

## PSX ELECTRICAL SPECIFICATION

### INDEX

PSX1	Scope of the Electrical Work.....	1
PSX1.2	Work Included.....	1
PSX1.2	Specific Work Scope .....	2
PSX1.3	Supply of Equipment & Material .....	2
PSX2	General Specifications .....	3
PSX2.1	Applicable Standards and Particular Specifications .....	3
PSX2.2	Installation Guidelines .....	3
PSX2.3	Commissioning Test Equipment.....	4
PSX2.4	Documentation .....	4
PSX3	Electrical Distribution .....	6
PSX3.1	Electricity Supply .....	6
PSX3.2	Instruments, Meters, Relays and Ancillary Equipment.....	6
PSX3.3	Motor Control and Distribution.....	6
PSX3.4	Instrument, Panel and Junction Box Labels .....	6
PSX3.5	Notices.....	7
PSX3.6	Testing and Commissioning .....	7
PSX4	Cabling .....	8
PSX4.1	Scope .....	8
PSX4.2	General Cable Installation Requirements .....	8
PSX4.3	Service Conditions.....	8
PSX4.4	Cable Testing .....	9
PSX4.5	Cable Identification .....	10
PSX4.6	Cable Terminations .....	10
PSX4.7	Cable Routes .....	11
PSX4.8	Cable Lengths .....	13
PSX5	Electrical Equipment and Installation.....	14
PSX5.1	Electrical Protection Methods.....	14
PSX5.2	Luminaires .....	14
PSX5.3	Conduit .....	14
PSX5.4	Ducting .....	15
PSX5.5	Cable Racking .....	15
PSX5.6	Junction Box Supports .....	15
PSX5.7	Control Station Supports .....	15
PSX5.8	Emergency Stop Stations.....	16
PSX5.9	Fire Alarm Stations .....	16
PSX5.10	Motor Isolators.....	16
PSX5.11	Stop/Start Stations.....	16
PSX5.12	Light Switches In Hazardous Areas .....	16
PSX5.13	Earthing .....	16
PSX5.15	Fire Extinguishers.....	17
PSX5.16	Final Positions .....	17
PSX5.17	Testing, Commissioning and Quality Control Procedures.....	17
PSX5.18	Training.....	17
PSX5.19	Commissioning Spares .....	18

PSX5.20	Certificate of Completion .....	18
PSX5.21	Schedule of Technical Information .....	18
PSX6	Standby Generator .....	18
PSX7	Motor Control & Distribution Centres .....	19
PSX7.1	Scope .....	19
PSX7.2	General Requirements .....	19
PSX7.3	Standards .....	19
PSX7.4	Service Conditions.....	19
PSX7.6	Physical Barriers and Construction .....	19
PSX7.7	Doors and Barriers .....	19
PSX7.8	Cable Securing Arrangement .....	20
PSX7.9	Earthing .....	20
PSX7.10	Degree Of Protection.....	20
PSX7.11	Busbars .....	20
PSX7.12	Wire Specifications .....	21
PSX7.13	Wiring Colours .....	21
PSX7.14	Wire Routing.....	21
PSX7.15	Wiring Termination .....	21
PSX7.16	Wiring Terminals.....	22
PSX7.17	Painting.....	22
PSX7.18	Labelling .....	22
PSX7.19	Switchgear and Accessories .....	23
PSX7.20	Marshalling Cubicles .....	25
PSX7.21	Balancing Of Load .....	26
PSX7.22	Power Factor Correction .....	26
PSX7.23	Emergency Stop .....	26
PSX7.24	Uninterruptible Power Supply .....	27
PSX7.25	Intrinsically Safe (I.S.) Cubicle .....	27
PSX8	MATERIAL SCHEDULE .....	28
PSX13.5.1	Training.....	29

**PSX1      Scope of the Electrical Work**

The Scope of the Contract consists of the work performance relative to the electrical and instrument installation of the Island View Complex CFI Upgrade.

Drawings and specifications outlining the work to be completed by Contractor are contained herein.

**PSX1.2      Work Included**

PSX1.2.1      The Contractor shall provide and do everything necessary to execute the work specified in or reasonably to be inferred from this specification, the drawings listed in the Drawing Register hereof and the Contract in its entirety including, but not necessarily limited to the following:-

- (a)      collection of Equipment from the Client's store(s), loading, transportation to, off-loading at and receiving of same into Contractor's store, or the receiving of Equipment at Contractor's store;
- (b)      the supply, delivery to, off-loading at and handling on Site of all Material as well as the painting (and touching up) thereof, as applicable, and as required by this Specification;
- (c)      the removal from Equipment of all packing materials such as protective mouldings, transportation supports, stiffeners and struts and the transportation thereof to and off-loading at a point designated by the Engineer for that purpose;
- (d)      the checking of all Equipment for conformity to packing lists and for damage and the reporting to the Engineer of any discrepancies or damage discovered;
- (e)      the erection of all plant and the modification of existing panels in accordance with drawings and specifications;
- (f)      the performance of meggar, continuity and loop checks and performance of all Electrical Tests as detailed herein, including the provision of all necessary test apparatus;
- (g)      the off-loading, installation, testing and connection to the various distribution boards and Motor Control Panels;
- (h)      the installation of all field junction boxes;
- (i)      the supply and installation of all cable support conduits and trays/racks;
- (j)      the timeous supply and supervision of all labour required to complete the Works;
- (k)      the supervision of and attendance on the installation of electrical sleeves and trenching in accordance with Clauses PSX4.7.1 hereof.
- (l)      the provision of site establishment including a "safe" area for material and equipment;
- (m)      the supply of Documentation as specified;
- (n)      the supply of all Construction Equipment necessary for the execution of the Works.

**PSX1.2     Specific Work Scope**

The Electrical work contained in the Schedule of Quantity and the tender drawings and included in the Works Specification

**PSX1.3     Supply of Equipment & Material**

**PSX1.3.1     Equipment**

Equipment to be supplied by the Contractor shall include but may not necessarily be limited to:-

- (a)     Cable racks & Supports
- (b)     Power & Instrument Cables & glands
- (c)     Earth conductors

**PSX1.3.2     Material**

Material to be supplied by the Contractor shall include but may not necessarily be limited to:-

- (a)     cables, cable glands, cable trays, "Pratley" type cable junction boxes, conduits, conduit fittings, cable markers, cable clamps, strapping and trunking;
- (b)     supports/brackets;
- (c)     crimp connectors, metal and/or plastic tags for cables, conduit, screws, bolts, plate, angle iron, paint and holding down bolts;
- (d)     engraved labels as per schedule;
- (e)     consumables, such as gas, oxygen, grinding wheels, cutting discs, molycote, graphite, oil, drills, saw blades, brushes, solder, paint, tape, welding rods, etc., necessary for the Completion of the Works;
- (f)     adaptors;
- (g)     junction boxes;
- (h)     isolators and Emergency Stop Stations;
- (i)     terminals;

**PSX2      General Specifications**

**PSX2.1      Applicable Standards and Particular Specifications**

Although not bound in nor issued with the document, the latest revision of the following standardised specifications shall form part of the contract document.

Act 84 of 1993	:	Occupational Health and Safety Act and Regulations
SANS 558	:	Cast iron surface boxes and MH and IC covers and frames
SANS 791	:	PVC sewer and drain pipes and pipe fittings
SANS 950	:	Non-metallic conduit
SANS 966-1	:	Components of uPVC pressure pipe system
SANS 1117	:	Plastic wrappings for the protection of steel pipelines
SANS 1195	:	Busbars
SANS 1200 L	:	Medium pressure pipelines
SANS 1200 LB	:	Bedding (pipes)
SANS 1200 LC	:	Cable ducts
SANS 1973-1	:	Low voltage Switchgear and Controlgear Assemblies Part 1: Type tested assemblies with a rated short-circuit withstand strength above 10kA
SANS 1507	:	Electric Cables ... for Fixed Installations
SANS 1601	:	Structured wall pipes and fittings of uPVC for buried drainage & sewerage systems
SANS 1765	:	Low voltage Switchgear and Controlgear Assemblies with a rated short-circuit withstand strength up to and including 10kA
SANS 10044	:	Welding
SANS 10086-1	:	Installation, inspection and maintenance of equipment used in explosive atmospheres
SANS 10089-2	:	The Petroleum Industry Electrical and other installations in the distribution and marketing sector
SANS 10108	:	The Classification of Hazardous Locations and the selected of Electrical Apparatus for the use in such locations.
SANS 10129	:	Plastic tape wrapping of steel pipelines
SANS 10142-1	:	The Wiring of Premises
SANS 10313	:	The protection of structures against lightning.
SANS 10400	:	The application of National Building Regulations
SANS 60079	:	Electrical Apparatus for Explosive Gas atmosphere
SANS 60439-1	:	Low voltage Switchgear and Controlgear Assemblies Part 1: Type tested and partially type tested assemblies.
SANS 60439-2	:	Low voltage Switchgear and Controlgear Assemblies Part 2: Particular requirements for busbar trunking systems.
SABS 60529	:	Degrees of protection provided by enclosures (IP Code)
SANS 61386-1	:	Metallic conduits and fittings

**PSX2.2      Installation Guidelines**

- (a) This code of practice is to be used as a guideline for all electrical, instrument and control system installation work. It is the CONTRACTOR'S responsibility to ensure that he has read and is aware of the relevant sections of this Code of Practice before he commences any installation work.
- (b) Any work which has been completed by the CONTRACTOR and which does not meet with the requirements of this Code of Practice, will not be accepted by the Client. It will be for the CONTRACTOR'S account to rectify the work.

