Distribution boards shall be painted and labelled in accordance with the details as specified below:

| | Normal Supply | Essential Supply | UPS Supply |
|--------------------------------------|---|--|--|
| Colour of Indoor Distribution Board | White or Beige | White or Beige but preferably Red | White or Beige but preferably Blue |
| Colour of Outdoor Distribution Board | Electric Orange colour B26 of SANS/IEC 10140 (Part II) | Electric Orange colour B26 of SANS/IEC 10140 (Part II) | Electric Orange colour B26 of SANS/IEC 10140 (Part II) |
| Colour of Face Plate | White or Beige (Indoor) Electric Orange (Outdoor) | Signal Red colour B26 of SANS/IEC 1091 | Blue colour F06 of SANS/IEC 1091 |
| Label Type | Black letters on White Ivorene label | White engraved letters on red Ivorene label | White engraved letters on blue Ivorene label |
| Label Fixing | Ivorene label to be glued with super glue or pop riveted to face plate or frame | | |
| Distribution Board Label Details | Distribution Board name e.g. DB A | Distribution Board name e.g. DB AE | Distribution Board name e.g. DB AU |
| Face Plate Label Details | Distribution Board Name; Indication of Feeder source; Size of Feeder cable; Fault level; Rating of Distribution Board; Phase rotation | | |
| Letter Font | Arial | | |
| Letter Size | Distribution Board label 6mm Face Plate label 3mm | | |
| Labelling of Cables | All incoming and outgoing cables must be labelled with Ivorene labels indicating the designation and size of the cable | | |

4.8 Conduit and Accessories (PVC)

The conduit and wiring system shall include all conduit, draw boxes (where required), joints, elbows and other accessories required for the completion of the Contract Works. Consumables, including saddles, fixers, screws, conduit bushes, etc., are deemed to be included within the rates quoted. A minimum number of joints shall be permitted in any length of conduit run between draw boxes, switch socket outlets, luminaries, distribution boards, etc.

All the conduiting shall be done on the roof trusses (attached by means of saddles onto the bottom of the trusses) or on top of the ring beams or chased into walls or cast in concrete where applicable. The conduit work shall cater for face brick external wall finishes and plastered/face brick internal finishes to all buildings. No surface conduit shall be allowed and the successful Contractor shall build conduits into the walls. Where services exit in face brick walls, the successful Contractor is to ensure that the conduit box or switch box is symmetrical with the nearest brick course.

The successful Contractor shall be responsible for the conduit routing. Draw-boxes are to be provided in accordance with the Wiring Code and wherever necessary to facilitate easy wiring.

The successful Contractor shall have a representative in attendance at all times when the casting of concrete slabs takes place, to ensure that no movement or damage to conduit occurs.

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Unless other methods of installation are specified for certain circuits, the installation shall be in conduit throughout. No open wiring in roof spaces or elsewhere will be permitted.

The conduit and conduit accessories shall comply fully with the applicable SABS specifications and the conduit shall bear the mark of approval of the South African Bureau of Standards.

The bonding of PVC tubing to connectors, elbows or termination boxes shall be carried out using a good quality adhesive, rendering the pipe work completely watertight.

The loop in system shall be used throughout the installation. This means that all wiring shall be possible from below the ceiling and that no inspection or draw boxes shall be allowed in the ceiling space.

For light and socket outlet circuits, the conduit used shall have an external diameter of 20mm.

For telephone and LAN circuits, the conduit used shall have an external diameter of 25 or 32mm. In all other instances the sizes of conduit shall be in accordance with the Wiring Code for the specified number and size of conductors. For a single outlet point, a 25mm conduit must be installed and a 32mm to power skirting for every 5 or less outlet points.

Only one manufactured type of conduit and conduit accessories will be permitted throughout the installation.

Under no circumstances will conduit having a wall thickness of less than 1.6mm be allowed in screeding laid on top of concrete slabs.

