

**Section K      Standard Electrical Specifications**

**CONTENTS**

<b>NO</b>	<b>DESCRIPTION</b>	<b>PAGE</b>
E200.1	SCOPE OF WORK	K3
E200.2	ELECTRICITY SUPPLY	K3
E200.3	GENERAL	K3
E200.4	COMPLIANCE WITH REGULATIONS AND STANDARDS	K3
E200.5	STANDARD SPECIFICATIONS	K4
E200.6	BUILDER'S WORK	K9
E200.7	DRAWINGS, MANUALS, LITERATURE, TUITION, SPARES AND TOOLS	K10
E200.8	INSPECTION, TESTS AND COMMISSIONING	K13
E200.9	FIRE EXTINGUISHERS. FIRST AID KITS DANGER AND INSTRUCTION SIGNS FOR SUBSTATIONS	K17
E200.10	NAMEBOARDS	K18
E201	MATERIALS	K18
E202	FINISHING AND PAINTING OF MATERIALS AND EQUIPMENT	K19
E203	CONDUIT AND CONDUIT FITTINGS	K20
E204	LOW VOLTAGE SWITCHBOARDS & MOTOR CONTROL CENTRES	K24
E205	BUSBARS IN BUILDINGS	K30
E206	CURRENT TRANSFORMERS	K32
E207	LOW VOLTAGE MOTOR CONTROL GEAR	K33
E208	LOW VOLTAGE POWER CABLES	K34
E209	MEDIUM VOLTAGE CABLES	K36
E210	INSTRUMENTATION AND METERING	K40
E211	EARTHING	K43
E212	EARTH BAR	K46
E213	EARTH ELECTRODES	K46
E214	CABLE TRUNKING	K47
E215	CABLE TRAYS	K49

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<b>NO</b>	<b>DESCRIPTION</b>	<b>PAGE</b>
E216	PVC WIRING	K50
E217	WALL SWITCHES AND SOCKET OUTLETS	K51
E218	INTERIOR LUMINAIRES	K53
E219	INSTALLATION OF INTERIOR LUMINAIRES	K55
E220	POWER FACTOR CORRECTION EQUIPMENT	K56
E221	VOLTAGE TRANSFORMERS	K60
E222	MV SWITCHGEAR	K61
E223	CIVIL WORKS ASSOCIATED WITH THE INSTALLATION OF UNDERGROUND CABLES	K67
E224	VARIABLE SPEED DRIVES (VSDs)	K74
E225	SOFT STARTERS	K77
E226	LOW VOLTAGE ELECTRIC MOTORS	K80
E227	AIR CIRCUIT BREAKERS	K81
E228	MOULDED CASE SWITCHGEAR	K82
E229	AIR BREAK SWITCHGEAR (FUSE SWITCHES AND FUSES)	K83
E230	ARMoured LOW VOLTAGE CABLES	K84
E231	POWER SKIRTING TRUNKING SYSTEM	K86
E232	WIRING TRAYS AND DRAW IN BOXES	K87
E233	LIGHTNING PROTECTION FOR BUILDINGS	K88
E234	PHOTO ELECTRIC CELLS	K90
E235	NON MAINTAINED EMERGENCY LIGHTING	K91
E236	AUTOMATIC EARLY WARNING FIRE AND SMOKE DETECTION SYSTEM	K91
E237	CONNECTIONS TO MOTORS	K96
E238	CAST RESIN TYPE POWER TRANSFORMERS	K98
E239	POWER METER	K101

## **E200.1 SCOPE OF WORK**

- 1.1 The scope of work for the electrical portion of the works is set out in the Detail Specification, Drawings and bill of quantities.
- 1.2 These shall be read in conjunction with the standard specifications. In the event of conflict of meaning the detail specification shall take precedence over the standard specifications

## **E200.2 ELECTRICITY SUPPLY**

- 2.1 The electricity supply will be made available by the Supply Authority as described in the detail specification. The Contractor shall ensure that the installation complies with the Supply Authority's requirements.
- 2.2 Where specified in the detail specification the Contractor shall make application for the electricity supply, liaise with the Supply Authority to plan and coordinate work and regarding protection settings

## **E200.3 GENERAL**

### **3.2 Definitions**

- 3.2.1 *Extra low voltage* refers to voltages of 50 V or less
- 3.2.2 *Low voltage* refers to voltages above 50 V but not above 1 000 V
- 3.2.3 *Medium voltage* refers to voltages above 1 000 V but not above 35 000 V
- 3.2.4 *Supply* shall mean manufacture, procure, store off site as necessary, deliver to site and off-load, position, stack and store on site as necessary.
- 3.2.5 *Install* shall mean set out, erect, mount, align, fix, connect, adjust, test, commission and hand over in proper working order.
- 3.2.6 *Provide* shall mean supply and install.
- 3.2.7 *Installation* shall mean the electrical installation described by this document
- 3.2.8 *Approved* shall mean acceptable to the Engineer in the sole opinion of the Engineer

## **E200.4 COMPLIANCE WITH REGULATIONS AND STANDARDS**

- 4.1 The electrical installation shall comply with the latest revisions and amendments of the following:
  - 4.1.1 The SANS Code of Practice for the Wiring of Premises, SANS 10142 referred to herein as the Wiring Code.
  - 4.1.2 The Occupational Health and Safety Act and Regulations (Act No 85 of 1993) in its entirety.
  - 4.1.3 The Municipal By-laws and Regulations and any regulations of the electrical supply authority.
  - 4.1.4 The regulations and requirements of the Local Fire Office.
  - 4.1.5 The standard regulations of any Government Department or other statutory body where applicable.
- 4.2 No claims for extra costs arising from failure of the Contractor to comply with any of the regulations and standards listed above will be considered.
- 4.3 Where conflict appears to exist between any of the regulations and standards listed above such conflict shall be referred to the Engineer for his ruling.
- 4.4 Immediately after award of the contract and at any time thereafter as may be necessary the Contractor shall notify the relevant authorities of intention to proceed with the works and shall pay any fees due to the authorities and take any other steps required to comply with the authorities' requirements.

The Contractor shall copy related correspondence to the Engineer.

## E200.5 STANDARD SPECIFICATIONS

All equipment and materials shall conform to the latest revisions of the relevant SANS, NRS or IEC Specifications. For equipment and materials not covered by the following table reference shall be made to the list of normative references in SANS 10142.

DESCRIPTION	SANS	IEC	NRS
<b>1. SWITCHGEAR AND CONTROL GEAR</b>			
1.1 MV switches for rated voltages above 1 kV and less than 52 kV	60265-1		
1.2 AC metal enclosed switchgear and control gear for rated voltages above 1 kV and less than 52 kV	62271-200		
1.3 HV a.c. switch fuse combinations	62271-105		
1.4 HV a.c. contactors and contactor based motor starters	60470		
1.5 Common specifications for HV switchgear and control gear standards	60694		
1.6 a.c. insulation –enclosed switchgear and control gear for rated voltages above 1 kV and less than 52 kV	62271-201		
1.7 Metal-enclosed switchgear for rated a.c. voltages above 11 kV and up to and including 36 kV	1885		
1.8 HV a.c. circuit breakers	62271-100		
1.9 Metal-clad switchgear for rated voltages above 11 kV and up to and including 24 kV - Part 2 : Standardized panels			003-2
1.10 Moulded-case circuit breakers	156		
1.11 LV switchgear and controlgear assemblies - Part 1: Type-tested and partially type-tested assemblies above 10 kA	1973-1 60439-1		
1.12 LV switchgear and controlgear assemblies - Part 2: Busbar trunking systems	60439-2		
1.13 LV switchgear and controlgear assemblies — Part 3 : Type-tested and partially type-tested assemblies up to and including 10 kA	1973-3		
1.14 LV switchgear and controlgear assemblies — Part 8 : Safety of MTAs above 10 kA	1973-8		
1.15 LV switchgear and controlgear assemblies - Part 5: Particular requirements for assemblies intended to be installed outdoors in public places - cable distribution cabinets	60439-5		
1.16 LV switchgear and control gear-Part 2: Circuit breakers	60947-2		
1.17 LV switchgear and controlgear - Part 3 : Switches, disconnectors, switch-disconnectors and fuse-combination units	60947-3		

1.18	LV switchgear and controlgear - Part 4 - 1: Contactors and motor starters (electro-mechanical) Part 4 - 2 : Contactors and motor starters (semi-conductor) Part 5-1 : Electromechanical control circuit devices Part 5 - 2 : Proximity switches Part 5 - 5 : Electrical emergency stop device with mechanical latching function Part 6 - 1: Automatic transfer switching equipment	60947-4-1 60947-4-2 6097-5-1 60947-5-2 60947-5-5 60947-6-1		
1.19	Earth-leakage protection units - Part 1 : Fixed earth-leakage protection circuit breakers	767-1		
1.20	RCCBs without integral overcurrent protection for household and similar use - Part 1: General rules	61008-1		
1.21	Switches for appliances - Part 1: General requirements	61058-1		
1.22	AC disconnectors and earthing switches above 1 kV	62771-102		
1.23	Busbars	1195		
1.24	Metal-enclosed ring main units for ac voltages 1 kV to 24 kV	1874		
<b>2.</b>	<b>TRANSFORMERS AND MINISUBS</b>			
2.1	Power transformers	60076		
2.2	Dry-type power transformers		60726	
2.3	Distribution transformers	780		
2.4	Semiconductor converters - Part 1 - 3 : General requirements and line commutated converters - Transformers and reactors	60146-1-3		
2.5	Convertor transformers - Part 1: Transformers for industrial applications	61378-1		
2.6	Safety of power transformers, power supply units and similar Part 2-4: Particular requirements for industrial applications Part 2-6: Particular requirements for safety isolating transformers in general use Part 2 - 15 : Particular requirements for isolating transformers for the supply of medical locations	61558-2-4 61558-2-6 61558-2-15		
2.7	Miniature substations	1029		

DESCRIPTION		SANS	IEC	NRS
<b>3.</b>	<b>CABLES</b>			
3.1	The selection, handling and installation of electric power cables of rating not exceeding 33 kV (Parts 1 to 14)	10198		
3.2	Impregnated paper-insulated metal-sheathed cables for rated voltages 3,3 kV to 33 kV	97		
3.3	XLPE-insulated cables for voltages from 6,6 kV to 33 kV	1339		
3.4	Paper-insulated metal-sheathed cables for voltages up to 18/30 kV - Part 1 : Test on cables and their accessories - Part 2 : General construction requirements		6055-1 6055-2	
3.5	Electric cables with extruded solid dielectric insulation for fixed installations (300 / 500 V to 1900 / 3300 V)	1507		
3.6	Flexible electric cables for use in mines - Part 1: LV (640/1100 V and 1900 / 3300 V) - Part 2 : HV (6,6 kV to 33 kV)	1520-1 1520-2		
3.7	Flexible cords and cables	1574		
3.8	Materials of insulated electric cables and flexible chords (Parts 1 to 7)	1411		
3.9	Mechanical cable glands	1213		
3.10	Single core arc welding cable	1576		
3.11	Lugs and ferrules for insulated electric cables – Part 1: copper conductors	1803-1		
3.12	Power cables with extruded insulation and their accessories from 1 kV to 30 kV – Part 4 : Test requirements on accessories	60502		
<b>4.</b>	<b>CURRENT AND VOLTAGE TRANSFORMERS</b>			
4.1	Instrument Transformers Part 1: Current transformers Part 2 : Inductive voltage transformers Part 3 : Combined transformers Part 5 : Capacitive voltage transformers	60044-1 60044-2 60044-3 60044-5		
<b>5.</b>	<b>EARTHING AND LIGHTNING / SURGE PROTECTION</b>			
	Earth rods and couplers	1063		
	Design and installation of an earth electrode	10199		

	Neutral earthing in MV industrial power systems	10200		
	Protection of structures against lightning	10313		
	Protection against lightning			
	Part 1 : General principles	6305-1		
	Part 2 : Risk management	6305-2		
	Part 3 : Physical damage to structures and life hazard	6305-3		
	Part 4 : Electrical and electronic systems within structures	6305-4		
5.6	Surge protective devices connected to LV power distribution systems - Part 1 : Performance requirements and testing methods	61643-1		
5.7	Surge arrestors - Part 1: Non-linear resistor type gapped surge arrestors for a.c. systems	60099-1		
5.7	Surge arrestors - Part 4 : Metal-oxide surge arrestors without gaps for a.c. systems	60099-4		
<b>6.</b>	<b>METERS, INSTRUMENTS AND RELAYS</b>			
6.1	Meter cabinets	60439-5		
6.2	Electrical instruments and meters		60051	
6.3	a.c. electromechanical watt-hour meter	62052-11		
6.4	Electrical relays-Part 3: Single input e with energizing quantity measuring relays with dependent and independent time		60255-3	
6.5	Electrical relays-Part 20: protection systems		60255-6	
6.6	Watt-hour meters-a.c. electronic meters for active energy	1799		
6.7	Electricity metering equipment-static meters	62053-21 to 23		
<b>7.</b>	<b>CAPACITORS</b>			
7.1	Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V			
	Part1: General-Performance, testing and rating-safety requirements-Guide for installation and operation	60871-1		
	Part 2: Endurance testing	60871-2		
	Part 3: Protection of shunt capacitors and shunt capacitor banks	60871-3		
	Part 4: Internal fuses	60871-4		
7.2	Shunt power capacitors of the self-healing type for a.c. systems having a rating up to and including 1 000 V			
	Part 1: General-Performance, testing and rating-Safety Requirements-Guide for installation and testing	60831-1		

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**E200.6 BUILDER'S WORK**

**6.1 Building and casting in**

The Contractor shall be responsible for placing in position all wireways, conduits, conduit boxes etc. for the building contractor to build or cast in, shall provide attendance on the building contractor during building or casting in and shall ensure firm fixings acceptable to the building contractor and accurate positioning.

**6.2 Chasing**

- 6.2.1 The Contractor shall chase only where it is impossible to build in or cast in.
- 6.2.2 No face brick or finished surface may be chased without the permission of the Engineer and the building contractor
- 6.2.3 No structural concrete may be chased without the permission of the Engineer.
- 6.2.4 The building contractor will make good all chases and openings in building work.
- 6.2.5 The Contractor will be held responsible for any damage caused by him to the building work or any other service.