- (c) The CONTRACTOR shall ensure that all relevant local and statutory requirements are complied with and that all personnel in his employ are fully conversant with these requirements.
- (d) The CONTRACTOR shall obtain approval from the Client before power or pneumatic supplies are switched on.
- (e) The CONTRACTOR shall furnish a detailed list of each employee stating his or her name, I.D. number, qualification and, in addition, ensure that a "Master Installation Electrician" supervises the electrical work in a hazardous area, as defined by SANS 10108. If there is no electrical work in a hazardous area, an "Installation Electrician" shall supervise the electrical work.
- (f) "Master Installation Electrician" and "Installation Engineer" are as defined in the Occupational Health and Safety Act, Electrical Installation Regulations.

### **PSX2.3      Commissioning Test Equipment**

The CONTRACTOR shall provide a list of any special test equipment and/or sub-contractors, which will be required to commission and maintain the system. The cost of the test equipment and/or sub-contractors, shall be included by the CONTRACTOR within the Schedule of Quantities.

### **PSX2.4      Documentation**

#### **PSX2.4.1      General**

- (a) This section describes the minimum requirements for the documentation to be supplied by the CONTRACTOR. All documentation shall be in ENGLISH.
- (b) For the purposes of the TENDER, the following technical information is to be provided:
  - (i) Project schedule depicting procurement, downtime per area and commissioning duration
  - (ii) Where standard vendor documentation is supplied, it shall be marked clearly and unambiguously to represent the actual equipment and system being supplied.
- (c) At the end of the project, the CONTRACTOR will be required to provide the Engineer, with the following documentation:
  - (i) Certificate of Compliance, including supplementary sheet, as required.
  - (ii) All issued drawings marked up 'As-Built'.
  - (iii) All schematic and detailed loop diagrams.
  - (iv) Single line power distribution drawings and all loads shall be itemised
  - (v) Schedules of all power and signal cables updated to "As Built" status;
  - (vi) Information on location of equipment;
  - (vii) Information on the location and depth of underground services and earth mats
  - (viii) Information on the distribution and control boards.
  - (ix) Maintenance Manuals of specified equipment from equipment suppliers.
  - (x) Test Reports/Certificates.
  - (xi) Explosion Protected Equipment, Classification Certificates.
  - (xii) Training and Operational Manuals.

#### **PSX2.4.2      Design & Supply or Turnkey basis**

- (a) If the CONTRACT has a Design & Supply or Turnkey basis, the following is to be submitted with the tender in addition to the above
  - (i) Block diagram of any CONTRACTOR designed infrastructure

- (ii) References of installations using the proposed equipment.
- (b) After the contract has been awarded, the Contractor shall supply all the necessary documentation for all equipment supplied to facilitate the installation. The ENGINEER will control the final documentation issued to the client.
- (c) In order to achieve this, the tenderer must provide sufficient detail to permit the ENGINEER to complete the following:
  - (i) Block diagrams
  - (ii) Loop diagrams
  - (iii) Junction box termination diagrams
- (d) In addition, the following documentation including, but not limited to the following must be provided (if applicable):
  - (i) Hazardous rating certification
  - (ii) Interfacing with other software (communications protocols, etc).
  - (iii) Maintenance and trouble-shooting (diagnostics).
  - (iv) Certificates of compliance.
  - (v) Recommended spares list.

**PSX3      Electrical Distribution**

**PSX3.1      Electricity Supply**

**PSX3.1.1      General**

The CONTRACTOR shall complete all commencement forms and necessary documentation as required by the local electricity supply authority to ensure that the permanent electricity supply required by THE ENGINEER on site is achieved as soon as possible. All staff members must attend a compulsory Safety Standards/Work Permit seminar, required by THE CLIENT prior to any work being carried out on site. On completion of the work the CONTRACTOR shall supply THE CLIENT with the "Certificate of Compliance" as required by the Occupational Health and Safety Act.

**PSX3.2      Instruments, Meters, Relays and Ancillary Equipment**

The CONTRACTOR shall be responsible for the installation of all instrumentation, meters, relays and ancillary equipment and the glanding of all cables as detailed in the cable schedule and as defined in Section PSX4 hereof. In addition, the CONTRACTOR shall terminate all cables in the MCC and to intermediate Junction Boxes but shall not terminate onto any instrument, meter or ancillary device, unless tested and approved by the Engineer.

**PSX3.3      Motor Control and Distribution**

The CONTRACTOR shall be required to interconnect all components making up the Motor Control and Distribution Boards (MCC/DB's) as itemised in the Schedule of Quantities.

Where appropriate, schematic diagrams shall be included in the Drawing Register, hereof.

The CONTRACTOR shall be responsible for the supply, off-loading, handling, installation and protection of all free issued main and sub motor control and distribution centres. The Schedule of Quantities itemises those electrical boards required for pricing. Naturally the Contractor is to liaise with the supplier of the boards to establish the dimension and weight of each unit.

**PSX3.4      Instrument, Panel and Junction Box Labels**

**PSX3.4.1      General**

- (a) The labels shall be manufactured from White laminated Gravoply, Trafalite or equivalent as approved by THE CLIENT, with Black lettering unless otherwise stated.
- (b) All engraving shall be centred unless otherwise stated.
- (c) Engraving width shall be 0,5mm unless otherwise stated.
- (d) Labels are to be square with slightly chamfered edges on the engraved side.
- (e) The labels shall be 1,5mm thick unless otherwise stated.
- (f) Labels shall be secured with two 3mm pan head stainless steel screws and nuts or else within appropriately sized extruded aluminium rail.
- (g) Label size, character height and colour shall be specified by label type unless otherwise stated.
- (h) Wherever practical, the field instrument labels shall be secured in a holder clamped to the instrument stand with stainless steel "Band-it" strap

**PSX3.4.2      Junction Boxes**

- (a) All junction boxes shall be labelled with labels detailing the area number and junction box signal type followed by the number as indicated on the Junction Box Schedule.  
e.g. 01-JBX-001



- (b) Intrinsically safe junction boxes shall be blue and also be labelled on the inside of the Junction Box door with a special sticker i.e. "Intrinsically Safe System Unauthorised modifications prohibited" (MTL type ISL3).
- (c) Ex rated junction boxes must not be drilled, consequently these labels must be mounted on the support frame with two 3mm stainless steel pan head screws and nuts if the labels were not supplied already fitted to the junction box.

#### PSX3.4.3 Panels and Cabinets

The boards shall be in colour coded for each service and shall be clearly labelled in terms of this Specification. All panels and cabinets shall have a label detailing the panel/cabinet type, number and, if applicable, the side identification i.e. front or rear.

#### PSX3.4.4 Additional Instruments and/or Panel Signage

Any Instrument and/or Panel where it is possible to touch the electrical supply of between 50 and 250 volts AC/DC, must be labelled with clearly visible label stating the voltage present e.g. "CAUTION - 110 VOLTS AC".

#### PSX3.4.5 Label Schedule

The Electrical Contractor is to study the Cable Schedule and identify the Labels of each piece of equipment as listed within the Schedule of Quantities, the contractor is to state the quantity and price of the labels.