Bending and setting of conduit must be done with special bending apparatus manufactured for the purpose and which are obtainable from the manufacturers of the conduit systems. Damage to conduit resulting from the use of incorrect bending apparatus or methods applied must, on indication by the Client's Representative, be completely removed and rectified, and any wiring already drawn into such damaged conduits must be completely renewed at the successful Contractor's expense.

Flexible connections between conduit and appliance or other equipment shall be by means of flexible conduit.

Contractors must ensure that general approval of the proposed conduit system to be used is obtained from the local electricity supply authority prior to the submission of their tender. Under no circumstances will consideration be given by the Engineer to any claim submitted by the successful Contractor that may result from a lack of knowledge in regard to the requirements of the supply authority.

The Contractor shall make himself familiar with the positions of all fittings, such as blackboards, pinning boards, cupboards, shelving, work-tops, etc, before commencing the conduit installation. The position of switches and socket outlets as indicated on the drawings are approximate only. The Contractor must verify that the final position of these will not be covered by the installation of the fittings referred to above, or come midway between the junction of any dadoes and upper wall finishes.

No extras will be entertained for moving switches or socket outlets as a result of the Contractor's failure to verify the final positions of the fittings or type of wall finish.

4.9 Conduit in Roof Spaces

Conduit in roof spaces shall be installed parallel or at right angles to the roof members and shall be secured at intervals not exceeding 1.5m by means of saddles screwed to the underside of the roof timbers.

Nails or crampets will not be allowed.

Where non-metallic conduit has been specified for a particular service, the conduit shall be supported and fixed with saddles with a maximum spacing of 450mm. The successful Contractor shall supply and install all additional supporting timbers in the roof space as required.

Under flat roofs, in false ceilings or where there is less than 1m of clearance, or should the ceilings be insulated with glass wool or other insulating material, the conduit shall be installed in such a manner as to allow for all wiring to be executed from below the ceilings.

4.10 Surface Mounted Conduit

Wherever possible, the conduit installation is to be concealed in the building work, however, where unavoidable or otherwise specified, conduit installed on the surface must be plumbed or levelled and only straight lengths shall be used.

The use of inspection bends is to be avoided and instead the conduit shall be set uniformly and inspection couplings used where necessary.

Conduit will be secured on heavy duty approved spaced saddles rigidly secured to the mounting surface.

Alternatively, fittings, tees, boxes, couplings etc., are to be cut into the surface to allow the conduit to fit flush against the surface. Conduit is to be bedded into any wall irregularities to avoid gaps between the surface and the conduit.

Crossing of conduits is to be avoided; however, should it be necessary, purpose-made metal boxes are to be provided at the junction. The finish of the boxes and positioning shall be in keeping with the general layout.

Where several conduits are installed side by side, they shall be evenly spaced and grouped under one purpose-made saddle.

Distribution boards, draw-boxes, industrial switches and socket outlets etc., shall be neatly recessed into the surface to avoid double sets.

In situations where there are no ceilings the conduits are to run along the wall plates and the beams.

Only approved plugging materials such as aluminium inserts, fibre plugs, plastic plugs, etc, and round-head screws shall be used for fixing saddles, switches, socket outlets, etc., to walls. Wood plugs and the plugging in joints in brick walls are not acceptable.

No extras will be entertained for moving switches or socket outlets as a result of the Contractor's failure to verify the final positions of the fittings or type of wall finish.

4.11 Wiring

In general, all wiring used in installations shall be of at least 600/1000V grade in accordance with SABS 1507 and PVC insulated, subject to volt drop calculation results.

Light, ceiling fan and extractor fan circuits shall be wired with 1.5mm² 7 strand copper conductor PVC insulated wire, subject to volt drop calculation results.

Switched socket outlets and power points shall be wired with 2.5mm² 7 strand copper conductor PVC insulated wire, subject to volt drop calculation results.

Geyser, air conditioner and heater circuits shall be wired with 4mm² 7 strand copper conductor PVC insulated wire, subject to volt drop calculation results.

Stove and oven cooker circuits shall be wired with 6mm² 7 strand copper conductor PVC insulated wire, subject to volt drop calculation results.