**6.3 Ducts, Sleeves and Openings**

- 6.3.1 The Contractor shall provide co-ordination between various service providers with the installation of ducts, sleeves, manholes, openings and any other building work associated with the electrical installation to ensure correct and accurate positioning.
- 6.3.2 No openings or cuts may be made in structural concrete without prior permission of the Engineer.



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## **E200.7 DRAWINGS, MANUALS, LITERATURE, TUITION, SPARES AND TOOLS**

- 7.1 The Engineer's drawings covering the various sections of the installation are listed in the schedule of drawings. The working drawings of the Contract shall, however, consist of the following, where applicable:
- 7.1.1 The Engineer's drawings;
  - 7.1.2 The Architect's drawings;
  - 7.1.3 The Structural Engineer's drawings;
  - 7.1.4 The Engineer's drawings of the other disciplines, as applicable
  - 7.1.5 The drawings of other services installations that are relevant for co-ordination and installation.
  - 7.1.6 The installation drawings of other Contractors and Subcontractors where applicable.
  - 7.1.7 The Contractor's construction drawings as discussed below.
- 7.2 Unless otherwise specified, three sets of the Engineer's drawings will be issued to the Contractor for construction purposes. Any further copies may be purchased from the Engineer
- 7.3 The Contractor shall submit one set of construction drawings to the Engineer for examination and to demonstrate compliance with the Contract. Construction drawings shall include drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are prepared by the Contractor, Manufacturer, Supplier or Distributor and shall, together, illustrate the entire electronic component of the work. No part of the works shall be installed before construction drawings representing that portion of the works have been submitted to the Engineer, the Engineer has reviewed these and has given the Contractor permission to proceed.
- The Engineer's examination of construction drawings or samples shall not relieve the Contractor of responsibility for any deviation from the requirements of this Contract unless the Contractor has informed the Engineer in writing of such deviations at the time of submission of shop nor shall the Engineer's examination relieve the Contractor of responsibility for errors or omissions in the shop drawings or samples or for responsibility for erection or installation fit.
- 7.4 The Contractor shall submit to the Engineer one copy of marked-up structural drawings, or other drawings, showing changes and/or additional requirements to be made in the structure in order to accommodate equipment installed under this Contract.
- 7.5 The Contractor will not be allowed to rely on the Engineer for as-installed information which he may have compiled, to produce record drawings.
- 7.6 Drawings to be entitled "Record!" shall bear the signature of the Contractor, or his authorised representative, and the date.
- 7.7 The Contractor shall obtain from the Engineer, if available, a CD containing the Engineers' drawings, which have been drawn on a PC-based CAD system for the preparation of record drawings to be provided by the Contractor. One set of paper prints of the record drawings shall be provided for verification by the Engineer. A CD containing the record drawings shall be provided upon completion of the contract. Otherwise the Engineer will issue a set of Engineer's drawings to the Contractor at completion of the installation. The Contractor shall mark these drawing to indicate the record of the installation.
- 7.8 A set of final layout and schematic record drawings shall be provided in a purpose made holder inside the door of each distribution board and motor control centre, or where no doors are fitted, to the front plate of the cabinet. The frame shall be adequately sized to receive the equivalent of two A1 size drawings folded to a nominal size of A4.  
For MV switchboards, MCCs and Main LV distribution boards the Contractor shall provide laminated as-

- built drawings of single-line diagrams in aluminium/wooden frames fixed to the wall of the room housing the switchboards/MCCs
- 7.9 The Contractor shall submit to the Engineer three (or quantity as specified in the Detail Specification') manuals bound between hard covers including the following :-
- 1) Dimensioned +drawings of the layout of the equipment and systems.
  - 2) Wiring diagrams cross referred to the drawings described above, and to the Engineer's layout drawings and single-line diagrams.
  - 3) All Test Certificates for tests done at the factories and on the site.
  - 4) System and equipment descriptions.
  - 5) Operating instructions.
  - 6) Maintenance, adjustment and calibration instructions with preventive maintenance schedule and fault-finding procedures.
  - 7) Spare parts list with names and address of component suppliers and price list of all components and a list of recommended spare components to be kept in stock.
  - 8) The contractor shall submit preliminary copies of the manual to the Engineer for scrutiny.
- 7.10 The Contractor shall provide thorough tuition of the employer's staff in the operating and maintenance of the plant forming part of the Works.
- 7.11 When specified in the detail specification the Contractor shall allow in his price for photographs to be taken with a digital camera on a monthly basis, for the duration of the Contract, of all the areas and plant forming part of the Works. The photographs shall be properly dated with comments e.g. access to substation not possible etc. A CD with the photographs shall be handed each month to the Engineer at the site meeting. These photographs may be used for the evaluation of claims.
- 7.12 The Contractor shall provide all tools required for operating and/or maintaining the Works as specified in the applicable Standard Specification and the Detail Specification
- 7.13 Drawings to be supplied by the Contractor as described in Standard Specification E200.7 shall conform to the requirements indicated below.
- For all construction drawings for switchboards (DBs, Control Panels, Instrumentation Junction Boxes etc.), the following information shall be shown:
1. Project Name and Contract number
  2. Manufacturer/Supplier
  3. Consulting Engineer and contact person
  4. Client details
  5. Drawing Number and Revision

6. Drawing to be Signed
7. Source of Supply – MCC or transformer name etc
8. Switchboard General Description
9. Fault level (kA and time rating)
10. Form factor/Sectioning
11. Busbar Details (cross-section, material type, tinned etc)
12. Busbar Support Details - type, manufacturer
13. Earth bar details (cross-section, full-length, front or rear etc)
14. Switchboard Material type, grade, thickness etc.
15. Gland Plate details - material type, thickness, mounting etc
16. Colour internal and external
17. Switchboard Dimensions
18. Base Dimensions and bolting arrangements
19. Front door details - hinge and padlock requirements
20. Rear door details - hinge and padlock requirements
21. End panel details - removable cover details
22. Door details - Stiffeners and restrainers installed etc.
23. Hinge Details
24. Locking Details
25. Handle Details
26. Cable Entry Details
27. All bolts, nuts, screws material type (I.e. 316 Stainless Steel)
28. Equipment details CB ratings, fault levels, type, manufacturer
29. Equipment Layout details - Cubicle name, function, equipment function etc)
30. Indication Light colours
31. Section through switchboard

For all schematic drawings for switchboards (DBs, Control Panels, Instrumentation Junction Boxes etc.), the following information shall be shown:

1. Project Name and Contract Number
2. Manufacturer/Supplier
3. Consulting Engineer and contact person
4. Client details
5. Drawing Number and Revision
6. Revision details to be listed

7. Drawing Page Number
8. Drawing to be Signed
9. Reference Grid required on each schematic page
10. Source of Supply MCC or transformer name etc
11. Fault level (kA and time rating)
12. Voltages for all circuit to be clearly indicated
13. All devices to have reference number i.e. relays
14. Equipment ratings to be given i.e. motor ratings
15. All indication lamps to be labelled including required lamp colour
16. Legend to be provided

#### **E200.8 INSPECTION, TESTS AND COMMISSIONING**

- 8.1 On completion of erection and installation on site the Contractor shall perform all the tests that may be required by the Engineer in his presence to ensure that the Works are ready for handing over and putting into regular use.
- 8.2 Near completion, inspect and test the services installation in accordance with the Wiring Code, the Regulations of the Supplier of Electricity and the Occupational Health and Safety Act 85/1993. Record test results on printed test sheets and submit to the Engineer.
- 8.3 Testing of the electrical installation shall be in accordance with the Detail Specification, but shall include the following:
  - Ensure correct polarity, phase rotation and balance load between the phases. Verify polarity and phase identification.
  - Continuity and resistance of earth conductor including all bonding conductors.
  - Continuity of ring circuit.
  - Earth electrode resistance.
  - Insulating resistance.
  - Earth fault loop impedance test.
  - Operation of earth leakage protection devices and circuit breakers.
- 8.4 After inspection and testing, timeously arrange for any inspection and test by the Supplier of Electricity if required, and assist as necessary the Inspector of the Supplier of Electricity by providing access, tools, instruments and attendance.
- 8.5 Replace any portion of the electrical installation that does not comply with the Wiring Code or the Specification. Such replacement shall be done at the Contractor's expense.
- 8.6 Submit a "Certificate of Compliance by an accredited person" Annexure I in terms of the Occupational Health and Safety Act 85/1993, Electrical Installation Regulation 1992, to the employer and forward a copy to the Engineer.

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- 8.7 Carry out additional special tests as required by the Engineer and provide the required test equipment.
- 8.8 Timeously advise the Engineer of all inspections and tests as the Engineer reserves the right to witness such inspections and tests.
- 8.9 Provide access, tools, instruments and attendance, to assist the Engineer who may perform verification tests at any time.
- 8.10 The Engineer shall have the power at any time to examine any part of the Works or materials intended for use in or on the Works either on site, or at the place of manufacture or storage.
- 8.11 On completion of the works, the Contractor shall submit one indexed volume of all test certificates to the Engineer for tests done at factories and on site. (To be included in the manuals).
- 8.12 The Contractor shall be responsible to calculate all relay settings. The settings shall be submitted to the Engineer for approval at least two weeks before the commissioning of the works commences. The settings shall be substantiated by calculation sheets and graphs where applicable
- 8.13 The Contractor shall check that all protection relays and overload devices are properly set to protect equipment such as motors, cables and capacitors ,etc., before the system is energised or any motors are switched on. Where overload devices are overrated or the ranges of relays insufficient to protect equipment, the Engineer shall be informed and the equipment shall not be energized.

**8.14 INSPECTIONS, TESTS AND COMMISSIONING WITH REFERENCE TO MATERIAL AND EQUIPMENT.**

**8.14.1 FACTORY TESTS AND INSPECTIONS**

The manufacturer shall perform all routine tests in the factory as described by SANS, IEC and/or I3SS as well as the manufacturers own standard routine tests on all materials, equipment and auxiliary equipment. Type tests shall be performed as described in the relevant equipment specifications.

The Contractor shall submit a list of tests and inspections to be performed on the equipment for approval.

The Contractor shall perform any additional standard tests that may be required by the Engineer.

The Engineer shall indicate which tests shall be witnessed by the Engineer.

The Contractor shall submit four copies of the test certificates with the test results of all the tests performed to the Engineer not later than the delivery date of the equipment.

**8.14.2 SITE TESTS**

On completion of erection and installation on site the Contractor shall perform all the tests that may be required to ensure that the Works are ready for handing over and putting into regular use.

Contractors shall provide their own test equipment which shall be of accepted standards.

The Contractor shall submit a list of tests and inspections to be performed on the equipment for approval.

The Contractor shall perform any additional standard test that may be required by the Engineer.

All the tests shall be witnessed by the Engineer.

Four copies of site test certificates shall be submitted to the Engineer within 7 days after completion of each test.

The tests listed below shall be carried out on Site by the Contractor and witnessed by the Engineer. Costs of all testing shall be included in the rates submitted in the bills of quantities.

**B6.2.1 MV Switchgear**

- Visual checks (including paintwork)
- Insulation resistance measurement
- Checking of protection scheme and related equipment
- One minute power frequency voltage test (at reduced voltage applicable)

**B6.2.2 Ring main units**

- Mechanical operation
- One minute power frequency voltage test (at reduced voltage applicable)
- Insulation resistance measurement
- Verification of wiring
- Dielectric testing of auxiliary circuits

**B6.2.3 Transformers**

- Dielectric testing of auxiliary circuits
- Insulation resistance measurement
- One minute power frequency voltage test (at reduced voltage applicable)

**B6.2.4 LV Switchboards/gear**

- visual checks (including paintwork)
- impedance measurements
- Insulation resistance measurement
- current and voltage transformer tests
- proving of protection scheme
- high voltage tests
- circuit breaker operation tests
- control scheme test
- load testing

**B6.2.5 MV Cables**

- insulation resistance measurement
- high voltage tests/high potential test

#### B6.2.6 LV Cables

- insulation resistance test (after jointing and termination)
- phase rotation test (after jointing and termination)

#### B6.2.8 Earthing

- earth resistivity measurements
- earth electrode resistance measurements
- bonding conductor continuity tests

### 8.14.3 ARRANGEMENTS FOR WITNESSING TESTS

The Contractor shall make arrangements with the Engineer for tests to be witnessed.

Timeous (at least two weeks, or as specified in the Project Specification') notice shall be given to avoid undue delays in the completion of tests.

Arrangements for tests on site shall be made only after the Contractor has pre commissioned the equipment and satisfied himself that it is in running order.

### 8.14.4 Operation and Maintenance Manual

Two copies of the O & M Manual shall be issued to the Engineer prior to commissioning of the Works, and the Trial Operation Period shall not commence until the manual has been issued.

Before the Taking-over Certificate is issued (after the successful completion of the Trial Operational Period) six copies of the final approved version of the O & M Manual shall be issued to the Engineer.

The manual shall be of a standard acceptable to the Engineer and shall be subject to his approval. At least one (or one set) shall contain original copies.

Binders with hard plastic covers and four-ring spring clip holders shall be used. Binders shall not be over-filled to allow use without damage to the contents.

Manuals shall be in English only, with sections of equipment arranged by labelled dividing separator sheets.

Comprehensive indexes shall be included, with separate sections (with their own index) where required, as follows:

- (a) Details of the electrical equipment supplied including the name and address of the supplier, and descriptive and technical literature, giving performance and service information.
- (b) Full details of control and protection systems including logic sequence charts, logic controller programs, trip settings, etc.
- (c) Circuit diagrams
- (d) Dimensioned panel layout drawings.

- (e) Cable schedules for power and instrumentation cables. This shall include the cable type, start and finish points, route length, duty load, size, voltage drop, number of cores, number of cores used and gland size.
- (f) Record (as-built) drawings referenced to the above. As-built drawings shall be provided by the contractor. Cable routes to be surveyed on layout drawings
- (g) Recommended short term and long term spares list.
- (h) A comprehensive schedule of routine maintenance by time period for the system as installed.