### PSX3.5 Notices

PSX3.5.1 The following notices shall be supplied and mounted by the Electrical CONTRACTOR exhibited at all entrances and in suitable places within such premises where generating plant, transforming, switching or linking apparatus are situated:-

- (a) A notice prohibiting unauthorised persons from entering such premises.
- (b) A notice prohibiting any unauthorised persons from handling or interfering with electrical apparatus.
- (c) A notice detailing " DANGER - HIGH VOLTAGE"
- (d) A notice containing directions for resuscitation of persons suffering from the effects of electric shock.

#### PSX3.5.2 Quality and Quantity of Notices

The signs shall be Type ABS for internal use and Type Chromodec for external use. Signs to be to SANS 1186.

Catalogue No.	Size	Description
KW115	440 x 440mm	No unauthorised entry.
KW783	440 x 440mm	Danger this equipment starts automatically.
FB2	150 x 150mm	Fire extinguishers
KM146	600 x 800mm	Composite sign containing the above four statutory notices.

The quantity of notices will be itemised in the Schedule of Quantities.

### PSX3.6 Testing and Commissioning

The CONTRACTOR shall be present when any equipment is tested and commissioned. This is to ensure that if there are any problems with the connected system, they can be identified and the appropriate Contractor instructed to rectify the problem.

**PSX4      Cabling**

**PSX4.1      Scope**

This specification defines the minimum requirements for low voltage instrument, power, signal and control cables to be installed as part of the Fire Upgrade project. Reference is to be made to the Cable Schedules and Cable Type Codes for specific runs and applications of cabling in the Contract.

**PSX4.2      General Cable Installation Requirements**

- (a) Where the specification states that the CONTRACTOR shall "cable" or "install cable/cabling" this involves the following:
- (b) A complete study of cable schedule and layout drawings which will show the cable run to be installed in cable trenches, cable trays, cable ladder rack or supported on structures.
- (c) On site measurements of cable length before cutting off cable drum.
- (d) Terminating, glanding, making off.
- (e) All cables shall be installed in accordance with the detailed specification, in Section PSX4 hereof.
- (f) All cables shall be installed in one length. No intermediate jointing of cable will be permitted.
- (g) The CONTRACTOR shall take special note that the cable schedules must only be used as a guide. The CONTRACTOR shall be responsible for determining correct cable lengths.
- (h) Unless otherwise specified, screened instrument cables shall have Dekabon or steel wire armouring and/or screening terminated, with lugs, only at the control panel end of the cable. Note that thermo-couples terminations are one exception to this rule.
- (i) All wiring shall be neatly installed, and strapped or saddled in position to the panel or supporting steelwork. All strapping on horizontal supports shall be by means of proprietary cable straps. In addition, for vertical cable supports metal strapping (Bandit) or clamps must be installed at least every 1500mm.
- (j) Unless otherwise approved by the CLIENT, all conductors shall be terminated by means of crimped lugs using the correct type and size of lug for the different terminations. Crimped boot lace ferrules are required for smaller wires.
- (k) All cables to be labelled on either end as per PSX4.5
- (l) It shall be the CONTRACTOR'S responsibility to ensure that all dies and crimping tools, are the correct sizes.
- (m) Conductors shall not be carried over or formed around sharp edges or corners.

**PSX4.3      Service Conditions**

**PSX4.3.1      Definition of Cable Locations**

<u>Protected Environment:</u>	Indoors, for example within the office block, MCC or other buildings
<u>Overhead:</u>	Cable mounted and supported on cable trays or alternative mechanical support.
<u>Underground:</u>	Cable to be directly buried in ground/trench or taken through ducts or sleeves.

**PSX4.3.2      Instrument Cable Specifications**

- (a) Signal Cables
  - (i) Conductor 1,0mm<sup>2</sup> of flexible stranded twisted tinned copper wire and PVC insulated for at least 250 volts.
  - (ii) Insulated conductor pairs to be twisted at a rate of about 10 twists per metre.
  - (iii) For multicore cables the twisted pairs to be twisted in layers at rate normally supplied by cable manufacturer.

- (iv) Overall tinned copper wire braided screen or aluminium tape screen with drain wire.
  - (v) PVC sheath over screen.
  - (vi) Aluminium tape (Dekabon preferred) or steel wire armouring.
  - (vii) Overall PVC sheath.
  - (viii) Maximum L/R ratio 40  $\mu\text{H}/\text{Ohm}$  and maximum C 200 pf/metre between cores and 400 pf/metre between any cores and screen.
- (b) Cable Colours
  - (i) Normal signal cables - outer sheath to be black.
  - (ii) Intrinsically safe signal cables - outer sheath to be light blue or else the ends sleeved with blue heat shrink tubing.
  - (iii) Cable cores to be marked, although colour coding of cable cores can be applied and the actual colour code will be mutually agreed before cables are ordered.

#### **PSX4.4 Cable Testing**

##### **PSX4.4.1 General**

- (a) Immediately after cables are laid and before connection, all cables shall be checked for polarity, continuity and insulation resistance using proper test equipment. The CONTRACTOR shall furnish the Engineer with test certificates for ALL cables.
- (b) Underground cables shall be tested before backfilling commences.
- (c) The CONTRACTOR shall check the electrical supply to ensure that the correct supply, AC or DC, and the correct voltage is being fed to the instrument before it is commissioned.
- (d) Special attention shall be given to testing the shielding of cables and wires to ensure continuity of such screening and earth.
- (e) Reference is to be made to the Section PSX4.3 hereof for specific requirements for cable testing.
- (f) For each cable drum the manufacturer must complete a "CABLE TEST CERTIFICATE".

##### **PSX4.4.2 Test Cables (Instrument Cables)**

Use a 100V D.C. Megger to measure the following cable insulation resistance and continuity parameters:-

- (a) For each pair: conductor to conductor greater than 90M ohm.
- (b) For each pair: conductor to screen greater than 60M ohm.
- (c) Individual screen to overall screen greater than 10M ohm.
- (d) Overall screen to armour/protective sheath greater than 10M ohm.
- (e) Continuity of all conductors, screen and armouring (Dekabon or SWA)

All values to be recorded on Cable Test Certificates. (Refer Appendix PSX – B Cable Test Certificate)

**PSX4.4.3** Thermocouple cables must not be Meggered for continuity. The continuity and insulation is to be tested using a suitable method that will not damage the cable insulation. Details of the test method used are to accompany the cable test certificate.

##### **PSX4.4.4 Test Details (Power and Control Cables)**

Use a 500V D.C. Megger for 600/1000V cables and a 2500V DC Megger for 6kV/11kV cables to measure the following cable parameters:-

- (a) Phase - phase - greater than 90 Mohm
- (b) Phase - neutral - greater than 90 Mohm
- (c) Phase - earth and/or armouring - greater than 90 Mohm

- (d) Neutral to earth - greater than 90 Mohm

In addition, check for continuity of every conductor. All values to be recorded on the Cable Test Certificates. (Refer Appendix PSX – B Cable Test Certificate)

#### **PSX4.5 Cable Identification**

- (a) It will be the CONTRACTOR'S responsibility to correctly identify the cable type required on the cable schedule before installation. Cross referencing shall be done to verify the following parameters: number and colour of cores/pairs, core/pair strand details, screen wires, armouring, (SWA or DEKABON) and cable outer sheath colour.
- (b) Reference is to be made to the Cable Schedule column 1 "Cable No." which will be used to reference all cables (14/18).
- (c) Cables shall be identified with the "Cable No." and the "To" or "From" as on the cable schedule with stainless steel embossed tags at either end. The appropriate "To" or "From" will be to permit identification of what the cable is connected to. Hence at the "From" location the cable will have a tag indicating the "Cable No." and the "To" description.
- (d) Cables must be identified after completing continuity tests and prior to commissioning.
- (e) SPECIAL NOTE: Payment will only be made for those cables which are identified and have completed test certificates.
- (f) All wire numbers shall be CRITCHLEY or equal approved and of the interlocking, marking ferrule type and the numbering shall be consistent with that indicated on the drawings.
- (g) All equipment shall be checked to ensure it has been correctly identified and tagged.

#### **PSX4.6 Cable Terminations**

PSX4.6.1 All cable terminations shall be done in accordance with the "Code of Practice for the Wiring of Premises" SANS 10142-1 and the "Classification of hazardous locations and the selection of electrical apparatus for use in each locations" SANS 10108 (as amended).

All cables shall be tested in accordance with SANS 1507.

PSX4.6.2 As a rule, the following gland types (CCG or equivalent) will be used.