Wiring for circuits not specified shall be according to SANS/IEC 10142-1.

Associated with every circuit, a stranded copper earth conductor shall be run and connected to the terminal of the appliance or outlet and on the installed earth bar within the distribution board. Wire sizes shall be as follows:

| | | |
|------------------------------|---|-------------------------------|
| 6mm ² conductor | : | 4mm ² earth wire |
| 4mm ² conductor | : | 2.5mm ² earth wire |
| 2.5mm ² conductor | : | 2.5mm ² earth wire |
| 1.5mm ² conductor | : | 2.5mm ² earth wire |

Where circuits are run in metal conduit, bare earth conductor shall be used and PVC insulated earth conductor shall be used for circuits run in PVC conduit.

4.12 Lighting

4.12.1 Lighting Conduit Work

Lighting circuits are to be conduited using 20mm conduit, and all lighting circuits are to be routed via the ceiling, either cast into the ceiling slab or saddled to roof trusses and brandering in the ceiling void. A separate circuit shall be run from the distribution board for each of the light circuits as indicated on the layout diagrams.

Light points are to consist of 60mm round boxes 32mm deep with side/back entry. Where a light point is to be cast into a ceiling slab a deep conduit box with extension ring shall be used to provide a 61mm deep conduit box.

For external wall mounted lighting the conduit shall be attached to the fitting in such a manner as to provide a weatherproof and vermin proof seal. Where a luminaire is to be installed on a face brick wall, conduit shall be chased into the inner skin or routed in the wall cavity, and shall only protrude at the position of the mounting, terminating in a conduit box over which the luminaire shall be mounted.

The light switch point shall consist of a galvanised pressed steel conduit box of dimensions 100mm x 50mm x 50mm deep recessed into the brickwork to allow for a flush mounting.

The successful Contractor is to co-operate closely with the building contractor to ensure that luminaires are symmetrically positioned with regards to the ceiling pattern. The exact positioning of lights and switches is to be confirmed with the Client's Representative.

4.12.2 Lighting General

Lighting shall comply with the SABS standards where applicable. The luminaires specified are detailed in the Bill of Quantities and drawings and luminaire schedule. Where alternative luminaires and lamps are offered, the details shall be submitted with the tender. All alternatives shall be subject to the approval of the Client's Representative. Earth conductors shall be connected to the earthing terminal of all luminaires and in accordance with SANS/IEC 10142-1.

All luminaires shall be supplied complete with a first working fitting of the appropriate lamp in each lamp holder.

Each lighting circuit on the Distribution Board shall consist of a 16A single pole MCB of 2.5kA rupturing capacity, unless specified otherwise on the single line diagram.

Unless otherwise specified in the Bill of Quantities or the drawings, the light switches shall be of Clipsal Series 2000, Crabtree Diamond or other approved. The correct PVC cover plate shall be provided with the light switch and included in the rate for the light switch.

The colour coding of light switches shall be in accordance with the details as specified below:

| | Normal Supply | Essential/Emergency Supply | UPS Supply |
|-------------------------|--|--|--|
| Colour of Cover Plate | White | | |
| Colour of Switch Toggle | White | Red | Blue |
| Label Type | Black letters on White Ivorene label or engraved directly on the cover plate with Black infill | Red letters on White Ivorene label or engraved directly on the cover plate with Red infill | Blue letters on White Ivorene label or engraved directly on the cover plate with Blue infill |
| Label Fixing | Ivorene label to be glued with super glue or pop riveted to cover plate | | |

| | Normal Supply | Essential/Emergency Supply | UPS Supply |
|---------------------------|---|---|---|
| Cover Plate Label Details | Distribution Board name and circuit number feeding the switch e.g. DBA L1 | Distribution Board name and circuit number feeding the switch e.g. DBAE LE1 | Distribution Board name and circuit number feeding the switch e.g. DBAU LU1 |
| Letter Font | Arial | | |
| Letter Size | 3mm | | |

4.12.3 Fluorescent and LED Luminaires

Tubular Fluorescent luminaires shall comply fully with SANS/IEC 1119 and all amendments as well as the additional requirements of this specification. Luminaires shall also bear the SANS/IEC mark of approval and the SANS/IEC 1464 safety mark.