**E200.9 FIRE EXTINGUISHERS. FIRST AID KITS DANGER AND INSTRUCTION SIGNS FOR SUBSTATIONS**

**9.1 Fire Extinguishers**

- 9.1.1 Unless otherwise specified, 5 kg type fire extinguishers or nearest standard sizes offered by manufacturers, shall be supplied for substation building.
- 9.1.2 Fire extinguishers shall be of the CO<sub>2</sub> type or of a type approved for the fighting of fires where electrical apparatus and oil fires are involved.
- 9.1.3 Unless otherwise specified, fire extinguishers shall be provided as follows :
- Medium voltage switchrooms: one extinguisher per 30 m<sup>2</sup> of floor area,
- Low voltage rooms: one per room.
- Transformer rooms: one per transformer
- 9.1.4 Fire extinguishers shall be mounted on suitable wall mounted brackets.
- 9.1.5 Fire extinguishers shall be installed next to exit doors wherever possible.

**9.2 First Aid Kits**

- 9.2.1 Industrial type first aid kits as supplied by St John Ambulance or the South African First Aid Society, shall be provided for substation buildings.
- 9.2.2 The first aid kit shall be housed in a suitable metal box with internal trays and a metal lid.
- 9.2.3 The first aid kit shall be mounted on a suitable wall mounted shelf next to the substation main exit door.
- 9.2.4 One first aid kit shall be provided for every substation building.

**9.2 Danger signs and notices**

- 9.3.1 All outside doors of all substations and all substation yard entrance gates shall be provided with a sign showing a lightning strike.
- 9.3.2 Suitable notices prohibiting unauthorised persons from entering premises shall be provided on all doors and gates of substation buildings and yards.
- 9.3.3 The following notices shall be provided and. mounted against walls inside substation buildings:
- A notice prohibiting unauthorised persons from handling or interfering with electrical apparatus.
  - A notice containing directions as to resuscitation of persons suffering from the effects of electrical shock.

- A notice containing directions as to procedure in case of fire.

9.3.4 One set of notices called for above shall be provided and installed for each substation building

9.3.5 The notices shall be displayed at a prominent position inside the building.

9.3.6 The notices shall be made from suitable plastic with engraved lettering.

#### **E200.10 NAMEBOARDS**

When specified in the project specification' name-boards shall be supplied, delivered and erected by the Contractor. The Engineer will indicate the dimensions of the nameboards to the Contractor.

The name-boards shall be constructed of timber with masonite front, all of sufficient robustness and rigidity to the satisfaction of the Engineer, and shall be manufactured and finished as set out on the drawing. The Contractor can purchase the CESA emblem from Consulting Engineers South Africa.

#### **E201 MATERIALS**

1. Materials and equipment used in this Contract shall, where possible, be of South African manufacture and shall comply with this specification and relevant SANS, BSI and IEC Specifications and shall be approved and installed to the satisfaction of the Engineer.
2. The Contractor shall submit samples of all materials and equipment for examination by the Engineer before installation, unless prior consent to the contrary has been obtained in writing from the Engineer. Such samples will be held for comparison with equipment and materials installed and will be released on satisfactory completion of the Contract. Similar equipment and material shall be of the same manufacture and interchangeable and be standard products from established manufacturers.
3. Where a certain manufacturer's material or equipment is specified, listed in the Schedules or noted on the drawings, such materials or equipment shall be provided as specified, except where an alternative is allowed.
4. Where certain products of a specified manufacturer are unobtainable, substitutes may be offered, but shall only be supplied after written consent by the Engineer.
5. Where the words 'or approved equivalent' follow a manufacturer's name and catalogue reference, the materials shall be of the specified manufacture and reference, or, if the Contractor wishes to use a substitute the onus shall be on the Contractor to prove such substitute is equivalent to the specified manufacture and reference. The decision as to the acceptance of such substitute shall rest solely with the Engineer, whose decision shall be final. If the Engineer instructs the Contractor to install the materials of the specified manufacture and reference, then no alteration to the Contract value or rates will be allowed.
6. Where a detailed specification for material or equipment is not provided, the Contractor shall select such material or equipment to comply with normal practice and to suit the particular application in all respects.

#### **E202 FINISHING AND PAINTING OF MATERIALS AND EQUIPMENT**

1. The Contractor shall select materials and their finishing to avoid corrosion.

Exterior applications within 50 km of the coast shall be deemed corrosive.

Aluminium shall be anodized to SANS 999 - 1986 Grade A for exterior and Grade B for interior applications.

2. Unless otherwise specified, finish steel as follows :

Interior Applications and Non-corrosive Exterior Applications

Galvanize to SANS 121 or paint by :

- Preparing surface
- Priming with zinc chromate of dry film thickness of 25 microns (minimum)
- Applying two final coats of high gloss enamel paint to SANS 630 Grade 1, each coat of dry film thickness of 25 microns (minimum)

Exterior Corrosive Applications

- Hot dip galvanize to SANS 121
- Prepare surface and prime with calcium plumbate of dry film thickness of 25 microns (minimum);
- Apply undercoat to SANS 681 Type 2
- Apply two final coats of high gloss enamel paint to SANS 630 Grade 1, each coat of dry film thickness of 25 microns (minimum).

NOTE: Measure dry film thickness to SANS Standard Test Method 140 or 141.

Hot-dip galvanize steel after all fabrication. Reinstate damaged hot-dip galvanizing with hot zinc spraying. Reinstate damaged electro-galvanizing with two coats of zinc-rich paint.

Any unpainted steel shall be chromium-plated or similarly plated to approval.

3. Where required paint aluminium surfaces as follows

- Thoroughly clean.
- Apply a self-etch primer Plascon Hi-Sheen or approved alternative.
- Apply two final coats of high gloss enamel paint to SANS 630 Grade 1, each coat of dry film thickness of 25 microns (minimum).

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## E203 CONDUIT AND CONDUIT FITTINGS

### 1. GENERAL

- 1.1 Conduit shall be heavy gauge welded screwed steel conduit to SANS-162 and shall be either galvanised or enamelled as specified elsewhere. Alternatively non-metallic conduit may be used as specified in clause 8. No conduit smaller than 20 mm overall diameter shall be used.

### 2 CONSTRUCTION

- 2.1 Conduit fittings shall be galvanised where galvanised conduit is specified. In all instances, galvanised conduit and fittings shall be used in the following situations:
- (a) Where conduit runs are permitted in ground floor slabs;
  - (b) Where conduit is run exposed on external wall surfaces or rises free from floors;
  - (c) In damp situations;
  - (d) Where exposed to weather; and
  - (e) Where conduits rising from floor level and forming 'U' traps are permitted.
- 2.2 When used for underground direct burial conduit shall be painted with bitumastic paint.

### 3 INSTALLATION

- 3.1 Except where otherwise specified all conduit shall be concealed by laying in concrete, chasing in walls or by running in roof spaces. The Electrical Contractor shall be responsible for chasing. The Building Contractor shall be notified in good time of all holes, openings, sleeves, etc which may be required. The Electrical Contractor shall arrange to have all conduits, switchboards, etc ready in good time so that the building work is not delayed.
- 3.2 Drops to wall outlets shall be from ceiling level, except where noted.
- 3.3 Conduit shall be looped from point to point and no draw-in boxes which are not in themselves outlets, shall be permitted unless approved and approval shall be sought where necessary. Failure to comply with this regulation may render necessary structural alterations at the expense of the Contractor. Draw-in boxes shall be installed where it is necessary to draw cables round more than two 90° bends or sets to the equivalent thereof or where conduit runs exceed 20 metres. Draw-in boxes in the roof space shall be in easily accessible positions. Draw-in boxes in ceilings shall have flat metal covers and counter sunk screws so as to be flush with the ceiling. Cover plates shall overlap boxes by 12 mm on all sides and be painted to match surrounding finishes.
- 3.4 In roof spaces conduit shall be run along or at right angles to the direction of roof trusses. Conduit running parallel to ceiling joints or tie beams shall be fixed to the sides and not on the top of such timbers. In roof spaces and on surface installations conduit runs shall, where possible, be grouped together and conduit shall be kept at saddle distances apart and fixed with saddles at reasonable spacings (not exceeding 2 m). In surface installations conduit shall be supported on spacer saddles to allow approximately 5 mm clearance behind the conduit and shall be fixed at spacings not exceeding 1,50 m. Except for surface installations outlet boxes for ceiling fittings shall be finished flush with the underside of the ceiling. Only approved plugging material is to be used in fixing of

- equipment to walls, etc. Wooden plugs are not acceptable. Only round headed screws are to be used. Plugging in joints of brick walls is not acceptable.
- 3.5 All joints shall be metal to metal and shall be screwed home, with lock nuts where necessary. Running joints shall be avoided where possible but where used shall be fitted with lock nuts.
- 3.6 The conduit installation shall be watertight, mechanically and electrically continuous. During construction precautions shall be taken against the ingress of moisture and dirt and open ends shall be plugged with sockets and metal plugs or socket and conduit fishtails.
- 3.7 After screwing home, all joints shall be sealed externally with quick drying varnish or with approved anti-corrosive paint. Any exposed screw threads or parts where galvanising or enamel has been damaged shall be touched up with an approved anti-corrosive paint.
- 3.8 Conduit shall be installed as far as possible in straight runs with easy sets or bends, and where practical shall be drained. In concrete slabs hand made easy sets or bends may be made cold with a bending machine. All bends and sets shall be free of indentation and distortion. Bends with internal threads shall not be used. Unless otherwise approved manufactured bends, shall be of the inspection type. Circular boxes shall be used where tee-joints are required. Sheradized steel or brass screws shall be used on conduit fittings.
- 3.9 Unless approved no conduit shall be laid in any ground floor slab.
- 3.10 The inside of all conduit shall be cleaned free of burrs and sharp edges. Open ends shall be fitted with brass bushes.
- 3.11 Where conduit enters boards, trays and outlet boxes, couplings and male bushes shall be used.
- 3.12 Conduit laid in concrete shall be laid above the reinforcing bars, where possible, securely tied to the bars and shall terminate in long spout deep circular malleable iron boxes for lighting points.
- 3.13 Conduit chases in brick walls shall be secured at reasonable spacings (not exceeding 2 m) by means of pipe hooks or 75 mm cut nails driven into brick joints.
- 3.14 Conduits shall not terminate in or be fastened to motor foundations.
- 3.15 No conduits shall be installed within 75 mm of steam or hot water pipes, or appliances, except at crossings where conduits shall be at least 25 mm from the pipes.
- 3.16 Galvanised steel draw wires for use by others shall be provided by the Electrical Contractor in each conduit run over 3 metres in length, in which permanent wiring is not installed under this Specification.
- 3.17 Conduits serving outlets in Cold Rooms shall be run outside these rooms and enter only at service points. At such points, sealing fittings with sealing compound shall be inserted.
- 3.18 Surface erected conduit shall be installed parallel with or at right angles to the building walls and shall be supported adequately by saddles, or by other approved methods. Conduit at suspended ceilings shall be located, when practicable, between the concrete slab and the ceiling.
- 3.19 Conduit larger than 25 mm overall diameter in reinforced concrete slabs shall be parallel with or at right angles to the main reinforcement; when at right angles to the reinforcement, the conduit shall

be close to one of the supports of the slab. Conduit installed in concrete slabs shall be located so as not to affect the structural strength of the slabs.

- 3.20 Marred surfaces of installed steel equipment, conduit and trunking shall be cleaned, painted with red lead and zinc chromate and finished to match surrounding equipment and trunking.
- 3.21 No wiring shall be carried out until the installation has been installed and fixed in position. No wires shall be drawn through before the conduit has been thoroughly cleaned of all debris and moisture.
- 3.22 To ensure that all wires may easily be withdrawn from any circuit run, the Engineer reserves the right to have wires withdrawn from the conduit. If this is effected easily and without showing damage, the cost of the withdrawal and replacement of wire shall be borne by the Client. If however, the wires are damaged, the cost of the test and rectifying the work shall be borne by the Contractor.
- 3.23 For future extensions conduit for unwired switch and plug outlets under open roofs with more than 1 m roof clearance are to terminate 38 mm above the tie beams with the ends threaded, fitted with couplings and plugged.
- 3.24 Unused switch or plug outlet boxes are to be covered with blank metal cover plates.
- 4 EXPANSION JOINT
  - 4.1 Where conduit crosses expansion joints approved type draw boxes shall be provided.
  - 4.2 The draw box shall be installed adjacent to the expansion joint, and the conduit sleeve, one size larger than specified for the circuit, shall be provided on the side of the draw box nearest the joint. One end of the sleeve shall terminate at the edge of the joint and the other shall be secured to the draw box by means of locknuts.
  - 4.3 The conduit passing through the sleeve shall be terminated 32 mm inside the draw box, and the conduit end fitted with a brass bush. The gap between the sleeve and the conduit at the joint shall be sealed against the ingress of wet cement by means to be approved by the Engineer. An earth clamp shall be fitted to the conduit projection inside the draw box and the conduit bonded to the box by means of a 4,0 mm<sup>2</sup> bare copper earth wire and a brass bolt and nut.
  - 4.4 The other end of the circuit conduit shall be secured to the draw box by lock nuts and a brass bush.
  - 4.5 In addition to an earth wire which may be specified for a circuit, a 4,0 sq. mm bare copper wire shall be provided between the first conduit box on either side of the joint. The conduit boxes shall be drilled and tapped and the earth wire shall be bonded to the boxes by means of lugs and brass screws.
  - 4.6 Where a number of conduits are run in parallel they shall cross the expansion joint via a single draw box. A number of draw boxes adjacent to each other will not be allowed.
- 5 SCREWS
  - 5.1 Cover plate securing screws for all electrical or GPO boxes shall be chromium plated.

6 CONDUIT FROM DISTRIBUTION BOARD

6.1 The Contractor shall install spare conduits from the distribution to the ceiling void for each distribution board installed.

7 FLEXIBLE STEEL CONDUIT (SPRAGUE)

7.1 The flexible metallic tubing shall be made of galvanised steel, suitable for protection of cables against mechanical damage. The corrugations of the tubing shall have a rectangular cross-section to fit the standard brass connectors.

7.2 Flexible Metallic Tubing shall be used for:

- (a) Short connections where heavy gauge welded screwed conduit is impracticable.
- (b) Expansion joint crossings, as specified.
- (c) Outlet box to recessed luminaires, minimum length 1 200 mm, maximum length 1 800 mm.
- (d) Final connection to motor terminal boxes and other vibrating equipment. Maximum length 450 mm with 50% slack.
- (e) Connections to hot water cylinders and stoves.

7.3 For weatherproof installation, flexible steel conduit shall have PVC sheathing.

7.4 Connectors for the coupling on to the flexible tubing shall be of the gland or screw-in types, manufactured of either brass or cadmium or zinc plated mild steel, and the connectors after having been fixed onto the tubing, shall be durable and mechanically sound.