<b>Gland Type</b>	<b>Cable Type</b>	<b>Location</b>	<b>Area Classification</b>
CW	PVC SWA	Outdoor use Neoprene Shroud)	Safe
A2	FLEXIBLE	In and Outdoor (Use Neoprene Shroud)	Safe
A2E	FLEXIBLE	In and Outdoor (Use Neoprene Shroud)	Ex e
E1W	PVC SWA	Outdoor	Ex e
FLP + screw on earth tag	PVC SWA	In and Outdoor (Use Neoprene Shroud)	Ex d
FLP-TR + screw on earth tag	FLEXIBLE	In and Outdoor (Use Neoprene Shroud)	Ex d
FLP Hose	FLEXIBLE + Outer Sheath (ie SPRAGUE tubing)	Outdoors	Ex d
POSISEAL	PVC SWA	Corrosive Environment IP68	Ex e
POSIGRIP	FLEXIBLE	Corrosive Environment IP68	Ex e

NOTE: Where other types of glands and cables are required, the Engineer will advise accordingly.

- PSX4.6.3 On all paired cables, the individual pairs must be sleeved with 6mm black PVC sleeving. Individual cores on all cables must be lugged with the correct colour coded bootlace ferrule or spade lugs, depending on the requirements. All lugs are to be double crimped using approved equipment and must withstand a pull test.
- PSX4.6.4 Terminations must be properly tightened and terminated so as not to infringe the safety classification of the installation.
- PSX4.6.5 All cable and wire terminals must be of the screw clamp and pressure plate type where the clamping screw does not act directly on the conductor; (Type: Phoenix or equal approved). Specifically "chocolate box" type connectors are not permitted;
- PSX4.6.6 Special attention shall be given to testing the shielding of cables and wires to ensure continuity of such screening and termination to earth. The shields typically must be connected to the earth system at the feed end only, with the unshielded tails being as short as possible. The specific detail will be shown on the appropriate termination drawing.
- PSX4.6.7 All unused conductors shall be bonded to the nearest earth.
- PSX4.6.8 All cables to be tagged with stainless steel embossed tags (allow max 9 characters).

#### **PSX4.7 Cable Routes**

The routing of cables is dictated by the sleeve and cable ladder positions. Consequently, the CONTRACTOR is to liaise with the ENGINEER to ensure that sleeves, cable racks and manholes are located in the correct positions and that the cables are installed in the correct positions.

##### **PSX4.7.1 Trenching**

- (a) Where the CONTRACTOR is responsible for trenching, he must adhere to this detail specification.
- (b) The CONTRACTOR shall take and accept all responsibility for the character of the ground and an extra over price will be allowed if rock, debris, rubble, boulders, loose stones, running sand, water, mud, etc, are encountered; at the rates as specified in the Schedule of Quantities.
- (c) Cable trenches are to be closed as follows:
- (d) Fill with rock free river sand to a depth of 150mm, if required.
- (e) Cover with cable slabs or tiles and danger tape as detailed in PSX4.7.5, if HT cables are laid in the same trench.
- (f) Backfill with graded material and make good the surface.
- (g) Cable trenches to be marked with approved cable markers every 30 metres and at every change of direction.
- (h) All waste material shall be removed from the site and transported to an approved tip outside the depot.

##### **PSX4.7.2 Electrical Cable Sleeves**

- (a) Where the supplying only, installation only or the supply and installation of sleeves is called for in the project specification, the following requirements shall apply.
- (b) The Electrical Contractors shall install draw-wires in all cable sleeves and at least one draw wire must remain in each sleeve at the completion of the contract.
- (c) Sleeves shall be "Kableflex" and nominally 110-mm diameter for power and signal cables, unless otherwise indicated.
- (d) Unless otherwise specified, sleeves shall be laid at a depth of 600mm.

- (e) The radius of the bends used in the sleeves shall not be less than six times the diameter of the sleeve, (twelve times for XLPE cables) and the sleeve not be less than twice the sum of the cable diameters unless otherwise specified.
- (f) The sleeves shall extend at least 1m beyond each side of the road crossings and shall be effectively sealed at the ends. As a minimum one power and one signal sleeve shall be provided at each crossing.
- (g) Both ends of all sleeved crossings shall be marked by means of cable markers as elsewhere specified, labelled "Cable Sleeve".
- (h) The CONTRACTOR shall make all necessary arrangements with the CLIENT for closing sidewalks and/or half the roadway at a time, and he shall comply fully with any the CLIENT statutory requirement. The surfaces shall be made good to the satisfaction of the CLIENT Site Engineer, but where tarring or paving has to be laid or re-laid, this shall not be done until the Engineer has given the necessary approval.
- (i) Where cables cross over or pass under other services, such as water or drainpipes, they shall be run in sleeves. Where these crossings present a particular hazard to the cable, the CONTRACTOR shall draw the attention of the Engineer to any such crossing requiring special attention.

#### PSX4.7.3 Cable Sleeve Manholes

Where the Electrical CONTRACTOR is responsible for the supply of all material and the construction of cable sleeve manholes along the various cable routes, reference is to be made to the applicable detailed construction drawing and quantities specified in the Schedule of Quantities.

#### PSX4.7.4 Segregation of Telephone/Instrument/Computer Cables with Electrical Power Cables

- (a) Instrument and computer cables may be run adjacently on the same tray, trunking or conduit.
- (b) LV Electrical power cable must be separated from telephone instrument and computer cables by at least 300mm unless otherwise agreed with the Engineer.
- (c) Where telephone/instrument/computer cables cross-electrical power cables at a distance less than 0.5m, they should cross at right angles.
- (d) Reference is to be made to the method of screening and earthing cables section in conjunction with the above sub-sections.

#### PSX4.7.5 Cable Protection Slabs and Warning Tape

- (a) Except as may be required for protection between services, concrete protection slabs shall only be laid over H.T. cables unless otherwise specified. Concrete slabs shall be at least 230mm wide X 50mm thick, and laid 75mm above each cable on a bed of sand or sifted selected backfill (100mm deep compacted).
- (b) Plastic warning tape is required above all cables. The tape(s) shall cover the full width of a trench and be laid 300mm above the cable(s).

#### PSX4.7.6 Markers

Cable route, joint, sleeve, telephone and earth point markers, shall comprise of either:-

- (a) concrete blocks in the shape of truncated pyramids 300mm high, 225mm x 225mm at the base and 150mm at the top;
- (b) formed blocks 15mm above a new concrete slab.

In each case, the top shall have a 80mm x 80mm x 10mm deep recess into which a 3 - 4 mm stainless steel (316) plate containing lettering and direction arrows shall be grouted.

The lettering and direction arrows shall be engraved 10mm high x 5mm wide x 1mm deep, into the stainless steel plate prior to installation.

The lettering and direction indication shall be:-

For Power, Signal and Data Cable route markers, as applicable

**Power  
Cable**



**Signal  
Cable**



**Data  
Cable**



For cable sleeve, post office and earth point marker, as applicable

**Cable  
Sleeve**

**Telkom**

**Earth  
Spike**

**Earth  
Mat**

The markers shall be buried in the ground or built in concrete slabs directly over the cable route, joint, sleeve end or earth point, with the top protruding 15mm above the finished ground level except where they may cause obstruction, in which case the top shall be flush with the finished ground level.

Route markers shall be placed at every change of direction and at 30m intervals along straight runs.

The CONTRACTOR shall ensure that the ground under and around each marker is properly compacted.

#### **PSX4.8      Cable Lengths**

All scheduled cable lengths are for tendering purposes only and the CONTRACTOR shall measure the actual lengths required before ordering. In such cases cables lengths will be re-measured after installation and the lengths indicated in the schedule will be adjusted accordingly. The CONTRACTOR will be paid for the actual lengths measured on site and any allowance for snaking, joints or ends must be incorporated in the unit price.

Final documentation shall include "as built" cable schedules inclusive of actual lengths.

**PSX5      Electrical Equipment and Installation**

**PSX5.1      Electrical Protection Methods**

It shall be the CONTRACTOR'S sole responsibility to ensure that their entire system installation is in accordance with the codes and standards as listed in Section PSX2.1

All certified equipment used must be certified by a SANAS approval body.

**PSX5.2      Luminaires**

The luminaries, as specified in the Schedule of Quantities, must be supplied complete with electronic ballasts, lamps and fixing material, as required.

**PSX5.2.1      Existing Installations**

At the site visit, the Contractor is to identify and familiarise himself with each of the above mentioned areas and quote a lump sum price for:

- (a) electrical isolation;
- (b) dismantling of all electrical equipment including but not limited to lighting, switches, control boxes, junction boxes, etc.
- (c) removal of cabling between each facility and the source of supply unless this activity requires trenching and the breaking of concrete.