Tubular fluorescent lamps light colour shall correspond to cool white i.e. colour 2 (4 300°K) as defined in SABS 1003. Lamps shall comply with SABS 1003 and shall bear the SABS mark. Lamps shall be devoid of flicker and shall readily strike when switched on. The successful Contractor is to hand over a fully operational system with all lamps in working order.

Fluorescent lamps are to be of the Osram or Phillips manufacture or other approved. All fluorescent lamps are to be controlled by electronic ballasts, which ballasts shall be matched to the lamps specified. T5 and LED lamp technology shall be used. Electronic dimmable control gear compatible with DALI shall be used for all office area lighting. Standard ECG shall be used for plant rooms and basement parking areas. **All LED luminaires shall not be less than LM97; B50 type; with a minimum of 50000 hours life and 5 year warranty.**

Fluorescent luminaires to be mounted on roof trusses shall be secured by means of two 40mm no.10 round head brass screws and washers. The luminaires shall be bonded to the conduit as defined previously.

4.13 Switched Socket Outlets (Plugs)

Plug circuits are to be conduited using 20mm conduit, and all plug circuits are to be cast into the floor slab, unless circumstances specific to the installation require otherwise. A separate circuit shall be run from the distribution board for each of the plug circuits as indicated on the layout diagrams.

The plug point shall consist of a galvanised pressed steel flush/surface mounted conduit switch box of dimensions 100mm x 100mm x 50mm deep recessed into the brickwork to allow for a flush mounting.

Unless otherwise specified in the Bill of Quantities or the drawings, the socket outlets shall be of the round pin 16A rating double or single outlet type where indicated, similar in design and construction to the Clipsal Series 2000, Crabtree Diamond or other approved. The correct cover plate shall be provided with the switched socket outlet and included in the rate for the plug.

The colour coding of switched socket outlets shall be in accordance with the details as specified below:

| | Normal Supply | Essential/Emergency Supply | UPS Supply |
|---------------------------|--|---|---|
| Colour of Cover Plate | White | | |
| Colour of Switch Toggle | White | Red | Blue |
| Label Type | Black letters on White Ivorene label or engraved directly on the cover plate with Black infill | Red letters on White Ivorene label or engraved directly on the cover plate with Red infill | Blue letters on White Ivorene label or engraved directly on the cover plate with Blue infill |
| Label Fixing | Ivorene label to be glued with super glue or pop riveted to cover plate | | |
| Cover Plate Label Details | Distribution Board name and circuit number feeding the socket outlet e.g. DB A/P1-1 Each socket outlet on a circuit shall be labelled | Distribution Board name and circuit number feeding the switch e.g. DB AE/PE1-1 Each socket outlet on a circuit shall be labelled | Distribution Board name and circuit number feeding the switch e.g. DB AU/PU1-1 Each socket outlet on a circuit shall be labelled |
| Letter Font | Arial | | |
| Letter Size | 3mm | | |
| Earth Pin | Round | | |
| Colour of Female Insert | White | | |

All switched socket outlets fed from circuits equipped with Earth Fault Monitoring equipment shall be equipped with double pole switches.

Dedicated switched socket outlets for computer equipment only, shall comply generally with those fed from the normal supply, but shall have red cover plates, switch toggles and female inserts, and shall only accept plugs with D-shaped earth pins.

All switched socket outlets shall comply with SABS 164 and shall be rated at 16A.

Not more than six 16A double switched socket outlets shall be connected to any one circuit without the approval of the Client's Representative.

Each power circuit on the distribution board shall consist of a 20A single pole MCB of the correct kA rupturing capacity as specified on the single line diagram.

Spurs and additions to any switched socket outlet circuit will not be accepted.