Note: Aluminium and zinc alloy connectors are not acceptable.

8 NON-METALLIC CONDUIT AND FITTINGS.

8.1 Non-metallic conduit to SANS 950 may be used only if specified for a specific service provided that it complies with SANS 0142 Code of Practice for the Wiring of Premises, and the local Municipal requirements.

8.2 The use of PVC conduit is not permitted in return air plenums of air conditioning plant.

OUTLET BOXES

9 GENERAL

9.1 The locations of outlets and switches shall be verified on site with Architectural Drawing of interior details and finishes. In centring outlets and locating boxes, overhead pipes, ducts and mechanical equipment, variations in fireproofing, plastering, window and door trim, panelling, hung ceilings, etc shall be allowed for. Any inaccuracy, resulting from non-compliance with the instruction shall be corrected without expense to the Client.

10 CONSTRUCTION

- 10.1 Outlet boxes, junction boxes, conduit hangers, rods, inserts and supports shall be either hot dipped galvanised or painted with zinc chromate and finished to match surrounding equipment, conduit and trunking.
- 11 INSTALLATION
- 11.1 Outlet boxes shall be square and true with the building finish.
- 11.2 Outlet boxes for luminaires recessed in hung ceilings shall be accessible through openings created by removal of luminaires.
- 11.3 The height of outlets from finished floor level to centre-line of outlet, shall generally be as follows:
- |                            |                      |
|----------------------------|----------------------|
| Wall switches, general     | 1 100 mm             |
| Socket outlets, general    | 300 mm               |
| Motor                      | starters<br>1 500 mm |
| Bells,                     | buzzers<br>2 400 mm  |
| Fire alarm stations        | 1 600 mm             |
| Fire alarm gongs           | 2 400 mm             |
| Telephone outlets, general | 300 mm               |
| Clock outlets              | 2 400 mm             |
- Exceptions are as follows:
- (a) At junction of different materials in wall finishes.
  - (b) Where outlets would occur in moulding, break in wall surface or unsuitable location in tile, wood or similar finish.
  - (c) In removable metal partitions.
  - (d) Socket outlets in kitchens shall be mounted at a minimum height of 200 mm from the worktop or where the worktop height is not known, at a minimum height of 1 200 mm from finished floor level.
  - (e) Socket outlets in workshops and garages shall be mounted at a minimum height of 1 500 mm.
  - (f) As noted or directed otherwise.
- 12 GUARANTEE
- 12.1 Tenderers shall give a 12 month's guarantee to replace free of charge any part of the conduit and conduit fittings in which any manufacturing defects may develop within that period. Such period will commence from the date on which the conduit and conduit fittings are accepted by the Engineer.

## E204

### LOW VOLTAGE SWITCHBOARDS AND MOTOR CONTROL CENTRES

The manufacture of motor control panels, distribution boards (DBs) and PLC Panels shall strictly comply



with the latest revisions of the following standards whichever are applicable:

SANS 60439-1	LV Switchgear and Controlgear ASSEMBLIES Part One: Type-tested, Partially Type-tested ASSEMBLIES'.
SANS 60439-2	Switchgear and Controlgear Part Two: Busbar Trunking
SANS 1473-1	LV Switchgear and Controlgear ASSEMBLIES Part One: Type-tested, Partially Type-tested and Specially Tested ASSEMBLIES'.
SANS 1765	Switchgear and Controlgear ASSEMBLIES (distribution boards) with a rated short-circuit withstand strength of up to and including 10 kA
SANS 1973-1	Low-voltage switchgear and controlgear ASSEMBLIES Part 1: Type-tested ASSEMBLIES with stated deviations and a rated short-circuit withstand strength above 10 kA
SANS 1973-3	Low-voltage switchgear and controlgear ASSEMBLIES Part 3: Safety of ASSEMBLIES with a rated prospective short-circuit current of up to and including 10 kA
SANS 1973-8	Low-voltage switchgear and controlgear 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.

Unless otherwise stated the form of construction of the MCCs shall be 4a.

Separate compartments are to be provided for each motor started as indicated on the general arrangement drawing and separate compartments are to be provided for the power cables from the starters to the motors.

Wiring for Instrumentation and control cables

The wiring for instrumentation and control cables shall be kept separate from power cables and busbars up to the point where they enter the compartment where they are to be connected to equipment.

To provide for this separate sheet metal compartments shall be provided in the busbar and cable compartments.

Pushbuttons and indicating lamps

Pushbuttons shall be instated in the motor starter compartments as follows:

Function	Colour
Emergency Stop	Red
Start	Green
Stop	Red
Reverse (where applicable)	Yellow
Lamp Test	Black

Indicating lamps shall be installed in the motor starter compartments as follows:

Function	Colour
----------	--------

Run	Green
Trip	Red
Forward (where applicable)	Green
Reverse (where applicable)	Yellow

#### Metering and Indication Instruments

The following shall be provided in each motor starter compartment:

- Ammeter (maximum demand indicating type)
- Voltmeter with 6 way selector switch so that all phase to phase and all phase to neutral voltages can be read
- Running hour meter

The instruments shall be connected to and shall communicate with the SCADA system.

## 1. GENERAL

- 1.1 The switchboard(s) shall comply with BS 5486, IEC 439, the Occupational Health and Safety Act of 1993, and local authority's requirements. Switchboards shall be either of wall mounting type with front access or free standing with front and/or rear access, as specified.
- 1.2 The switchboard(s) shall be dustproof, vermin proof and adequately ventilated to prevent overheating of the equipment.
- 1.3 Drawings of the switchboard(s) shall be submitted to the Engineer for approval prior to manufacture.
- 1.4 Surface mounted cartridge type fuses for instrument protection, as specified, shall be mounted on the busbars.
- 1.5 Current transformers (ratio and burden as specified) shall be of the pedestal type or as noted, and shall be securely mounted in the switchboard.
- 1.6 The completed switchboard(s) may be inspected by the Engineer at the manufacturer's works prior to despatch. The Electrical Contractor shall inform the Engineer timeously in writing when the switchboard(s) is ready for inspection.

## 2. CONSTRUCTION

- 2.1 The switchboard(s) shall be of robust construction consisting, in general, of a channel, box or angle iron frame covered with sheet steel panel(s) of 1,6 mm minimum thickness. The panel(s) shall be reinforced to prevent distortion and to ensure rigidity.
- 2.2 The electrical equipment shall be flush mounted on a chassis within the switchboard. The panel shall be suitably slotted or drilled to allow the operating handles of the switchgear to protrude.

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- 2.3 Removable panels shall be provided for access to the wiring, busbars and equipment. The panels shall be held in position by chromium plated coin slot, square key or knurled captive thumb screws. Switchboards shall have lockable doors where specified.
- 2.4 Space for 50% spare ways, unless otherwise noted, shall be allowed on the switchboard for future equipment. Each spare outgoing way shall include sufficient space for future switchgear and associated instrumentation, similar to the equipped outgoing ways.
- 2.5 All drilling, cutting or any other metalworking operations shall be completed prior to any paint process being undertaken.
- Prior to painting, all metal parts shall be prepared to SANS 064 clause 6.2.2 for high quality - finished commodities, medium weight phosphating may be employed.
- In the period 24 - 96 hours after phosphating, a high quality zinc-chromate primer to SANS 679, Type 1, shall be applied, followed by two coats of high quality alkyd based enamel to SANS 630. Care shall be taken to cover all edges properly.
- The paint to be used shall have an impact resistance of 9 kg on a 9 mm mild steel plate and a scratch resistance of 1000 grams.
- After baking, the minimum film thickness of the paint shall not be less than 0,06 mm.
- The switchboards shall be finished in the colour specified on the outside and white on the inside.
- 3 BUSBARS
- 3.1 Busbar details shall be shown on the drawings submitted in accordance with paragraph 1.3.
- 3.2 The busbars shall comply with SANS 1195 and shall be braced for the fault currents specified.
- 3.3 Busbars shall be of rectangular section manufactured from copper or aluminium.
- 3.4 Aluminium and copper busbars shall have joints of adequate contact area for the current rating and to prevent joint relaxation by cold flow of the metal. Spring washers shall be used when bolting joints.
- 3.5 All joints in the busbars shall be firmly bolted together with suitable high tensile steel bolts and nuts. Spring washers shall be used.
- 3.6 Bolted joints shall be designed to maintain contact pressure permitting rated current at rated temperature and thermal expansion without buckling of busbars. Joints shall not loosen under vibration. Joints on aluminium busbars shall be suitably prepared.
- 3.7 The manufacturer shall specify the tightening torque to be applied to bolted joints in busbars.
- 3.8 All busbars shall be carried on insulated supports placed at intervals not exceeding 600 mm for main busbars, or 300 mm for busbars droppers. They shall be adequately identified in phase colours. Connections to busbars shall be made by means of bolted take-offs.
- 3.9 Busbar insulator material shall be Tufnol of suitable grade, or equivalent, shaped and spaced to provide protection against tracking, flashover or distortion of busbars.

- 3.10 The insulators shall be tested in accordance with SANS 161.
- 3.11 The moisture absorption resistance shall be in accordance with SANS 161.
- 3.12 Incoming and outgoing busbar stubs, where required, shall be suitably insulated where they pass through the top panels of the switch board and shall be suitably and firmly supported within the board.
- 3.13 Incoming and outgoing collector bars for cables in parallel shall be so arranged that the multiple cable ends can be connected to the collector bars with reasonably short tails to eliminate crossing of conductors.
- 3.14 Busbar droppers to and from circuit breakers shall not be supported only by the circuit breaker terminals (or the circuit breaker cradle terminals) and the main bus bars, but shall also have a suitable intermediate insulated support. Heavy out going cables shall be supported so that there is no undue strain on circuit breaker or circuit breaker cradle terminals.
- 3.15 Where stub bars are used to accommodate large cable ends at the circuit breaker terminals, the Electrical Contractor shall ensure that the clearance between phases is adequate.
- 4 SWITCHGEAR - GENERAL
  - 4.1 All switchgear shall be flush mounted behind removable panels with operating handles only projecting through suitable machine punched slots or holes. Equipment of normally surface-mounted types such as energy meters, time switches and relays, shall be mounted on suitable chassis behind hinged front panels. In the case of supply authority meters the removable front panels shall have glass inserts to facilitate reading the meter.
- 5 EARTHBAR
  - 5.1 Each board shall be equipped with a copper earth bar of sufficient length to allow for the termination of all the incoming and outgoing earth conductors. The size of the earth bar to be as noted on the drawings. The earth bar shall be complete with adequate brass bolts and nuts.
- 6 CABLE ENTRIES/TERMINATIONS
  - 6.1 Cable gland plates shall be galvanised and of at least 3 mm thickness. The gland plate shall be bonded to the main earth bar with a copper earth strap having a cross-sectional area equivalent to that of the earth bar. When cables enter the top of the board a similar cable gland plate shall be incorporated in the top of the switchboard and shall be connected to the main earth bar in a similar manner. Spare entry holes in the top gland plates shall be provided with galvanised blank seals.
  - 6.2 Gland plates and cable end support bars must be placed at suitable heights having regard to the bending radii of the cables concerned and convenience in making off. The support bars should preferably be of a section similar to "Unistrut" and be fitted with sliding clamping bolts.
  - 6.3 The entire board shall be vermin proof and at the gland plate the vermin-proofing shall consist of expanded metal of a suitable gauge secured to the gland plate and the framework of the board.

7 WIRING

- 7.1 All internal wiring shall be laced or run in wiring channels and shall be clearly marked with numbered ferrules and colour coded.
- 7.2 Stranded wire shall be used having a minimum area of cross-section of 2,5 mm<sup>2</sup> and shall comply with SANS 1507.
- 7.3 Where circuit breaker terminals are designed to take stranded conductors, PVC insulated stranded conductors shall be used. The jumpers to each breaker shall be separately run and the individual conductors in each set separated from each other by a spreader secured to the conductor to prevent movement during fault conditions and to maintain conductor spacing.

8 LABELS AND DIAGRAMS

- 8.1 All equipment shall be clearly labelled as specified. The labels shall be of ivory or plastic secured by screws or rivets.
- 8.2 All switchboards shall be labelled as specified. Glass- or clear perspex- covered, framed legends shall be fixed to the boards or adjacent thereto.
- 8.3 All fuse-switches, circuit breakers and other apparatus on switchboards shall be labelled to indicate their function.
- 8.4 The incoming isolating switch or circuit breaker on each board shall be labelled "Main Switch".
- 8.5 10 mm high letters shall be provided on each switchboard indicating voltage present.
- 8.6 All labels shall be in the language(s) specified.
- 8.7 All masking tape and other temporary markings are to be removed on completion of the installation work.
- 8.8 The Electrical Contractor shall provide separate diagrammatic charts showing essential features of the as-installed electrical system, including single line and riser diagrams on which equipment designation shall correspond with labels.

9 BALANCING OF LOAD

- 9.1 The Electrical Contractor will be required to balance the load as equally as possible over the multi-phase supplies.

10 NOTICES

- 10.1 The following notices in compliance with the Occupational Health and Safety Act of 1993, in the languages specified, shall be supplied and installed by the Electrical Contractor.

a notice prohibiting unauthorised persons from entering the switchroom or substation.

- b notice prohibiting unauthorised persons from handling or interfering with electrical apparatus.
- c notice containing directions as to procedure in case of fire.
- d notice containing directions as to restoration of persons suffering from the effects of electric shock.
- e danger notices (skull and crossbones).

- 10.2 The notices defined under (a) and (e) above shall be mounted on the outside of the switchroom/substation door(s).

All other notices shall be mounted in a conspicuous position inside the switchroom/substation.

The notices shall comprise black embossed letters, at least 15 mm high, on a yellow backplate.

11 GUARANTEE

- 11.1 The tenderer shall give a 12 months guarantee to replace free of charge any parts of the low voltage switchboard in which manufacturing defects may develop during this period. Such period shall commence from the date on which the switchboard is accepted by the Engineer.