**PSX5.2.2      Typical Installations**

New Luminaire types will be installed by the Contractor within the Depot, operational areas, as quantified in the Schedule of Quantities:

**PSX5.3      Conduit**

- (a) All conduit shall carry the SABS mark of quality and approval.
- (b) Galvanised and painted, "Bosal" conduit shall be used to support individual cables on all vertical and horizontal straight runs within the SITE.
- (c) SABS approval, PVC conduit may be used within the office and general buildings and where conduit is buried or cast in concrete.
- (d) Above ground conduit shall be hot-dipped galvanised steel except final connections to thermocouple heads and solenoids, which shall be flexible.
- (e) All conduit runs shall be installed with a minimum number of bends and offsets. Generally a run of conduit containing low voltage wire shall have a maximum pulling distance of 30 metres and contain not more than 3½ quarter bends, (315 degrees total) including offsets and bends located immediately adjacent to the pull location. On runs over 30 metres, this shall be reduced to 2 quarter bends (180 degrees total).
- (f) Where bends or offsets are required, they shall be made with suitable conduit bending equipment. Uniform circular cross-section of the conduit shall be maintained at such bends. No single bend shall be greater than 90 degrees.
- (g) Couplings or other fittings shall not be installed in the curved portion of bends. Where unions are required because of bends they shall be installed at least one joint from the bend.
- (h) Pull fittings, including 90-degree elbow fittings, shall have cast covers and shall be of adequate size so that the cable can be installed without bending it on a radius less than six times the cable diameter. Exposed threads of fittings shall be painted after installation to protect against corrosion.
- (i) All pull boxes and fittings shall be installed so that covers are easily removed.
- (j) Conduits shall be cut square and reamed with a taper reamer. Rigid metallic conduit joints shall be threaded, cleaned out and made up tightly with a suitable thread compound. The compound must be a lubricant, which will provide corrosion protection and permit the joint to be disassembled at a future date. Thread compound shall not interfere with earthing continuity of conduit system.



- (k) All conduit shall be terminated with insulated or brass bushings to prevent damage to wire during pulling operations, except in enclosures where their design is adequate to prevent insulation damage.
- (l) Conduit seals must be placed in each conduit run in a classified (hazardous) area entering enclosures. The seal shall be no further than 450mm from the enclosure. In each conduit run of 50mm or larger conduit, seals shall be placed not only at the above enclosures, but also at junction boxes and fittings containing terminals, splices or taps and the seal shall be within 450mm of the box or fitting. When a conduit run, within the classified area, between two enclosures is 900mm or less in length, one seal midway between the two could be 450mm or less from either enclosure, and one seal may serve for both enclosures.
- (m) Conduits to be sealed with Green Henley Plastic Compound (GEC/ Alsthom); a fire resistant putty.
- (n) Where the sleeve is large, it is permitted to mechanically seal the sleeve with polyurethane foam prior to vapour sealing with fire resistant putty.

#### **PSX5.4     Ducting**

Within the various areas, it is necessary to install a matrix of power ducting for the supply to various small power items of equipment.

The Contractor must supply and install power ducting as itemised in the Schedule of Quantities at various heights along routes as shown. The ducting is to be supplied complete with hangers and supported at regular intervals as recommended by the manufacturers.

Power ducting shall be supplied complete with bends, elbows, ends, covers and accessories as required.

#### **PSX5.5     Cable Racking**

The Contractor shall supply and install galvanised cable ladder, Type "O-Line" or equivalent approved. "Unistrut" supporting brackets, fixtures and all material associated with the installation and supporting of the cable ladder, at intervals recommended by the manufacturer, shall be included.

The cable racking specified in the Schedule of Quantities and as represented on the appropriate drawings must be read as preliminary and subject to re-routing and subsequent re-measurement on site.

#### **PSX5.6     Junction Box Supports**

All junction box mounting and support brackets are to be manufactured from Unistrut or equivalent sections where possible. The use of welded channel or angle iron as means of manufacturing brackets will be limited to special applications only. Junction boxes must be firmly and rigidly secured to the brackets using the fastening facilities supplied by the manufacturer, taking care not to invalidate the safety classification of the junction box.

Construction must be such as to allow for the unrestricted bottom entry of cables. To comply with general specifications, the brackets are not to be secured onto pipes, cladding, vessels or onto handrails. Junction boxes shall be installed 1.4 meters above grade and in easily accessible positions. A permit will be required for any work in the hazardous area. It is advisable to complete as much preparatory work in a safe area as is practical.

#### **PSX5.7     Control Station Supports**

All control station supports must comprise a 3mm stainless steel or aluminium backing plate, predrilled and tapped (or welded nut) with a minimum of two holes per station to which the control station is fixed with either brass or stainless steel bolts.

The backing plate must be designed for fixing to a Unistrut (P9000) support and must all be uniform in design for each type of control station. (Refer appropriate subsections for details of Control Stations).

As the support of each packing plate is dependent on the application the P9000 support material has been included in the Schedule of Quantities as a total quantity.

**PSX5.8      Emergency Stop Stations**

Emergency Stop stations shall be as detailed in the SoQ; EEx 'de'; 55mm mushroom head, push, lock and twist to release action. The housing shall be a glass fibre reinforced, polyester resin, IP65 enclosure. Contacts required: 1x N/O and 1x N/C. Provision to be made for dual cable entry and EEx 'e' approved plugs provided for unused openings.

**PSX5.9      Fire Alarm Stations**

Fire Alarm stations shall be CEAG GHG 411 8100 R0002 (or equal approved), EEx de; mushroom, stay-put and pull-to-release push button action. The housing shall be a glass fibre reinforced, polyester resin, IP65 enclosure. Contacts required: 1x N/O and 1x N/C. Provision to be made for dual cable entry and EExe approved plugs provided for unused openings.

**PSX5.10     Motor Isolators**

Motor isolators (Safety Switches), as detailed in the SoQ shall be STAHL or CEAG, EEx de, Lockable. The housing shall be a glass fibre reinforced, polyester resin, IP65 enclosure. Auxiliary status contacts, provision for a Label and a PE terminal are required.

**PSX5.11     Stop/Start Stations**

Stop / Start stations shall be Type: CEAG GHG 411 8300 R0001 (or equal approved), EEx de; Dual Push Button. The housing shall be a glass fibre reinforced, polyester resin, IP65 enclosure. Contacts required: 1x N/O and 1x N/C with 1x Green indicator light, 50-250Vac/dc.

**PSX5.12     Light Switches In Hazardous Areas**

Light Switches, as detailed in the SoQ, shall be, EEx de, non-lockable. Required contacts are 1 x N/O + 1 x N/C and provision for a label and a PE terminal is also necessary.

Alternatively, a 3 pole motor isolator can be used.

**PSX5.13     Earthing**

Although provision is made in the Schedule of Quantities for the earth conductors, it must be brought to the Contractor's attention, the importance of effectively earthing ALL field equipment, junction boxes, motors, structures etc. Reference is to be made to the specific earthing drawings and cable schedules.

The Earthing infrastructure shall essentially comprise but not be limited to the following main areas:

- (a) An earth conductor between the Main Distribution Board and a local earth spike. The bare copper earth conductor is to be bonded to the MCC earth bar and the respective earth spike as detailed on the earthing layout. Earthing conductors are then reticulated to Potential Equalising Bars (PEB) for the secondary earthing function of equipment and sub-distribution boards.
- (b) All Motor Control and Distribution equipment shall be separately bonded to the PEB.
- (c) Each motor in a hazardous area shall be separately bonded to the respective PEB via an insulated secondary earth.

The Electrical Engineer will advise on the appropriate method of Earthing, whether it is:

- (a) Lightning protection
- (b) Safety earth
- (c) High quality earth

**PSX5.15 Fire Extinguishers**

The Contractor shall provide fire extinguishers as per the Schedule of Quantities in the Main MCC Room. The units and backing signage have been quantified in the Schedule of Quantities.

Allowance must be made for the supply and fixing of mounting hooks in each case.

**PSX5.16 Final Positions**

The Vendor shall agree with the Engineer the final positions, routes and methods to be used with installing all equipment and material.

**PSX5.17 Testing, Commissioning and Quality Control Procedures**

**PSX5.17.1 Factory Acceptance Tests (FAT)**

Not applicable for this contract.