4.14 Equipment Isolators

The colour coding of isolators located adjacent to items of fixed equipment as prescribed in SANS/IEC 10142-1 or elsewhere in this specification or drawings, shall be in accordance with the details as specified below:

| | Normal Supply | Essential/Emergency Supply | UPS Supply |
|-----------------------|---------------|----------------------------|------------|
| Colour of Cover Plate | White | | |

| | Normal Supply | Essential/Emergency Supply | UPS Supply |
|---------------------------|--|--|--|
| Colour of Isolator Toggle | White | Red | Blue |
| Label Type | Black letters on White Ivorene label or engraved directly on the cover plate with Black infill | Red letters on White Ivorene label or engraved directly on the cover plate with Red infill | Blue letters on White Ivorene label or engraved directly on the cover plate with Blue infill |
| Label Fixing | Ivorene label to be glued with super glue or pop riveted to cover plate | | |
| Cover Plate Label Details | Distribution Board name and circuit number feeding the isolator e.g. DBA I1 | Distribution Board name and circuit number feeding the isolator e.g. DBAE IE1 | Distribution Board name and circuit number feeding the isolator e.g. DBA U/IU1-1 |
| Letter Font | Arial | | |
| Letter Size | 3mm | | |

Where Blue isolator toggles are not obtainable and written approval was obtained from the Engineer, an isolator switch incorporating a Red or Blue neon or LED indicator may be used. Alternatively, a White isolator toggle may be used but the isolator toggle must be tagged with a non-removable Red or Blue sticker.

Unless otherwise specified in the Bill of Quantities or the drawings, the isolator outlets shall be similar in design and construction to the Clipsal Series 2000, Crabtree Diamond or other approved. The correct PVC cover plate shall be provided with the isolator outlet and included in the rate.

4.15 Earthing and Lightning Protection

All workmanship and materials used shall be of the highest standard and shall be carried out in accordance with the best modern practice, as determined by the Engineer.

The entire installation shall comply in every respect with the latest amended publication of the relevant specifications.

Definitions

Lightning Protection System

The whole system of conductors used to protect a structure from the effects of lightning.

Air Terminal

The part of a lightning protection system that is intended to intercept lightning discharges directly.

Down Conductor

A conductor that connects the air terminal (s) to the earth terminals (s).

Earth Terminal

The part of a lightning protection system that is intended to discharge lightning currents into the general mass of the earth.

Earthing Electrode

The part of an earth terminal which makes direct electrical contact with the earth.

Bond

A conductor that provides electrical connection between the lightning protection system and the metal work of the structure to be protected or between various parts of this metal work.

Joint

A mechanical junction between two conductors for purpose of providing electrical continuity between two parts of the lightning protection system.

Testing Joint

A joint in a down-conductor or in a bond connecting two sections of the lightning protection system so designed and situated as to enable measurements to be made of the resistance to earth or of electrical continuity of parts of the lightning protection system.

5. TESTING & INSPECTION

The successful Contractor shall comply with the relevant requirements concerning registration of electricians, registration of the works, testing and inspection.

The successful Contractor shall ensure that all equipment is installed and tested in full compliance with the requirements of the manufacturers of the equipment so as to ensure that the guarantees offered by the manufacturers are not compromised. The successful Contractor shall familiarise himself in detail with the manufacturer's requirements prior to the installation of the equipment, and, where necessary, the installation work shall be carried out under the supervision of the manufacturer/supplier.

The successful Contractor shall carry out continuity, earth leakage, earth loop impedance and insulation tests to ensure that the installation is functional and safe.

A full functional test will be carried out on the installation for a period to determine the satisfactory working thereof after completion of the works and before first delivery is taken. During this period the installations will be inspected and the successful Contractor shall make good, to the satisfaction of the Engineer, any defects that may arise.

The successful Contractor shall provide all instruments and equipment required for testing and any water, power and fuel required for the commissioning and testing of the installations at completion.

The successful Contractor shall on completion of the tests, submit, in terms of the OHS Act No.85 of 1993 (as amended), a completed and signed Certificate of Compliance for Electrical Installations to the Clients Representative.