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**E205      BUSBARS IN BUILDINGS**

1.            GENERAL
- 1.1           Busbars shall be in accordance with the drawings and shall comply with SANS 1573-2 and SANS 1195.
- 1.2           Busbars shall be braced for the fault currents specified.
- 1.3           Detailed shop drawings of the busbar runs shall be submitted to the Engineer for approval prior to fabrication.
- 2            CONSTRUCTION
- 2.1           Busbars shall be of rectangular section, manufactured from copper or aluminium complying with SANS 1573-2 and SANS 1195 and suitable for flat, or vertical mounting.
- 2.2           Horizontal busbar runs shall have a minimum clearance of 2 400 above the finished floor, except where busbar enters or leaves distribution equipment.
- 2.3           Busbar trunking shall be maintained at all points except where passing through floors, partitions, and as otherwise specified. Location with other trades shall be co-ordinated on site.
- 2.4           Busbar access shall be maintained at all points except where passing through floors, partitions, and as otherwise specified. Location with other trades shall be co-ordinated on site.
- 2.5           Busbar enclosures and covers shall be manufactured from galvanised sheet steel in accordance with SANS 1473-2 except where otherwise specified.
- 2.6           All joints in the busbars shall be properly cleaned and shall be firmly clamped together with suitable clamps and high tensile steel bolts and nuts.
- 2.7           Clamped joints shall be designed to maintain contact pressure permitting rated current at rated temperature and thermal expansion without buckling of busbars. Joints shall not loosen under vibration.
- 2.8           The manufacturer shall specify the tightening torque to be applied to bolted or screwed joints in busbars.
- 2.9           Maximum temperature rise for plated joints shall not exceed 50°C over 30°C ambient.
- 2.10           Aluminium busbars shall have joints of adequate contact area for the current to be carried and to prevent joint relaxation by cold flow of the metals used.
- 2.11           All busbars shall be carried on insulated supports placed at intervals not exceeding 600 mm.
- 20.12           All current carrying parts, connecting strips, collector bars, etc are to be adequately marked in phase colours with heat shrink PVC sleeving or be painted and colour coded. The colour yellow shall not be associated with any conductor which is not at earth potential.

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- 2.13 Connecting strips and collector bars shall be of sufficient cross-sectional area to carry the full rated current of the switches served, irrespective of the fuse or trip rating.
  - 2.14 At openings through floors the general contractor shall provide 100 mm x 100 mm concrete kerb or approved equivalent, to prevent water from running down. The Electrical Contractor shall close the openings through the floor with approved non-combustible material fitted closely around the busbar.
  - 2.15 Non-ferrous drip pans, extending 300 mm beyond the sides of the busbars shall be provided under water, steam, soil, sprinkler, etc, pipes where pipes are routed over busbars.
  - 2.16 Built in fire barriers shall be provided at every floor level on vertical runs, and at locations where busbars go through fireproof walls. Busbars shall have approved clamped joints above and below fire barriers for easy removal of busbars.
  - 2.17 Nameplates on busbars in all LV switchrooms, risers etc shall be provided.
  
  - 3 BUSBAR INSULATORS
  - 3.1 The insulators shall comply with SANS 161.
  - 3.2 A laboratory report shall be submitted giving the material content, physical properties and electrical characteristics of the insulators, if required.
  - 0.3 Busbar insulator material shall be Tufnell, or equivalent, shaped and spaced to provide protection against tracking, flashover and warping of busbars.
  - 3.4 Busbar insulator supports and clamps shall prevent deflection during short circuits.
  - 3.5 Provision shall be made for expansion of the busbars.
  
  - PLUG-IN BUSBARS
  
  - 4 GENERAL
  - 4.1 The busbars shall be in accordance with details on the drawings, shall comply with SANS 1573-2 and SANS 1195, and shall be braced for fault currents in accordance with these specifications.
  - 4.2 Detailed shop drawings of the busbars shall be submitted to the Engineer for approval prior to fabrication.
  
  - 5 CONSTRUCTION
  - 5.1 The busbars shall generally be in standard 3 m sections with smaller sections as required for joint access and installation requirements.
  - 0.2 The joints shall be designed to maintain contact pressure, permitting rated current at rated temperature and thermal expansion without buckling of the busbars. The joints shall not loosen under vibration.



- 5.3 Busbar access shall be maintained to all points except where passing through partitions and as otherwise noted.
- 5.4 The busbars shall be colour coded as detailed in 2.12.
- 5.5 Suitable lugs shall be provided at joints for busbar distribution assemblies.
- 6 EARTH BAR
  - 6.1 A copper earth bar shall be provided running the full length of the busbars. It shall be fastened to the outside of the busbar enclosure every 1 500 mm.
- 7 ENCLOSURE
  - 7.1 The enclosure shall be of galvanised sheet steel of thickness in accordance with the relevant SANS specification and shall have adequate protection of the busbars.
  - 7.2 The enclosure shall be treated inside and outside with an approved rust inhibitor and finished with an approved grey enamel.
- 8 PLUG-IN SWITCH AND CIRCUIT BREAKER UNITS
  - 8.1 The circuit breaker units shall be completely enclosed in sheet steel housings with hinged covers.
  - 0.2 Adequate knockouts and attachments shall be provided. High contact pressure silver plated stubs to engage the busbars shall be provided, totally enclosed in shock-resisting thermosetting plastic insulators. All load terminals shall have solderless lugs.
- 9 GUARANTEE
  - 9.1 Tenderers shall give a 12 month guarantee to replace free of charge any portion of the busbars in which manufacturing defects may develop during that period. Such period shall commence from the date on which the busbars are accepted by the Engineer.

**E206 CURRENT TRANSFORMERS**

- 1. GENERAL
  - 1.2 Current transformers shall be suitable for mounting in panels for use with measuring instruments, protective relays and for operating circuit breaker trip coils.
  - 1.3 Current transformers shall comply with BS 3938.
- 2 CONSTRUCTION
  - 2.1 The current transformers shall be of the ring type without frame or insulators, but are to be well taped with the leads brought out. The clear opening is to be of at least 50 mm diameter. The

accuracy shall be as specified, the capacity 5 kVA, the secondary rated current is to be 5 Amps unless otherwise stated, the transformer must be suitable for operating on systems up to 600 V, 50 Hertz AC.

Bolt through busbar-mounting type current transformers will be acceptable for use with ammeters on outgoing circuits.

### 3 GUARANTEE

- 0.1 Tenderers shall give a 12 months guarantee to replace the current transformers free of charge if any manufacturing defects develop within that period. Such period will commence from the date on which the current transformers are accepted by the Engineer.

## E207 LOW VOLTAGE MOTOR CONTROL GEAR

### 1. GENERAL

- 0.2 The starters and control gear shall comply with BS 587, operate at the rated voltage and shall be suitable for mounting on panels or motor control centres as specified. The starters shall be totally enclosed in a metal-clad dust proof enclosure suitably treated to prevent rust.
- 0.3 The starters shall be designed so that their contacts open positively on overload and cannot be held in by pressing the push button. All connections shall be made from the front of the starters without removing the starters from their housing.
- 0.4 The starters shall be of the contactor type, and the solenoid shall operate as no-volt release when the voltage drops below 65% of its rated value.
- 0.5 Starters in motor control centres shall all be of the same make when practicable.

### 2 CONTACTORS

- 0.1 The contactors shall be of the open or totally enclosed triple or double pole, air break, general purpose and magnetically operated type.
- 0.2 Contactors which shall comply with SANS 60947-4-1, shall be of adequate rating to carry at least 1,2 x the current specified at 0,85 power factor.
- 20.3 Spare normally open and normally closed auxiliary contacts shall be provided as specified.

### 3 STARTERS

- 3.1 Starters shall be of the following types as specified:-
- a) Direct-on line, non-reversing
  - b) Direct-on line, reversing

- c) Star-delta, non-reversing
- d) Star-delta, reversing
- e) Solid state

#### 4 OVERLOAD PROTECTION

- 4.1 All motor starters shall have overload protection on each phase, with positive protection against single phasing. Each pole shall be protected by means of a bi-metal thermal or solder pot overload trip as specified, indirectly heated by separate heating element connected in series with the load.
- 4.2 The thermal overload trips shall be adjustable over the full range of the trips by means of a dial mounted in front of the starter.
- 4.3 The current range of the overload trips and the coil voltage shall be as specified.
- 4.4 Back-up protection shall be by means of HRC fuses or circuit breakers as specified.

#### 5 PUSH BUTTON SWITCHES

- 5.1 Push button switches shall be of the heavy duty type with two or more push buttons, as required by the device being controlled, and a pilot-light. Contacts shall be rated at 600 volts, sustained or monetary contact as required.
- 5.2 Where push buttons are located adjacent to a motor, lock-out features shall be provided to permit locking of control circuit in the "OFF" condition. Pilot lights may be omitted as noted.
- 5.3 For remote control switch operation, two normally open contacts, key-operated "OFF" and push button operated "ON", shall be provided as specified.
- 5.4 The push-buttons and hand reset shall be mounted on the starter. Wiring terminals shall be provided for remote control.

#### 6 GUARANTEE

Tenderers shall give a 12 months guarantee to replace free of charge any part of the control gear in which manufacturing defects may develop during that period. Such period will commence on the date when the equipment is taken

### **E208 LOW VOLTAGE POWER CABLES**

#### 1 SCOPE

This specification covers the manufacture, testing, supply and delivery to site of low voltage power cables and general requirements for installation and jointing.

## 2 STANDARDS

The following specifications are applicable.

SANS 10198	:	The selection, handling and installation of electric power cables not exceeding 33 kV.
SANS 1411	:	Materials of insulated electric cables and flexible cords.
SANS 1507	:	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300 V)
SANS 1574	:	Electric cables – flexible cords and flexible cables.
BS 6346	:	PVC-insulated cables for electricity supply.

All references to standards/specifications shall be deemed to refer to the latest amendment of the latest issue of such standard/specification.

## 3 GENERAL

All low voltage cables of one type of construction shall be supplied from one manufacturer.

## 4 CONSTRUCTION

Unless otherwise specified, cables shall be of stranded copper conductors, PVC insulated, steel wire armoured and PVC sheathed.

## 5 INSTALLATION

In addition to the requirements for installation described in the standard specifications, the following shall apply.

- 5.1 The cables shall be laid in the position indicated on the drawing or wayleave plan. At crossings of sealed roads (bitumen or concrete), cables shall be pulled through pipes. At other road crossings they shall be buried directly.
- 5.2 Cables shall be laid on a 75 mm thick bed of well compacted sifted soil. The cable shall be covered by a 100 mm layer of sifted soil before backfilling with other material and compacting in layers.
- 5.3 All cables shall be covered with a plastic warning sheet with the lightning strike insignia and the word "DANGER" printed in black at regular intervals. The warning sheet shall be placed 250 mm above the top of the cables.
- 0.4 Where cable ends are buried, the ends shall be adequately sealed to prevent the ingress of moisture. Where cable ends are to be left buried for location by others, they shall be marked by a steel marker extending from the cable end to 100 mm under the finished ground level.

## 6 TERMINATIONS AND JOINTS

- 6.1 Cables shall be terminated in metal, non-rusting, compression glands of the type which provide anchorage for the armour wires. The gland shall be completely encased by a PVC or rubber shroud.
- 6.2 Aluminium cables shall be terminated using friction welded bi-metallic lugs.
- 6.3 Joints shall be waterproof. In joints between cables, the mechanical and electrical integrity of the armouring shall be maintained. In joints from armoured to unarmoured cables, the armouring shall be connected to a 2400 mm earth spike using a bi-metallic connector and bare stranded copper conductor of cross-section equal to at least half that of the phase conductors.
- 6.4 Not more than one joint shall be permitted in runs which are less than the length of cable supplied on a drum.
- 6.5 Joints shall be marked by an approved concrete cable marker.
- 7 **TESTS**  
 The following electrical tests shall be performed after installation and the results recorded in writing :
  - a) The insulation resistance shall be tested with an approved "Megger" type of instrument.
  - b) Phase connections are to be checked at each termination to ensure consistency of phase rotation throughout the installation.
- 8 **MEASUREMENT**
  - 8.1 Cable lengths shall be measured on site and an allowance made for making terminations. Allowance for wastage or a joint in a run of length less than the length of cable supplied or a drum shall be made by the Contractor in the rates. Cable joints and joint markers for long runs shall also be included in the price for the cable unless otherwise specified or measured in the schedules of prices. Rates include installation in trenches and drawing through ducts and sleeves, and strapping to poles, but exclude trenching, warning sheeting and terminations.
  - 8.2 Trenching shall include excavation, bedding material, back-filling and cable warning sheeting. Irrespective of the volume excavated, the measurement of excavation shall be according to route length.
  - 8.3 Cable terminations shall include all materials, glands, lugs, labels and other parts required.

## **E209 MEDIUM VOLTAGE CABLES**

- 1 **SCOPE**  
 This specification covers the manufacture, testing, supply, and delivery to site of 6,6 kV to 33 kV cables and general requirements for installation and jointing.

## 2 STANDARDS

The following specifications are applicable.

- SANS 97 : Impregnated paper-insulated electric cables
- SANS 0198 : The selection, handling and installation of electric power cables
- SANS 1339 : Cross-linked polyethylene-insulated electric cables
- BS 6480 : Impregnated paper-insulated cables for electricity supply

All references to standards/specifications shall be deemed to refer to the latest amendment of the latest issue of such standard/specification.

## 3 GENERAL

All cables of one type of insulation shall be supplied from one manufacturer.

## 4 CONSTRUCTION OF PILC CABLE

Unless otherwise specified, the construction of paper insulated, lead covered cable shall be as follows.

### 4.1 Conductor

Copper

### 4.2 Conductor Screen

Required

### 4.3 Insulation

Mass impregnated, non-draining, paper insulated

### 4.4 Screening

Cores shall be individually screened.

### 4.5 Sheath

Lead sheath

### 4.6 Anti-Electrolysis Bedding

A PVC Sheath shall be extruded over the lead sheath.

4.7 Armour

A double layer of galvanised steel tape armour coated with a suitable water proof compound.

4.8 Overall Sheath

Bituminised and jute served overall.

5 JOINTING MATERIAL - PILC CABLE

5.1 Straight through joint boxes shall be of cast-iron, split on the centre line, be provided with tongue and groove joints and shall have large filling holes secured by means of mechanical bolt or screw latch. Each end shall be fitted with a suitable armour clamp.

Each joint box shall be complete with solid drawn seamless lead sleeve having two large compound filling holes with two pressed lead caps for covering the holes when the sleeve has been filled. It shall have a complete set of insulating materials consisting of impregnated paper separation, or porcelain dividers, paper cotton tape and paper cotton or silk tape hermetically sealed in a tin.