**PSX5.17.2 Loop Tests, Quality Control Procedure (QCP)**

A comprehensive QCP is to be submitted by the successful tenderer upon award of contract, for acceptance. Once all checks are made the Instrumentation work will, only then, be ready for commissioning. The contractor/equipment vendor accepts full responsibility for the installation and verification of design drawings. Any loss or damage due to incorrect installation will be for the contractor/vendor's account.

**PSX5.17.3 Wet / Dry Commissioning**

Upon completion of the above mentioned QCP the contractor/vendor will then proceed with hot (Power on) dry (No product) commissioning of the installed instrumentation. Once this is successfully completed wet (product in line) commissioning can commence. Calibration of gauges, temperature transmitters and the like will form part of wet commissioning.

**PSX5.17.4 Site Acceptance Tests (SAT)**

Once wet commissioning is completed a SAT will be performed on the system to test functionality in the field. This test will resemble that of the FAT described and specified in PSX5.17.1. The SAT will be witnessed by THE ENGINEER and must form part of the formal handover.

**PSX5.17.5 Hand Over**

The handover of the system will only be made once the SAT is successfully completed and all other snag items have been rectified. This will be witnessed by THE ENGINEER.

**PSX5.18 Training**

The CONTRACTOR shall include in his price, training for up to eight (8) persons from the end-users, operational and technical personnel to fully familiarise them in the following:-

- Operation of system
- Equipment maintenance and fault finding.

The duration of the course shall be adequate to enable the trainees to take over full on-site set-up, operation and diagnostics of the system. It is recommended that the training form part of the site commissioning period on site.

**PSX5.19     Commissioning Spares**

The Vendor is to ensure sufficient commissioning spares are carried during time of commissioning. As this is a remote site the delay associated with new equipment failure may be lengthy and costly.

**PSX5.20     Certificate of Completion**

- (a) Before completion of the contract any damage, which may have been incurred during the installation, shall be repaired and made good.
- (b) A payment certificate will only be issued after completion of all notified defects (punch list) and once all test certificates called for in the Specification have been submitted and accepted.
- (c) The appropriate Certificate of Compliance as stipulated by the OHSA act shall acknowledge practical completion of works and the commencement of the period during which the appropriate contractor will be responsible for any defect.

**PSX5.21     Schedule of Technical Information**

The Tenderer should ensure that the following technical details have been adequately addressed and enclosed within the submission.

- (i) Data Sheets
- (ii) Drawings
- (iii) Block Diagram of the Infrastructure
- (iv) SABS Approvals
- (v) Project Schedule, depicting design, procurement, construction and commissioning activities
- (vi) Alternative Offers

Alternative options may be offered but the Vendor must motivate the preferred option to suit the Tender Specification.

**PSX6         Standby Generator**

Not Applicable for this contract.

## **PSX7      Motor Control & Distribution Centres**

### **PSX7.1      Scope**

This Specification together with the detail drawings and distribution board (DB) information indicated on each DB single line diagram (SLD) covers the requirements for Low Voltage Switchboards. Should the relevant DB information not be on a SLD, the onus is on the contractor to inform the ENGINEER so that corrective measures may be taken.

### **PSX7.2      General Requirements**

- (a) All equipment items including cubicles, terminal blocks, fuses, etc. shall be individually identified with clear permanent labels.
- (b) All wires shall be identified at each termination using core markers.
- (c) Each terminal shall be clearly and permanently labelled.
- (d) Cabinets shall have an insulated copper earth bar, suitably sized, to accommodate the connection of instrument cable screens and connections to the earthing system.
- (e) Input trunking from hazardous areas shall be coloured blue (if required) in accordance with intrinsic safety requirements. All other trunking shall be coloured grey.
- (f) The cabinet doors shall be lockable.
- (g) All general assembly drawings, schematic diagrams, termination schedules and power distribution drawings shall be submitted by the Client for construction.

### **PSX7.3      Standards**

Switchboards shall comply with SANS 10142-1 and SANS 1973-1/ SANS 1765, as appropriate. The, 'Form Factor' shall refer to SANS 60439.

Compliance with SANS 1973-1 shall mean that the switchboards have been tested by an independent recognised laboratory for the required short circuit levels as well as those test set out in SANS 1973-1.

### **PSX7.4      Service Conditions**

The switchboards shall be suitable for indoor installation at the SITE.

### **PSX7.5      System Conditions**

UPS Voltage	:	230 V AC 1 phase, 3 wire 50Hz
Normal power supply	:	400 V AC 3 phase, 4 wire 50Hz
Generator Power Supply	:	400 V AC 3 phase, 4 wire 50Hz
Frequency	:	50Hz
Rated short time withstanding current	:	Refer to each specific Panel

### **PSX7.6      Physical Barriers and Construction**

Depending on the Form specified functional units shall be located in their own compartments separated from each other and the busbars.

All motor control distribution centres shall be type tested and manufactured from standard and interchangeable modules (i.e. "CUBIC" panels or equivalent approved). This allows flexibility to change compartments and ensures standardisation where future additions are envisaged.

All floor-standing units shall be mounted on a plinth to allow easy access for bottom entry of cables and conduit.

### **PSX7.7      Doors and Barriers**

Each functional unit compartment and cable compartment should have their own door and shall be vermin proof.

Main busbars and vertical busbars should be provided with bolted on covers on doors.

Each door shall have adequate hinges to carry the equipment mounted on the door.

All doors with voltage and current carrying equipment should be earthed.

All normal access doors shall be fitted with a three point locking mechanism (refer Cubic system) and the remaining doors (ie. rear and sides) to be fitted with square key type locks and hinges, properly secured with a screw to prevent lateral movement.

#### **PSX7.8 Cable Securing Arrangement**

Galvanised gland plates with a minimum thickness of 3mm and a non-corrodible gasket material should be provided in each cableway.

For cables 95mm<sup>2</sup> and above, individual, robust, gland plates with a minimum thickness of 4mm should be provided.

For single core cables, non-ferrous gland plates should be provided.

All cables must be supported in such a manner that they exert no force on the point of termination.

Where stranded conductors are used, these shall be bound together by means of 'Helvin Strap' or equivalent, in groups not exceeding 10 conductors at the same potential.

#### **PSX7.9 Earthing**

Internal copper earth bars shall be adequately sized, fixed to the panel framework and shall run the full length of the panel. Provision to be made for connection to the main earth typically 70mm<sup>2</sup> and in addition the bar is to be fitted with sufficient slide-on clamps to suit the number of circuit connections.

All floors and gland plates shall be connected to the main framework by flexible, tinned copper straps.

High Quality Earth Busbars shall be mounted on stub insulators and clearly identify from the Safety Earth Busbars.

#### **PSX7.10 Degree of Protection**

The switchboard shall be designed and manufactured to the following degrees of protection as defined in SABS 60529.

Minimum degree of protection with doors open shall be IP20. Minimum degree of protection with doors closed shall be IP44.

The degree of protection between compartments shall be IP31.

#### **PSX7.11 Busbars**

- (a) Busbars shall be made of hard drawn copper of suitable dimensions and in accordance with SANS 60439-2 or SANS 1195 with regard to temperature rise at the specified altitude and mechanical strength for the rated fault levels.
- (b) The neutral busbar shall have a carrying capacity of half of that of a phase busbar. Neutral bars associated with each bank of MCCB's shall be positioned below each bank and shall be wired in the same sequence as the MCCB's.
- (c) Busbars shall be contained within their own compartment.

- (d) All jumpers between busbars and circuit breakers rated over 200 amps shall be solid copper.
- (e) All busbars shall be marked in such a way that they are easily identifiable. The following colours shall be used;

**red, white, blue - phases**  
**black - neutral**  
**green and yellow - earth**  
**green - high quality earth**

- (f) Spacing of busbars shall be calculated in accordance with SANS 60439-2 but shall not be less than 50mm. All busbar connections shall be torque tightened to comply with the manufacturer's specifications and then a drop of paint placed between the nut and protruding bolt thread. A record of all torque settings shall be furnished to the Engineer prior to testing the busbars.

#### **PSX7.12 Wire Specifications**

- (a) Power circuit wiring and interconnecting wiring in a switchboard shall be rated to the full rating of the associated equipment and not to the circuit or fuse rating.
- (b) Wire shall be general-purpose 600/1000V grade PVC insulated wire to SANS 1507.
- (c) Direct wiring onto main busbars such as current or voltage wiring shall be in a minimum of 6mm<sup>2</sup> double insulation. However cognisance must be made of the stated fault level and conductor size and insulation rated accordingly.
- (d) Control circuits shall be wired using a minimum of 1.0mm<sup>2</sup> multi strand wire.
- (e) Wiring up to 50V shall be in 0.5mm<sup>2</sup> flexible multi strands 300/500V grade PVC insulated wire in accordance with SANS 1507
- (f) Where different control voltages are used within the same MCC (i.e. PLC and UPS circuits), each control system shall be wired using different coloured insulation.