On completion of the Contract Works, the successful Contractor shall remove all dirt and debris arising from the Contract Works from site, paying particular attention to roof spaces.

Only Contractors registered with the Electrical Contracting Board of South Africa in accordance with Regulation 5 of the Occupational Health and Safety Act will be accepted and permitted to do work under this Contract. The requirements of Regulation 5(2) will be strictly enforced, and are repeated for convenience purposes:

“5(2) The Electrical Contracting Board of South Africa shall, free of charge, register as an electrical contractor and enter into a register kept for that purpose the name of any person who applies therefore in terms of sub-regulation (1) and who

- (a) has a fixed address and has a telephone listed in his name; and
- (b) employs an accredited person on a full-time basis, or is himself an accredited person.”

An “accredited person” is defined in the Regulations as “.....a person registered in terms of Regulation (9) (of the Act) as an electrical tester for single phase, an installation electrician or a master installation electrician, as the case may be”. If, for any reason whatsoever, the successful Contractor fails to comply with these statutory requirements during the Contract period, after having been accepted initially to do work under this Contract, the services of the successful Contractor will be terminated in accordance with Clause 56 of the Conditions of Contract.

6. SCHEDULE OF DRAWINGS AND DOCUMENTS

The successful Contractor shall provide four sets of “as built” drawings and operational manuals for all equipment installed in terms of this specification, the drawings and Bill of Quantities. One set shall be provided to the Clients Representative and three to the Employer.

The maintenance and operational manuals must be complete with an index and be bound in a suitable hard cover binder such as Bantex A4 Ring Binders. The files must be provided with stiff dividers on which the relevant sections are indicated and are to be in printed or typed format. Drawings shall be housed in plastic pockets in the file, and only one (1) drawing per pocket will be allowed.

In addition all “as built” drawings must be stored on CD in .dwg format and must also be submitted with the manuals.

All schematic electrical “as built” drawings of distribution boards must be laminated and attached to the inside of the doors with double sided tape.

The main distribution board/electrical panel schematic diagram in the low voltage plant room or in other plant rooms as well as the schematic site reticulation layout, if applicable, must be suitably framed with Perspex and be mounted in the plant room in a position as indicated on site.

The maintenance and operational manuals must consist of the following sections where applicable to the project:

- Operations section, covering description of the system and functioning thereof, all starting up and stopping procedures, fault-finding procedures, pre-start checks and equipment running checks.
- Comprehensive data log sheets to be kept by the user of the system.
- General system description and general information schedules of plant and equipment, such as description of equipment, model number, capacity, electrical requirements of equipment, name and address of supplier, name of manufacturer.
- Design information: Design data sheet containing all design and selection parameters, calculations, selection curves, etc. Settings and values recorded during commissioning. Manufacturers' brochures, pamphlets, pump curves, etc.
- Maintenance data and schedules: The lapse of time between services and the description of service requirements for each part, piece of equipment or item installed under the Contract. This section must also include the detailed daily, weekly, monthly, three monthly, six monthly and yearly preventative maintenance instructions and checklists.
- Manufacturers' literature indication lubrication points, lubricants to be used and other data referred to above.
- Commissioning data of all equipment and systems with all set points listed in table format relating to the specific piece of equipment and/or system.
- All other data relating to other components forming part of the system/reticulation such as valves, diffusers, medical gas outlet points, etc.
- Critical spare parts list for all equipment.
- All test certificates (any certificates required in terms of the installations as pertaining to the project), compliance certificates, lightning protection certificates, certificates of construction of electrical panels.
- Schematic wiring diagrams and equipment ratings of all electrical panels and distribution boards.
- All "As-Built" drawings of mechanical and electrical installations pertaining to the project. "As-Built" drawings must be the true reflection of the installation as on site and must include the actual particulars of the equipment as installed on site and must be signed and dated by the responsible consultant and must be marked "AS BUILT".
- All "As-Built" drawings, including wiring diagrams, must be produced in Autocad format and be stored on CD as listed above.