5.2 Cable end boxes shall be of the indoor metal clad type or of the outdoor metal clad inverted type, with armour clamps and brass or gunmetal conical wiping glands for lead covered, steel tape or wire armoured cables.

The lead sheath shall be plumbed onto the conical gland and the armouring (lined in the case of steel tape armouring) shall then be firmly clamped to the conical gland using cast brass armour clamps. Provided that the Contractor can show the Engineer that he has adequate experience in making them, pot wipes (RMJ's) may be used.

The indoor boxes shall be suitable for vertical panel mounting, and the outdoor boxes for wall or pole mounting. All boxes shall comply with BS 542 where applicable.

5.3 Joint compound shall be suitable for filling cast iron joint end boxes, and HV joint boxes between the lead sleeve and the cast iron box.

The compound shall comply with BS 1858, shall be non-hygroscopic and have high dielectric strength. It shall adhere to cast iron and shall be suitable for high ambient temperatures, and voltages up to the specified voltage.

5.4 Alternatively, cold filling compound shall be suitable for end and joint boxes up to the specified voltage. It shall consist of two components, a compound and a hardening agent, supplied in separate containers in the correct proportions ready for mixing. The compound shall be used at atmospheric pressure and without the application of heat. Shrinkage shall be small and the topping up of boxes shall be unnecessary.

The compound shall be non-hygroscopic and have a high dielectric strength.

6 CONSTRUCTION OF XLPE CABLE

6.1 Three core cables shall be type A. Single core cables shall be type A1.

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- 6.2 The cable shall be made using a curing process that does not make use of steam or water.
- 6.3 An extruded semi-conducting screen shall be provided, freely strippable without the use of special tools.
- 7 JOINTING MATERIAL - XLPE CABLE
- Jointing and terminations shall be made in accordance with the manufacturer's instructions by jointers experienced in this work. Appropriate kits for the size of cable shall be used as supplied by the cable manufacturer.
- 8 INSTALLATION
- In addition to the requirements for installation described in the standard specifications the following shall apply.
- 8.1 The cables shall be laid in the position indicated on the drawing or wayleave plan. At street or road crossings, they shall be pulled through protective ducts.
- 8.2 Cables crossing voids shall be suitably supported in an approved manner, and be protected against damage.
- 8.3 Where cable ends are to be left buried the ends shall be adequately sealed to prevent the ingress of moisture.
- 8.4 Sufficient cable slack shall be left in the immediate vicinity of all joints to permit the future remaking of the joints.
- 8.5 Joints shall be made off only by experienced cable jointers and particular attention shall be given to maintaining the earth continuity of the lead sheath and armour, tapering of the conductor insulation, butting together of the conductor strands and prevention of voids.
- 8.6 The installation work shall be carried out strictly in accordance with statutory and municipal regulations and any special requirements of the local supply authorities.
- 9 LAYING CABLES IN PREPARED TRENCHES
- 9.1 Cables shall be laid at a depth of 1000 mm in the prepared trench.
- 9.2 Before the cables are laid, the bottom of the trench shall be covered with a 75 mm layer of well compacted earth which shall have been passed through a sieve with a maximum mesh of 12 mm. The Contractor shall lay the cables on the prepared bed carefully to avoid cuts and damage. Cable rollers shall be used.
- 9.3 Cables shall be covered with at least 100 mm of earth sieved through a mesh of not more than 12 mm.
- 9.4 The trench shall be back-filled as soon as possible after cable has been laid. To avoid theft and possible damage, long lengths of cable shall not be left exposed in an open trench overnight.



- 9.5 Water shall not be allowed to accumulate at any part of the works. The Contractor will ensure that no cable laying is carried out until the trenches are free from water.
- 9.6 All side channels, sumps or temporary excavations for dewatering purposes shall be filled in after use.
- 10 PLASTIC CABLE WARNING SHEETING
- All cables shall be covered with a plastic warning sheet with the lightning strike insignia together with the word "DANGER" printed in black at regular intervals. The warning sheet shall be placed 300 mm above the top of the cables.
- 11 CABLE WARNING TILES
- Where specified, cables shall be covered with concrete tiles 600 mm long x 225 mm wide x 50 mm thick of approved design, or with approved toughened plastic tiles. The cable tile shall be 200 mm above the cable.
- 12 MARKERS
- 12.1 Where specified the routes of all underground cables and duct ends shall be marked by means of approved concrete markers having cast insert the words "Electric Cables". They shall be positioned at every change of direction, every point of crossing another cable or service, and at spacings not exceeding 50 m of straight run.
- 12.2 All joints shall be marked by a cable marker.
- 13 INSPECTION AND TESTS
- 13.1 During manufacture and prior to despatch the cable may be inspected at the manufacturer's works by the Engineer and put to such further tests which the Engineer may deem necessary. A "functional" bending test shall be conducted on a sample of each type and size of cable.
- 14 SITE TESTS
- 14.1 Tests shall be carried out in the presence of the Engineer on each completed section of laid and jointed cable as follows :
- (1) The insulation resistance shall be tested with an approved "Megger" type of instrument of not less than 1 000 V, 2 of 5 kN.
- (2) A high voltage test shall be carried out in accordance with Table 4 of SANS 1339 or Table D-1 of SANS 97 if required by the Engineer.
- 14.2 The results of all the tests shall be recorded and submitted to the Engineer in writing.

**15 PAYMENT FOR CABLES**

If specified to reduce price escalation, the Contractor is to order all cables immediately upon award of contract, to deliver them to site and to store same at his own risk. Upon delivery to site, a sum equal to 80% of the site value of cables will be paid and the balance will be paid upon completion of the installation, less normal retention.

**16 MEASUREMENT**

- 16.1 Cable lengths shall be measured on site and an allowance shall be made for making terminations. However, not more than one joint shall be permitted in runs which are less than the length of cable supplied on a drum, and allowance for such joint or wastage shall be made by the Contractor when pricing rates. Any cable joints and joint markers which are necessary for long runs shall also be included in the price for the cable unless otherwise specified or measured in the schedule of prices. Rates shall include installation in trenches and drawing through ducts and sleeves, but exclude trenching, warning sheeting, tiles and markers, and terminations.
- 16.2 Trenching shall include excavation, bedding material and back-filling and shall include the cable warning sheeting. Irrespective of the actual volume excavated, the measurement of excavation shall be according to route length.
- 16.3 Cable warning tiles shall be measured according to route length.
- 16.4 Cable terminations shall include all materials, glands, lugs and other parts required. Terminations on overhead line structures shall include the cost of protective pipes.

**E210 INSTRUMENTATION AND METERING**

**1. GENERAL**

- 1.4 Metering equipment shall be provided in accordance with SANS 1607 and BS 37. Work shall be carried out to meet municipal requirements and as noted.
- 1.5 The supply authority will meter the electricity consumption at a central supply point. Metering equipment on the Main LV Switchboard shall be supplied by the Electrical Contractor.

**2 KILOWATT-HOUR METERS**

- 2.1 The kilowatt-hour meters shall be of the house service type, approximately 162 x 112 x 100 mm deep, of robust construction, housed in a dust proof sealed metal or plastic case, shall utilise a magnetic suspension for the disc and shall comply with BS 37.
- 2.2 The meter element shall be suitable for operation on single phase, or three phase as specified, 50 Hertz AC system and shall be of the inductor type, capable of continuously carrying the rated current. Accuracy shall be "Commercial Grade" as defined in SANS 1607.
- 2.3 The registering mechanism shall be of the cyclometer type giving a reading of six figures, the lowest indicating tenths of a unit.

2.4 The meters shall be suitable for the supply voltage specified and the rated current shall be as directed.

### 3 VOLTMETERS

3.1 Voltmeters shall be of the moving iron flush mounting type, rectangular or circular and size as specified. They shall be suitable for vertical switchboard mounting and studs shall be provided for back connection. The voltmeters shall be suitable for operation on a 50 Hertz system, and be calibrated as required. The voltmeters shall be manufactured in accordance with BS 89 to industrial grade accuracy as specified therein.

3.2 The voltmeters shall be protected by high rupturing capacity fuses to SANS 60269-1 & -2, housed in suitable insulated fuse carriers with a panel-mounting base. Voltmeter selector switches shall be incorporated.

### 4 AMMETERS

4.1 Ammeters shall be of the moving iron flush mounting type, in accordance with Clause 3.1 above where applicable, and of the pattern, size and scale range as specified. Ammeters for use in motor circuits shall have a suitably compressed overload range.

4.2 Ammeters selector switches shall be installed if specified. Selected switches having spring loaded contacts running over copper segments are not acceptable.

### 5 COMBINED MAXIMUM DEMAND AND INDICATING AMMETERS

5.1 The instruments shall be flush panel mounting, rectangular in shape, the dial size being approximately 125 x 125 mm or 80 x 80 mm as specified. The ammeters shall comply with BS 89.

5.2 The instrument shall comprise a moving iron ammeter showing the instantaneous current value, combined with a maximum ammeter employing a bimetallic spiral device which will indicate the mean current value on the basis of a 15 or 30 minute period as noted, and which is fitted with a residual pointer to indicate the maximum mean current reached during any period between manual resetting.

5.3 All three indications shall be registered on concentric scales, and instruments having small moving iron ammeters with window cut-outs scales are not acceptable. The bimetallic system shall incorporate ambient temperature compensation.

0.4 The instrument shall be used with a current transformer having a 5 ampere secondary winding. 6 Ampere or 8 ampere instruments may be offered, scaled to the full load primary current of the current transformers, with an additional overload scale in the case of 6 amp instruments.

### 6 POWER FACTOR INDICATORS

6.1 Instruments shall be housed in pressed steel cases. Shadowless scale plates shall be fitted. Instruments shall comply with BS 89. Indicators shall be suitable for flush mounting in switchboards. Current rating shall be 0,5 to 5 A continuous at the rate voltage. Power factor range shall be from 0,5 PF lead to 0,5 PF lag, and size shall be as specified.

7 ELAPSED TIME METERS

- 7.1 Time meters shall be of the flush mounting type, square phenolic frame, suitable for switchboard mounting. Registers shall be calibrated in hours and tenths of hours. Cyclometer details to be as noted. Voltage range shall be 200 - 250 V 50 Hz unless otherwise noted. Motors shall be self-starting, synchronous, non-reversing and shall be energised from the same supply as the apparatus being metered.

8 TRANSDUCERS

- 8.1 Transducers shall be suitable for use in remote indication systems for alternating current and voltage using lightweight telephone type pilot wires. Outputs shall be suitable for operating moving coil instruments and recorders.
- 8.2 Outputs and Inputs shall be as specified.
- 8.3 Output currents shall be independent of the load resistance over the stipulated range of load resistance.
- 8.4 Ambient temperature range - 10°C to ± 50°C.
- 8.5 Accuracies and linearity shall be according to the application as specified.
- 8.6 Open circuit. DC output voltages shall not rise above 18 volts when the load is removed or open circuited. Open circuiting of the output shall not result in damage to the transducer.
- 8.7 Short circuit. DC outputs shall be protected against a short circuit of the output terminals by a current limiting device.
- 8.8 Voltage, kW and kVA transducers shall be suitable for 3 wire unbalanced loads or as otherwise specified. Amplifiers shall be utilised where transducer outputs do not meet the required output range for the system.

9 LABELS

- 10.1 Labels shall be provided, as specified, to indicate the circuits in which measurements are made.

11 GUARANTEE

- 11.1 Tenderers shall give a 12 month's guarantee to replace free of charge any instrument in which manufacturing defects may develop within that period. Such period will commence from the date on which the instruments are accepted by the Engineer.

**E211 EARTHING**

This section covers the earthing of electrical installations in buildings or other structures. The total earthing system of any electrical installation shall be in complete accordance with SANS 10142 and of the AMEU Code of Practice for the Application of Protective Multiple Earthing to Low Voltage Distribution System.

## 1 EARTHING OF A GENERAL ELECTRICAL INSTALLATION

### 1.1 General

All earth conductors shall be stranded copper with or without green PVC insulation. The conductors shall comply with SANS 150. All earth conductor sizes shall be determined in accordance with SANS 0142, paragraph 4.6 where the earth does not form an integral part of the cable.

### 1.2 Mechanical Damage

Where earth conductors may be subject to mechanical damage they shall be suitably protected to a height of 2,0 m above floor or ground level unless otherwise specified. This requirement shall not apply to restricted access switch rooms or substations.

### 1.3 Ring Mains

Common earth conductors may be used in accordance with SANS 1574 05 1507. In such instances the sizes of earth conductors shall be specifically approved by the Engineer. Earth conductors for individual circuits branching from the ring main shall be connected to the common earth conductor with an exothermic weld, T-ferrules or soldered. The common earth shall not be broken.

### 1.4 Connections

Under no circumstances shall any connection points, bolts, screws, etc used for earthing be utilized for any other purpose.

The securing of earth conductors by means of self-threading screws will not be permitted.

It will be the responsibility of the Electrical 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 ends shall be tinned and lugged. Lugs may be crimped provided that the system used complies with the requirements of BS 4579, Part 1, "Compression Joints in Copper".

### 1.5 Water Pipes

Unless otherwise specified metal cold water mains shall be bonded by solid 12 x 1,6 mm copper strapping to the earth busbar in the Main Switchboard. All other hot and cold water pipes shall be connected with 12 x 0,8 mm perforated or solid copper strapping to the nearest switchboard. The strapping shall be fixed to the pipework with brass nuts and bolts and against walls with brass screws at 300 mm centres. In all cases where metal water pipes, down pipes, flues, etc are positioned within 1,6 m of switchboards an earth connection consisting of copper strapping shall be installed between the pipework and the board. In vertical building ducts accommodating both metal water pipes and electrical cables, all the pipes shall be earthed at each distribution board.

## 1.6 Roofs

Where service connections consist of overhead conductors, all metal parts of roofs, gutters and down pipes shall be earthed. One bare 10 mm<sup>2</sup> copper conductor shall be installed over the full length of the ceiling void, fixed to the top purlin and connected to the main earth conductor of each switchboard. The roof and gutters shall be connected at 15 m intervals to this conductor by means of 12 x 0,8 mm copper strapping (not conductors) and galvanised bolts and nuts. Self-tapping screws are not acceptable. Where service connections consist of underground supplies, the above requirements are not applicable.

## 1.7 External Advertising Signs

External advertising signs shall be earthed by means of a separate earth conductor.