#### **PSX7.13 Wiring Colours**

Main Circuit	
L1	red
L2	white
L3	blue
N	black
PE	green/yellow
HQE	green

Control circuits		
AC Voltage 220V *	Live	Brown
	N	Blue
	Control Circuit	Grey
DC Voltage 24V	Plus	Red
	Minus	Black

\*(Regardless of whether using control transformers or direct from Mains):

#### **PSX7.14 Wire Routing**

Provision must be made to route power and particularly variable speed drive cables within separate wireways to these used for digital, analogue and communication cabling.

#### **PSX7.15 Wiring Termination**

- (a) Joints in any wiring as well as terminating of more than one conductor in one lug shall not be permitted.
- (b) Control wiring shall be terminated with pre-insulated, compression type lugs or boot lace ferrules of the correct size to match the wires.

- (c) Power wiring up to and including 6mm<sup>2</sup> shall be terminated with pre-insulated compression type lugs. Power wiring above shall be terminated with hexagonal compression type lugs when used with stud type terminals. All terminations onto busbars shall be bolted with cadmium-plated high tensile bolts, washers and nuts.
- (d) Terminals or terminating conductors associated with one circuit shall have a protection rating factor of IP 20. Those that are not shall bear a shroud so that accidental contact is impossible

#### **PSX7.16     Wiring Terminals**

- (a) The control wiring shall be terminated with pin lugs in corrosion-proof Wieland/Phoenix, 2.5mm<sup>2</sup> (min) din mounted terminals or equal approved. Stacked/multilayer terminals are not permitted.
- (b) All control wiring shall be marked using CRITCHLEY or equal approved interlocking system in accordance with the Contractors wiring diagram, placed on the cable adjacent to each connection.
- (c) All inter-panel wiring shall be brought to a common marshalling cubicle at the top/bottom of each panel and shall be interlinked with the individual motor control compartments by PVC trunking. A minimum of 30mm shall be maintained between terminals and trunking.
- (d) Separate terminal strips shall be provided at the top base of each panel to accommodate the outgoing circuits, and/or small power circuits to motors etc. Note the field side marshalling trunking must be twice the volume of the cabinet side. (Typically leave 200mm minimum space.) Bulk distribution terminals will protrude through the backplane of the associated protection device (Circuit Breaker), allowing rear termination.

#### **PSX7.17     Painting**

- (a) The paint used in all applications shall be lead free and non-toxic.
- (b) Cold rolled steel shall be properly treated. The switchboard shall be corrosion resistant. The colour of the board shall be:
  - Externally -     Light Orange     B26 to SANS 1091
  - Internally -     Structured White mounting backplanes
- (c) The board shall be epoxy coated to a minimum of 50 microns. Note: Surface spray painting of boards by the Panel Manufacturer to change the standard colour to orange will not be acceptable.

#### **PSX7.18     Labelling**

- (a) All labels shall be engraved in laminated plastic (Traffolite) with **internal** signs being black lettering on a white background and **external** signs being white lettering on black background. Danger signs being red letters on a white background. All lettering to be in English.
- (b) Labels shall be provided for the following :
  - (i) main label identifying the panel;
  - (ii) size and origin of main supply, adjacent to Main Isolator;
  - (iii) labelling indicating the short circuit rating and the busbar rating;
  - (iv) A circuit breaker cascade warning note as required by SANS 10142-1, if required;
  - (v) component labels identifying the components to the set of drawings, the label not to be fixed to a removable device;
  - (vi) Each busbar compartment - 'Flash' (WW7 of SANS 1186-1) and a label indicating maximum voltage within - i.e.(400V, 50Hz).



- (c) All labels shall be attached to the panel either by a stainless steel channelling or holder, which will allow the label to be removed in the future. Adhesive labels are not acceptable on externally mounted equipment.
- (d) A legend card, covered in Perspex shall be installed on the inside door of the distribution boards and all circuits shall be designated on this card.

## **PSX7.19 Switchgear and Accessories**

### **PSX7.19.1 General**

In conjunction with the specific details listed in this specification the total distribution requirements for the switchboard, is detailed in this document and in the drawings forming part of the contract.

The Panel Manufacturer is at liberty to make alternative suggestions relating to the conceptual requirements of this specification. However, all alternatives must be separately priced and qualified in the appropriate section of this document

All queries relating to the electrical supply and this Specification must be referred to the ENGINEER.

### **PSX7.19.2 Quality of Material**

Note that the Panel Manufacturer must complete the material schedule, attached; as the adjudication of tenders will be based on the correct design, the quality of material and quality of workmanship and not necessarily on the cheapest solution.

### **PSX7.19.3 Main Incoming Circuit Breaker / Isolator**

The main incoming isolator of each Panel shall be a three-pole unit complete with door mounted, lockable, rotary handle. Where Circuit Breakers are used, cognisance must be made of discrimination between up and downstream circuit breakers.

Suitable glanding room and glanding plates shall be provided for the type, size and number of incoming cables.

Means shall be provided for locking 'OFF' the unit

The main isolating unit shall be clearly labelled in accordance with the regulations. Where isolators are used they shall be rated for 120% (FULL LOAD), load break, fault make.

### **PSX7.19.4 Load Circuit Protection**

All motor control circuits shall be individually protected by appropriately sized motor protection circuit breakers and overload units. Distribution circuits to be protected by Curve "L" circuit breakers and the Panel Manufacturer must ensure full discrimination between up and downstream circuit breakers.

All socket outlets to be protected by 30mA earth leakage units, in accordance with SANS 767-1 and SANS 10142-1 (as amended).

Submersible pumps and any other equipment specified in the motor control data sheets must have individual, core balance earth leakage protection relays. This protection may take the form of either a combination earth leakage/circuit breaker OR may be stand-alone earth leakage unit.

### **PSX7.19.5 Contactors**

All Contactors shall comply with SANS 60947-4-1.

Contactors shall be operated electro-magnetically. A common control voltage shall be used. Contacts shall be capable of carrying 125% of the full load circuit current continuously. The contactors shall be suitable for "intermittent duty" 15 operations per hour (AC3 duty).

Contactors shall be protected by appropriately matched circuit breakers but shall be able to withstand the prospective short-circuit current at the point of installation.

Unless otherwise stated all Contactors to have a minimum of two normally open and two normally closed auxiliary contacts.

#### PSX7.19.6 Overload Relays

The overload relays shall be of the electronic or thermal type with an element in each phase and shall conform to the characteristic curve held by the manufacturer with a tolerance of +10% of the values as specified. The thermal overload selected must incorporate single phasing protection

#### PSX7.19.7 Switches and Selector Switches

Triple, double and single-pole switches shall conform to SANS 60947-3.

All switches shall be rated for load break, fault make conditions.

Voltmeter switches shall be the 'break-before-make' type and shall have an 'off' and 'six' metering positions (i.e. phase-to-phase and phase-to-neutral).

Ammeter switches shall be the 'make-before-break' type with an 'off' and 'three' metering positions.

The units shall be of identical size and mounted below the respective meters.

Selector switches shall be equal to Schneider or Siemens subject to approval and shall be mounted to the access doors. All selector switches shall have a minimum rating of 15 amps.

#### PSX7.19.8 Ammeter and Voltmeters

The meters shall be of two sizes 96mm on the incomer panels and 72 x 72mm on the secondary panels.

The meters shall be of the moving iron type and the movements shall be mounted on shock-proof suspensions.

The accuracy shall meet class 1.5 i.e. 1.5% of full scale value at each reading. The meters shall have a 90 degree scale with platform step dials and bar pointers.

#### PSX7.19.9 Time Switches

Time switches shall be of the 24-hour type, operating on the control supply with a 12-hour spring reserve. The time switches shall be mounted behind the hinged access doors. Each time switch shall be fitted with "on" stops and "off" stops in half-hour increments thereby providing up to 48 operations per 24 hours. Tenderers may use electronic timers with battery backup, provided they have, as a minimum, the above standard requirements.

#### PSX7.19.10 Timers

The timers shall be of the Schneider, Siemens or similar electronic type operating off a common control supply. The timers shall be adjustable by turning a graduated knob. They shall be mounted facing the front of the board but behind the access door. Where

practical timers shall be fitted, an integral LED must be incorporated, to define timer status.