* * * * *

ANNEXURE 1 - DRAWINGS

| Drawing No. | Description |
|-------------------------|---|
| 10969-001-002- GGL-0001 | Overall Site Plan |
| 10969-001-2-BAR-0001 | Existing Building Refurbishment Layout |
| 10969-001-002-EED-0001 | Ground & Mezzanine Floor - Small Power & Lighting |
| 10969-001-002-ESL-0002 | DB-Workshop SLD |

PROJECT SPECIFICATION

PORTION 3: PARTICULAR SPECIFICATION

C1ST BUILDING REMEDIALS, HILO UNLOADER, SPILLER WALL AND CONCRETE HARDSTAND

1. BUILDING REMEDIALS

Scope of Work

The technical specification is to be read in conjunction with all of its Annexures in order to obtain a complete view of the scope of work. The Equipment/ Material to be supplied by the Bidder shall include but is not limited to the following:

- a) Cutting back roof steel cantilever and making good
- b) Removal and disposal of existing Asbestos roof covering
- c) Removal of Existing bracing and purlins
- d) New brackets to fix existing steel columns to existing brickwork
- e) Grinding and making good flame cut columns and applying cold Galv anti corrosion protection
- f) Installing new hot dipped galvanised purlins and bracing
- g) Installing new roof sheeting
- h) Installing new gutters
- i) Installing new 200mm thick concrete mezzanine slab
- j) Install new structural steel stair to mezzanine slab
- k) Cutting existing brickwork and installing brickwork lintels for new windows and doors
- l) Applying new coating to existing steel roof

2. HILO UNLOADER

Scope of Work

The technical specification is to be read in conjunction with all of its Annexures in order to **obtain** a complete view of the scope of work. The Equipment/ Material to be supplied by the Bidder shall include but is not limited to the following:

- a) Earthworks for preparation for pile caps and foundations
- b) Install new concrete piles and pile caps
- c) Supply and install new holding down bolts
- d) Install new Hilo Cane Loader

Exclusions from scope of works

- a) Procurement and supply of Hilo unloader

3. SPILLER WALL AND CONCRETE HARDSTAND

Scope of Work

The technical specification is to be read in conjunction with all of its Annexures in order to obtain a complete view of the scope of work. The Equipment/ Material to be supplied by the Bidder shall include but is not limited to the following:

- a) Earthworks for preparation for hardstand and foundations
- b) Imported layer works for hardstand area
- c) Install new concrete foundation for the structural steel spiller wall
- d) Install new structural steel spiller wall including chemical anchors
- e) New concrete hardstand

PROJECT SPECIFICATION

PORTION 2: VARIATIONS TO STANDARDIZED SPECIFICATIONS

PSMM **ANCILLARY ROADWORKS**

PSMM 1 **GUARDRAILS** (SUBCLAUSE 3.1.1)

Guardrails and endwings shall be manufactured from plain carbon steel and have a hot-dip galvanized zinc coating finish all in accordance with the requirements of SABS 1350.

Unless otherwise specified guardrails shall be terminated using Type 1(a) Standard endwings.

PSMM 2 **TIMBER POST AND SPACER BLOCKS** (SUBCLAUSE 3.1.2.1)

Timber posts and spacer blocks shall be manufactured from Strength Group B hardwood and, where necessary, the 'nailing and stapling' method of banding shall be used. Unless otherwise shown on the drawings timber posts shall be 2,0 metres in length, and shall have a single 20mm diameter bolt hole drilled through the post 200mm below the highest point of the dome or roofing cut, as applicable.

PSMM 3 **FIXING BOLTS FOR ROAD SIGNS** (SUBCLAUSES 3.2.3 AND 3.2.10)

Where a road traffic sign is to be supported on a single timber pole 2 x 10mm (minimum) diameter bolts shall be used to fix the sign to the support.

PSMM 4 **SURFACE PREPARATION FOR ROAD MARKINGS** (SUBCLAUSE 5.3.2)

The painting of road markings shall not be carried out sooner than two weeks after completion of the bituminous surfacing.