## 1.8 Computer Earth

An isolated earth bar located in the computer room shall be connected through an insulated earth conductor to an earth electrode. The maximum permissible earth loop impedance is one ohm on the earth bar. Under no circumstances is the computer earth to be interconnected to the lightning protection system at any point.

# 2 EARTHING TO SUBSTATIONS

All substations shall be earthed in accordance with the requirements of the Supply Authority. If no earthing method is specified and no specific requirements of the Supply Authority exist, the following method shall be adopted:

## 2.1 Main Earth Bar

A main earthing bar (minimum cross-sectional area 50 mm x 4 mm) shall be provided and fixed to the transformer room wall facing the LV side of the transformer and with a suitable space provided between the earth bar and the wall.

All earth wires shall be secured to the earthing bar by means of 10 mm diameter brass bolts. Locknuts shall be provided for all terminals. The point of origin of each earth conductor must be clearly indicated by means of a metal strip tag attached to the conductor in such a way that the conductors can be easily identified.

## 2.2 Earth Rods

Two 1,8 m x 16 mm earth electrodes shall be driven into the ground in the immediate vicinity of the substation at least 3 m apart with their tops not less than 600 mm below ground level. The electrodes shall be interconnected with a 70 square mm bare copper conductor buried at a depth of not less than 750 mm. A 70 square mm earth conductor shall be taken from each of the two earth electrodes, one to the neutral terminal of the transformer and the other to the main earthing bar in the transformer room.

## 2.3 Earthing and Bonding Wire

The HV switchboard, transformer earthing terminal and cable supports shall be bonded to the main earthing bar by means of 70 mm<sup>2</sup> earth conductors. The neutral busbar and earth bar in the main LV switchboard shall be bonded to the main earth bar with an earth conductor (or conductors in

parallel) having a cross-sectional area of not less than half the size of the LV phase conductor (or conductors in parallel) between the transformer and the main LV switchboard.

In addition, a 70 mm<sup>2</sup> copper earth conductor shall be laid in the cable trenches along with all incoming and outgoing HV cables for a distance of 40 m and the conductors shall be connected to the main earth bar.

#### 2.4 Earth Resistance Measurements

The Electrical Contractor shall carry out earth resistance measurements on completion of the installation of the earthing system and the results must be submitted to the Engineer for approval. Should the earth resistance exceed the value given by the formula:

Protective device system three phase voltage

Protective device maximum rated current x 2 x 1,732

the Engineer may request the Electrical Contractor to install additional earth electrodes or trench earths and/or separation of the neutral and/or an earth leakage device for which a variation order will be issued.

#### 2.5 Miniature Substation Earthing

The earthing of mini-substations is similar to the earthing requirements of substations described above except that a main earth bar is not required. The earthing bar in the LV compartment shall become the main earth bar. The HV switch, transformer earth terminal and neutral busbar shall be bonded to the earthing bar in the LV compartment as described for substations.

#### 2.6 Switch Rooms

The earthing of switch rooms utilising earth electrodes is similar to the earthing requirements of substations described above. A main earth bar is required to which the earthing electrodes and the HV switchboard shall be bonded by means of 70 mm<sup>2</sup> earth wires.

#### 2.7 Outdoor Equipment

In cases where substations contain transformers or switchgear installed outdoors, the fence shall be earthed as follows if no other method is specified:

- (a) A 70 mm<sup>2</sup> earth wire shall be installed 400 mm below ground level and 500 mm from the fence on the outside of the substation along the entire length of the fence. This earth wire shall be earthed at each corner by means of a 1,8 m x 16 mm earth electrode and the electrode and earth wire bonded to the fence. The earth wire shall also be bonded, at least at two points, to the main earthing system.
- (b) A 70 mm<sup>2</sup> earth wire shall also be buried at a depth of 400 mm around each transformer and switch and bonded to the main earthing system.

### 3 GUARANTEE

- 3.1 Tenderers shall give a 12 months guarantee to replace and install, or make good free of charge any portion of the earthing system which develops defects within this period. Such period shall commence from the date on which an acceptance certificate is issued by the Engineer.

BID DESCRIPTION: TENDER FOR THE REFURBISHMENT AND UPGRADE OF PUMP STATION 34, UPGRADE OF RISING MAIN PIPELINE FROM PUMP STATION 2 TO LEEUWKUIL WASTEWATER TREATMENT WORKS, UPGRADE OF WASH WATER PUMP STATION AT LEEUWKUIL, AND REFURBISHMENT OF INLET WORKS OF LEEUWKUIL AND RIETSPRUIT

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**E212      EARTH BAR**

1      GENERAL

1.1      The Electrical Contractor shall provide an earth bar for :

- a)      LV switch rooms
- b)      Substation chambers
- c)      Miniature substations

1.2      Where applicable the earthbar shall be connected to the following :

- a)      Earth electrode (resistance to be not greater than 5 ohms, unless otherwise specified)
- b)      Metallic water mains from the point of entry of the system into the premises
- c)      HV switchgear
- d)      Transformer tank
- e)      Earthbar on LV Distribution Board(s)
- f)      Neutral of star connected transformer(s)
- g)      Supplier's Earth

2      CONSTRUCTION

2.1      The cross-sectional area of the earth bar shall be as specified on the drawings. Earth bars shall be complete with 10 mm brass bolts and nuts.

3      INSTALLATION

3.1      A copper earth bar shall run the full length of busbars in buildings, secured to the outside of the busbar enclosure every 1 500 mm. The earth bar shall be connected to the equipment earth at each take off.

3.2      Each incoming cable gland shall be bonded to the earth bar in an approved manner.

**E213      EARTH ELECTRODES**

1      GENERAL

1.1      The earth electrodes shall comply with BS Code of Practice 1013.

2      CONSTRUCTION

2.1      The earth electrodes shall comprise one piece, 16 mm nominal diameter, 1,8 m long copperwelded rods made by the molten welding process with a steel core covered by a thick layer thoroughly welded thereto so that an interlocking crystalline union bonds the two metals.

2.2      The copper coating shall be continuous over the cylindrical portion of the rods except at the extreme ends. The thickness of copper on the cylindrical portion of the rod shall average not less than 0,5

mm. The rod when broken successive bending shall show no seams, pits, slithers or separation of the copper from the steel.

- 2.3 Conductor clamps shall be made of a strong cast bronze body to proved a high pressure contact between the earth wire and electrode.
- 2.4 The clamp shall be provided with a non-ferrous set screw.
- 2.5 The electrodes shall be supplied complete with a driving bolt for protecting the ends of the coupling whilst the electrode is being driven into the ground.

## **E214 CABLE TRUNKING**

### **1 GENERAL**

- 1.1 The cable trunking shall comply with BS 4678.

### **2 CONSTRUCTION**

- 2.1 Cable trunking shall consist of butting sections constructed from high grade sheet steel having a minimum thickness of 1,6 mm.
- 2.2 It shall be rustproofed by an approved metallising process, finished with one coat of rust resisting paint and one coat of high grade stove enamel.
- 2.3 The lids of the trunking shall be made from the same material, shall be removable over the whole length of the trunking and secured at centres not greater than 450 mm by cadmium plated mushroom headed screws. These screws shall be located into threaded bosses, pressed into the trunking.
- 2.4 Adjoining lengths of trunking shall be correctly aligned and the two sides at right angles to the cover shall each be jointed to the corresponding sides of the adjacent trunking by means of internal fishplate connectors.
- 2.5 The connectors shall be constructed from sheet steel not less than 2,6 mm thick, and attached by means of not less than eight cadmium plated steel mushroom headed 6 mm screws passing through clearance holes complete with shakeproof washers and nuts. Two pairs of screws on either side of the joint shall be connected by tinned copper braids with split soldered washers under the nuts to provide electrical continuity across the joints.

### **3 INSTALLATION**

- 3.1 Trunking shall be supported on both horizontal and vertical runs at the following centres:

Trunking Size	Maximum spacing of hangers and fixings
Up to 76 x 76 mm	600 mm centres
Up to 150 x 76 mm	1 000 mm centres
Up to 380 x 200 mm	1 200 mm centres

- 3.2 The trunking shall be mechanically continuous throughout. At each joint in the trunking continuity shall be maintained by the installation of copper or brass links secured by brass nuts, locking washers or bolts.
- 3.3 All tees, reducers, angles and other accessories for trunking shall have folded and welded corners.
- 3.4 All trunking bends shall be of easy sweep design with fillet corners, and where branch or cross-over connections are made the edges of the apparatus shall be rendered smooth with approved edging strips.
- 3.5 Where trunking is not directly fixed to surfaces it shall be hung from straps or rod hangers arranged to support the trunking rigidly in both directions.
- 3.6 Where inverted trunking is used the cables shall be retained in their individual compartments by clips at not less than 30 mm intervals. Groups of cable shall not be secured within the trunking with plastic tape.
- 3.7 The Electrical Contractor shall arrange his layout of trunking in conjunction with other trades and no work shall commence until the Electrical Contractor has verified that his trunking will not clash with the services of other trades by means of co-ordination drawings to the Engineer's approval.
- 3.8 All trunking shall be properly lined up and particular attention shall be paid to butting of sections and lids. Surfaces receiving trunking shall be prepared in a manner that will ensure proper alignment before the trunking is erected.
- 3.9 Adequate allowance shall be made for expansion and contraction on all runs and where the trunking passes over expansion joints in the building structure, expansion couplers shall be provided.
- 3.10 Care shall be taken to ensure that water, concrete and other foreign matter are not allowed to enter trunking particularly where trunking is cast into or through structural concrete or floor screeds.
- 3.11 When installing trunking the Contractor shall ensure that:
- (a) When cut, filed or drilled, the connections shall be given one coat of approved anti-corrosive paint subsequent to the removal of all burrs.
  - (b) Where conduits enter trunking, the connection shall be made with two locknuts and a female brass bush.

- (c) All swarf caused by drilling or machines shall be removed prior to the installation of cables and the fixing of lids.

#### 4 GUARANTEE

- 4.1 Tenderers shall give a 12 month guarantee to replace free of charge any sections of cable trunking in which manufacturing defects may develop during this period. Such period shall commence from the date on which the cable trunking is accepted by the Engineer.

## E215 CABLE TRAYS

### 1 CONSTRUCTION

- 1.1 Cable trays shall be of perforated mild steel in standard sections and lengths, the width being not less than 150 mm and the flange not less than 12 mm. The metal thickness shall not be less than 2,5 mm.
- 1.2 Cable trays shall be mechanically continuous throughout and shall be either hot dip galvanised or PVC coated.
- 1.3 The design and construction of the cable trays shall be such that a deflection of a 2 meter span shall not exceed 7 mm under the following loading conditions:

Cable Tray Width	Concentrated Load at Mid Span	Uniformly Distributed Load
Up to 150 mm	100 kgs	109 kg/m
Greater than 150 mm and up to 225 mm	109 kgs	119 kg/m
Greater than 225 mm and up to 300 mm	116 kgs	127 kg/m
Greater than 300 mm and up to 600 mm	145 kgs	160 kg/m

### 2 INSTALLATION

- 2.1 The Electrical Contractor shall arrange the cable tray layout in conjunction with other trades and no work shall commence until the Electrical Contractor has verified that his trunking will not clash with the services of other trades, by means of co-ordination drawings to the Engineer's approval.
- 2.2 Cable trays shall be securely fixed with brackets at not more than 1,5 metre intervals, with additional fixings provided at bends, tees and intersections.
- 2.3 Mushroom headed corrosion resistant screws and nuts shall be used on all joints and for sizing to brackets.
- 2.4 There shall be at least two bolts per joint.
- 2.5 Where a tray is damaged or cut, filed or shaped, the affected portion shall be given a coat of red lead or approved anti-corrosive paint. Where the touched up sections are visible to the public eye, they shall additionally be painted with two coats of paint to match the tray finish.
- 2.6 All painting shall be complete before running cables on the cable tray.
- 2.7 Cable tray accessories such as bends, tees and intersections shall have an inside radius of at least 50 mm, and shall be of the same construction and finish as the cable tray.

**3 GUARANTEE**

- 3.1 Tenderers shall give a 12 month guarantee to replace free of charge any cable trays in which manufacturing defects may develop during this period. Such period shall commence from the date on which the cable trays are accepted by the Engineer.

**E216 PVC WIRING**

**1 GENERAL**

- 1.1 Except where otherwise specified the entire installation shall be wired with PVC insulated annealed copper wire drawn into conduit. The wire shall comply with SANS 1574 & 1507 and the installation shall comply with the current SANS Code of Practice for the Wiring of Premises, SANS 10142.

**2 WIRE SIZES**

- 2.1 Unless otherwise specified no wire of less than 1,5 sq. mm shall be used.

**3 INSTALLATION**

- 3.1 Where wiring is run in trunking, conduit or cable trays, the wires of adjacent circuits shall be laced together and identified with indelible tags at the beginning and end of the wireway and in each case where the circuit is run through junction boxes or distribution boards. Appropriate grouping factors for circuits must be applied to prevent overheating where more than one circuit is run in a wireway.
- 3.2 Wires shall not be drawn in conduit until the complete circuit run has been installed and swabbed out clean and dry and the building has so far advanced that there is no likelihood of the ingress of dirt and moisture.
- 3.3 The number and size of wires to be run in any conduit shall not exceed the limits laid down in SANS 10142 for the particular conduit size and length of conduit run.
- 3.4 The wiring shall be looped from point to point. No joints will be permitted. Not more than three conductors shall be looped in any one terminal.
- 3.5 Powdered soapstone or approved pulling compound shall be used as lubricant, where necessary.
- 3.6 There shall be no cutting away, or nicking of wire strands.
- 3.7 Cable supports for wires in riser conduits and trunking systems shall be provided at least every 10 m.
- 3.8 Wires drawn into conduit shall be left sufficiently long to permit making final connections.
- 3.9 Where wires are drawn into wiring trunking, protective edge strip shall be fitted to all surfaces over which the insulated conductors are drawn to prevent damage to the insulation. Any conductors found to have damaged insulation shall be rejected by the Engineer. The Contractor shall replace all such conductors at his own expense.

4 GUARANTEE

- 4.1 The tenderers shall give a 12 month's guarantee to replace free of charge any sections of wiring in which manufacturing defects may develop within that period. Such period will commence from the date on which an acceptance certificate is issued by the Engineer.