#### PSX7.19.11 Relays

The relays shall be general-purpose din mounted type. All relays shall operate on a common control supply.

Interposing relays, for use primarily on PLC circuits must take into cognisance the switching burden of the PLC output cards. Units typically used for different applications are FINDER, OMRON or SCHNEIDER.

All relays are to be fitted with an integral LED to define relay status as well as a manual over-ride function.

Unless otherwise stated all Relays are to have a minimum of two normally open and two normally closed auxiliary contacts.

#### PSX7.19.12 Earth Leakage

All earth leakage relays shall fully comply with SANS 767-1, SANS VC 8035.

All units shall be suitable for operation at the system voltage, shall have test push buttons and, unless otherwise specified, the sensitivity of all units shall be 30mA maximum.

#### PSX7.19.13 Current Transformers

Current transformers for the LV switchgear shall be of the ring type, complying with the requirements of SANS 60044.

Current transformers for indication circuits shall be Class 5 rated dependent upon primary current. For metering applications where no supply authority specification exists, up to 200 ampere use Class 1, 250 - 600 ampere use Class 0.5 and 800 ampere and above use Class 0.2.

The current transformer ratio for all outgoing circuits shall be suitable to match the rating of the circuit.

#### PSX7.19.14 Switchboard Heaters (Where Specified)

Tubular type heater shall be mounted near the base of each tier of the various switchboards to limit corrosion due to moisture. The heaters in each switchboard shall be controlled by a suitably rated circuit breaker.

#### PSX7.19.15 Indication Lamps

Indication lights will be cluster LED panel indication lamps and shall follow the following colour guide:

Colour	Function
Green	'Running' or 'On' or 'Energised'
Red	'Stopped' or 'Off' or 'De-Energised'
Amber	'Alarm' or 'Failure'
Blue	'Status' or 'Step'
Others	As instructed

#### PSX7.19.16. Instruments, Meters, Relays and Ancillary Equipment

All instruments, circuit breakers, meters, relays etc. shall be of consistent manufacture (i.e. uniform product for each type of equipment)

The Panel Manufacturer shall be responsible for the supply and installation of all equipment, the re-termination of all existing wiring and the glanding of all cables, as detailed in the cable schedule.

**PSX7.20 Marshalling Cubicles**

- (a) The standards philosophy in all distribution, motor control, standby generator, uninterruptible power supply, programmable logic controller, etc. cubicles is that no field wiring must terminate directly onto control/protection equipment.
- (b) Consequently a discrete marshalling section for each service is to be provided to meet the present cabling requirements and allow 30% spare capacity.
- (c) Spare capacity implies that wireways, ducting, terminals and equipment supports must be provided for future use noting the de-rating of conductors within close proximity.
- (d) Marshalling cubicles are to be structured with incoming and outgoing, finger type PVC ducts on either side of a central marshalling rail. The marshalling rail will then be clearly marked and segregated based on the functionality.
- (e) The marshalling components i.e. terminals, fused terminals, interposing relays, etc. must be of similar manufacture (i.e. Phoenix / Legrand).
- (f) All components and wiring within the marshalling section shall be clearly identified/tagged and cross-referenced to the 'as-built' drawings.

**PSX7.21 Balancing Of Load**

The Panel Manufacturer is to design the internal circuitry in such a manner that the Electrical Contractor can balance the load as equally as possible over the multi-phase supplies.

**PSX7.22 Power Factor Correction**

**PSX7.22.1 General**

Where PF correction system are required and as detailed in the drawings they must be installed in dedicated enclosures. If there are space constraints, the Panel Manufacturer must qualify any alternatives to meet the specification.

**PSX7.22.2 P.F. Controller**

The PF Controller used must be similar or equal to the Nokian unit's functionality. The Panel Manufacturers may recommend alternative units with self checking and correcting functionality and remote alarm voltage free contacts. The Unit offered must be specified in the Material Schedule.

**PSX7.22.3 Capacitors**

Capacitors used for power factor connection purposes shall be sealed type Nokian; 440V or equivalent approved; complete with discharge resistors. Inductance coils (typically 5 off turns of each phase conductor) must be installed between the contactor and capacitors to reduce the change of current ( $di/dt$ ).

No equipment may contain Polychlorinated Biphenyl (PCB).

**PSX7.22.4 Fuses**

Fuses shall be rated for the capacitor steps and are typically 1.6 to 1.8 times the full load amp rating of the capacitors.

Fuse failure detection must comprise a 0.6A Motor Circuit Breaker connected in parallel with the fuse base. In the event of a blown fuse/capacitor failure the Breaker would trip on overload, generate a common alarm indication, electrically prevent the associated contactor from re-energising and provide a voltage free contact for remote alarm indication.

**PSX7.22.5 Contactors**

All contactors for PF control must be rated for a minimum AC3 duty.

**PSX7.23 Emergency Stop**

Whether remotely operated or door mounted, provision is to be made within each group of panels for discrete E/Stop control circuitry with the following functionality.

- a) Latching E/Stop requiring a MANUAL or AUTOMATIC RESET action, depending on the mode of operation.
- b) Interposing relays, specifically designed for E/Stop reliability shall provide sufficient auxiliary, voltage free, contacts for motor stop circuits and no volt release of designated power circuits and PLC status.

Note all control circuits are to be configured 'fail safe'.

**PSX7.24 Uninterruptible Power Supply**

In addition to the 'MAINS' and 'STAND-BY' supplies a 2 KVA, 1ph, 240V uninterruptible power supply (U.P.S.) is required for the following functions:-

- (i) All computer and peripheral devices
- (ii) All instrumentation
- (iii) All tank HI/LO Level Alarms
- (iv) Emergency stop functions and alarms

Reference is to be made to the accompanying drawings for those circuits connected to the U.P.S. system.

The Panel Manufacturer shall be required to incorporate a discrete U.P.S. 1Ø + N + E busbar system and distribution cubicle within the appropriate boards.

**PSX7.25 Intrinsically Safe (I.S.) Cubicle**

An Intrinsically Safe Barrier is a device, which limits the power (energy) which can be delivered from a safe area into a hazardous area.

To be assured of compliance with an I.S. installation, all equipment used must be approved by a recognised Agency and comply with any equivalent SABS specification. Suppliers of the equipment specified in the detailed drawings must provide the Panel Manufacture with the appropriate documentation.

All wiring must be checked and approved by the Engineer prior to field commissioning.

The exterior door of the I.S. cubicle(s) shall be painted blue. (Colour ref. number to be defined by Engineer at later stage).

**PSX8 MATERIAL SCHEDULE**

Reference is to be made to the Specific Engineering Data Sheets which stipulate the type of equipment permitted in this Contract. The Tenderer is to stipulate, **with the Tender submission**, which equipment has been selected from the preferred list of equipment.

ITEM	MATERIAL	MAKE OR TRADE NAME	IS MATERIAL TO SPECIFICATION?
1.	Single, double and triple pole circuit breakers.		
2.	Earth leakage relay 30mA double pole.		
3.	Contactors		
4.	Relays		
5.	Overload units		
6.	Ammeters		
7.	Voltmeter		
8.	Indication lamps		
9.	Selector Switches		
10.	Push Button Switches		
11.	Terminals		
12.	Timers		
13.	Power Factor Capacitors		
14..	Power Factor controller		
15.	Emergency Stop Buttons		
16.	Surge Suppression		
17.	Interposing Relays		
18.	Current Transformers		
19.	Switchboard System (to SANS 1973-1 if over 10kA)		

The above equipment and materials offered shall comply with the Specification in all respects and the Engineer reserves the right to instruct the Contractor, during the course of the contract, to change any equipment and materials, to meet the above requirement, without further cost implication.

.....  
DATE

.....  
SIGNATURE OF TENDERER

#### **PSX13.5.1 Training**

Training will be done during the commissioning phase of the project. Once site installation, termination and testing are complete, the Depot personnel will take over the operation of the system with immediate effect.

Once the site has been handed over and is run by Operations personnel, training may still take place when support is required. Problem identification and solving can be done via the telephone and modem, but rather than blindly resolving all issues, the emphasis is on training and explaining the causes of certain conditions and how the problems can be traced and resolved.

#### **PSX13.5.2 Site Acceptance Testing (SAT)**

Once all equipment has been configured and tested, a SAT will be held to allow the Client Project Manager and other key Client personnel (as defined by the Client Project Manager and Depot Manager) to assess the operation of the system and approve its use.