**E217 WALL SWITCHES AND SOCKET OUTLETS**

1 GENERAL

- 1.1 Wall switches shall comply with SANS 163. Except where otherwise specified switches shall be of the adjustable grid or of the rocker operated microgap type, and silent in operation. Where more than one switch is required at any position approved multiphase gang units shall be used. Switches shall be similar or equal to "MK".
- 1.2 Samples of all switches, socket outlets, complete with boxes and cover plates, shall be submitted for approval before installation is commenced. Samples of all other materials and apparatus and copies of the relevant BS or SANS test report shall be submitted to the Engineer on request. All such samples may be retained until completion of the contract. Labels shall be securely attached thereto, designating the contract by name and number (if any), the name of the contractor, and any further relevant information.

2 INSTALLATION

- 2.1 Locations indicated for local wall switches are subject to modifications. At or near doors, switches shall be installed on side opposite hinge, except where noted. Final door hinge location shall be verified on site prior to switch outlet installation.
- 2.2 Wall switches shall be installed to bear evenly and be level and plumb.
- 2.3 Where surface mounting switches are specified the boxes shall be galvanised or approved stove enamelled.
- 2.4 Cover plates shall be fixed perpendicularly and there shall be no gaps between the plates and the walls.
- 2.5 For flush type switches recessed boxes and proper length screws shall be used. Switch boxes shall be installed flush with the wall finish. There shall be no gaps between the walls and cover plates. No wooden wedges, shims or blocks for levelling shall be used.
- 2.6 Cover plates for flush mounting switches shall be of sheet steel. Finish shall be to approval but for tendering purposes assume coinage bronze unless otherwise specified.
- 2.7 Switches shall be flush mounted with bottom of box 1,350 mm above finished floor levels unless otherwise specified. Where shown on the same wall as the doors they shall be situated with the centre line between 150 mm and 300 mm from the edge of door frames, and shall on no account be hidden behind doors that are swung fully open. Where tiling extends to 1 500 mm above floor

level switches shall be mounted just above tiling instead of at 1 350 mm. Where tiling extends over 1 500 mm, switches shall be mounted at 1 .350 mm.

#### FLUSH SWITCH AND SOCKET OUTLET COMBINATION

### 3 GENERAL

- 3.1 Wherever a non dedicated switch socket outlet is installed it shall comprise a combination of one outlet to SANS 164-1 (old type) and one to SANS 164-2 (hexagonal type). Switches shall comply with SANS 163 and 164. Dedicated switch socket outlets refers to switch socket outlets without earth leakage protection. These shall be of the faceted earth pin type and shall be installed in accordance with SANS 10142-1.

### 4 CONSTRUCTION

- 4.1 Switched socket outlets shall be Crabtree or approved equal.

#### WEATHERPROOF SWITCH AND SWITCH SOCKET OUTLETS

### 5 GENERAL

- 5.1 Weatherproof switches shall be quick make and break type in robust brass or galvanised cast iron cases with machined joints and shall be suitable for outdoor use. They shall comply with SANS 1239.

### 6 CONSTRUCTION

- 6.1 Switches shall be operated by means of a milled rotary device. Socket outlets shall be protected either by a spring loaded cover or by a brass screw cover with retaining chain.

#### PRESSED STEEL SWITCH BOXES

### 7 GENERAL

- 7.1 All switch-boxes are to be manufactured from heavy gauge sheet-steel and shall be galvanised. The boxes shall suit the number of flush switch units for which the box is intended and shall comply with SANS 1084 and 1085.

### 8 CONSTRUCTION

- 8.1 Lugs shall be drilled and tapped at 80 mm centres suitable for fixing either flush switch or standard flush plug units. Fixing screws shall be provided.



- 8.2 The dimensions of the single gang boxes shall be approximately 50 mm wide by 50 mm deep by 100 mm long, with one knock-out at each end and at the back, and at least two knock-outs in each side.
- 8.3 All knock-outs shall be 20 mm in diameter suitable for 20 mm electrical conduit.
- 9 ARCHITRAVE SWITCHES
  - 9.1 These shall be of MK manufacture or approved alternative.
- 10 GUARANTEE
  - 10.1 Tenderers shall give a 12 months guarantee to replace free of charge any of the equipment in which manufacturing defects may develop within this period. Such period shall commence from the date on which the equipment is accepted by the Engineer.

**E218      INTERIOR LUMINAIRES**

**1          GENERAL**

- 1.1      The complete installation of luminaires, luminaire components and lamps shall comply with SANS 56, 165 and 1278 where applicable, the Standard Regulations and Municipal Requirements.
- 1.2      The types of luminaires shall be as shown on the drawings and as specified.
- 1.3      Reference shall be made to the constructional details of ceilings, luminaires and components shall be supplied to suit. Luminaire descriptions may not necessarily denote specific mounting accessories for the particular type of ceilings on or in which they will be installed.
- 1.4      The location of luminaires on electrical drawings is diagrammatic only.
- 1.5      The final positions and spacing of luminaires shall be checked with the architectural ceiling plans before the luminaires are installed.
- 1.6      When luminaires require circuits more involved than simple wiring, the electrical contractor shall submit wiring diagrams to the Engineer for approval at least 4 weeks prior to installation.
- 1.7      Drawings shall be provided showing the relative positions of luminaires and adjacent structures such as walls, columns, ducts, openings, etc.
- 1.8      The installation of luminaires shall be co-ordinated with other trades.
- 1.9      Where possible all lighting fittings shall be fixed directly to BS conduit boxes.
- 1.10     Luminaires exposed to the weather shall be anodised or suitably finished aluminium. Indoor luminaires shall be baked enamel or anodised except as otherwise individually specified.
- 1.11     No luminaire shall have rough edges anywhere which may be liable to cause damage or injury. All edges shall be finished and painted as specified below.
- 1.12     Every corner of whatever material on each luminaire shall be cut to a radius.
- 1.13     Adequate numbers of knock-outs are to be provided for wiring and installation.

**2          PAINTING**

- 2.1      The treatment and finish of all sheet steel surfaces of all luminaires shall comply with the requirements specified.
- 2.2      Before painting the metalwork of luminaires shall be thoroughly degreased and derusted. Thereafter the metal is to be treated with a hot phosphating solution in accordance with Section 2.4 of the SANS 064 - 1060 "Code of Practice" for the preparation of steel surfaces for painting.
- 2.3      One or more coats of white baking enamel shall be applied as necessary to all surfaces including edges.
- 2.4      Requirement of the finish.

- 2.4.1 The dry film thickness of the enamel shall not be less than 0,0396 mm.
- 2.4.2 The finish shall be smooth, glossy and free from grit or any other surface imperfections.
- 2.4.3 The finish on the luminaire, or on test specimens cut from the luminaire where necessary shall comply with the requirements in SANS 663 "Primer and Enamel Paint for Hospital Furniture" in respect of:
  - (a) Scratch resistance (Type 1 enamel)
  - (b) Impact resistance (enamel)
  - (c) Daylight 45 degree, 0 degree luminous directional reflectance of white enamel
  - (d) Yellowness,
  - (e) Specular gloss at 60 degrees.
- 2.4.4 The finish shall show no blistering, wrinkling or loss of adhesion, and not more than 1,5 mm rust or blister creep from an X-mark cut through the film, when degreased test specimens cut from the fitting and exposed in a salt spray cabinet, complying with and operated in accordance with SANS Method 155, for a period of 200 hours.
- 2.4.5 After stripping the paint, the underlying metal shall show no sign of corrosion, except along the X-mark where rust spots extending up to the limit specified above are permitted.
- 3 Nylon or powder coating of metal surfaces will be considered as an alternative provided that full information on the process and it's effect on the finished item is supplied at the time of tendering.
- 4 LIGHT DIFFUSERS AND LOUVRES

Diffusers shall be manufactured from colour stabilised plastic which is certified 100% virgin acrylic. No plastic will be accepted unless it is stabilised polystyrene or polycarbonate. The degree of stabilisation against discolouration shall be guaranteed in writing by the manufacturer.

  - 4.1 Light diffusers and louvres are intended to advantageously control light leaving the luminaire; none will be accepted which, due to use of inferior quality materials or bad design, introduces glare or has poor utilisation.
  - 4.2 Diffuser panels may be single piece injection moulded but must be positively located in position to prevent any movement or vibration.
  - 4.3 Diffuser panels and louver grids shall be easily removable to facilitate relamping or ballast replacement using approved clip arrangements and safety chains or other acceptable method to prevent the panel from falling during maintenance.
- 5 PARTICULARS TO BE SUPPLIED
  - 5.1 Tenderers shall submit with their tenders the following information:

(i) .ies type files

for all types of luminaires included in the tender.

**6 BULKHEAD LUMINAIRES**

- 6.1 Bulkhead fittings shall be manufactured to take lamps up to 150 W. The base of the fitting shall be of die cast or heavy gauge pressed aluminium. The base shall be treated against corrosion and shall have a black matt finish.
- 6.2 Threaded conduit entries to take 20 mm dia conduit must be provided on at least two sides and one for back entry. At least two of the conduit entries must be fitted with brass or neoprene stoppers.
- 6.3 The lens shall be injection moulded, prismatic, clear UV stabilised polycarbonate. The lens shall be held in position by two stainless steel screws via reinforced holes in the lens and the screws must be provided with gaskets to prevent the ingress of moisture. The fitting shall be provided with either a neoprene or a silicone gasket fitted between the lens and the base.
- 6.4 The internal finish of the fitting shall be of high grade heat resistant white enamel and the fitting shall be provided with a lampholder mounted on a removable metal lampholder platform. The fitting shall also be provided with a reflector between the lamp and the base, and wiring leads to the lampholder shall be high heat resisting and preferably covered with silicone.

**7 WATERTIGHT LUMINAIRES**

- 7.1 The watertight fitting is to consist of a cast iron base with reflector of approximately 225 mm diameter and fitted with a screw neck type well glass, rubber washer and porcelain bayonet cap lampholder.
- 7.2 A hole drilled and tapped 20 mm ISO thread shall be provided in the back of the cast metal base for the conduit entry and the finish of the base shall be matt black on the outside and white enamel on the inside.

**8 GUARANTEE**

- 8.1 Tenderers shall give a 12 months guarantee to replace free of charge any portion of the luminaires and ancillary equipment in which any manufacturing defects may develop within that period. Such period will commence from the date on which the luminaires are handed over to the client.

**E219 INSTALLATION OF INTERIOR LUMINAIRES**

**1 GENERAL**

- 1.1 This specification covers the installation of luminaires, luminaire components and lamps which will be supplied by others.

- 1.2 The work shall be carried out strictly in accordance with :-
  - a The latest issue of the "Standard Regulations for Wiring of Premises, SANS 10142", issued by the South African Bureau of Standards, hereafter called the "Standard Regulations";
  - b the Occupational Health and Safety Act 1993;
  - c the Municipal bye-laws and any special requirements of the local Supply Authorities;
  - d the local Fire Office Regulations.
- 1.3 The types of luminaires will be as shown on the drawings.
- 1.4 The positions and spacing of the luminaires shall be checked with the architectural ceiling and other plans before the luminaires are installed.
- 1.5 Drawings will be provided showing the relative positions of luminaires and adjacent structures such as walls, columns, ducts, openings, etc.
- 2 INSTALLATION
  - 2.1 When luminaires require circuits more involved than simple wiring, the Electrical Contractor shall submit wiring diagrams to the Engineer for approval at least four weeks prior to installation.
  - 2.2 The installation of luminaires shall be co-ordinated with other trades to avoid interference.
  - 2.3 Where possible all lighting fittings shall be fixed directly to BS conduit boxes.
  - 2.4 Where fluorescent fittings are fixed in continuous rows, wiring may be carried out from one outlet, and then wired through the channels of the fittings. The internal wiring shall be clipped to the sides of the channels.
  - 2.5 In cases where the fittings are suspended below the ceiling, they shall be fixed to two conduit droppers, these conduits shall be fixed by means of dome covers to conduit boxes cast in the concrete slab or in the ceiling.
  - 2.6 Connections to the wiring of luminaires and other appliances where connectors are used, shall be effected by means of brass screw couplers shrouded in porcelain, neoprene or PVC, or by means of approved spring steel locking connectors insulated in unbreakable material.
  - 2.7 In fittings capable of housing incandescent lamps above 150 watts, the wiring from the lampholder to the general wiring shall be silicone rubber insulated.
- 3 TESTS
  - 3.1 On completion of the installation all luminaires shall be switched on and checked in the presence of the Engineer and the Client or his representative. Any defects in the wiring or in the connection of the luminaires shall be made good at the expense of the Electrical Contractor.

**E220 POWER FACTOR CORRECTION EQUIPMENT**

**1 GENERAL**

- 1.1 This specification covers the supply, delivery, installation, testing and commissioning of power factor correction equipment which shall be fully automatic and shall include all the cabling, controls and indication.
- 1.2 All the equipment and workmanship shall be in strict accordance with the latest requirements of SANS and BS Standards.
- 1.3 All the equipment for this installation shall be suitable for operation at the working voltage of 400 V. All the switches, contactors, fuses and breakers supplied shall have the necessary rating to ensure safe and efficient working at all times.

**2 RESPONSIBILITIES**

- 2.1 The specialist supplier shall be responsible for the supply, delivery, testing and commissioning of the following:

The capacitor banks supplying the reactive load connected to series reactors as specified.

A ventilated rack or frame in which the capacitors and reactors shall be mounted, suitable for floor mounting.

Power factor correction panel/s as specified.

Protective devices and relays to limit excess voltages and currents to ensure safe operation and protection of component parts.

All the necessary internal interconnecting wiring for the complete operation of all the equipment.

Operating instructions and parts lists for all the equipment supplied.

The correct ratios, ratings and characteristics of the current transformers needed for the operation of the relay/s and power factor meter. The current transformers shall comply with BS 3938.

Wiring diagrams of the system.

A connection diagram of the equipment.

Drawings or clear sketches showing the dimensions of the panel/s and the rack or frame holding the capacitors.

Clear markings in the form of plastic ferrules on all terminals.

Commissioning and testing the equipment after installation by the Contractor.

An alarm bell and/or light as specified to warn of any failure of the PF correction equipment.  
A set of spare fuses for each fuse bank in the equipment.

4 CONSTRUCTION OF PANEL(S)

- 4.1 The power factor correction switching panel/s shall consist of a galvanised angle or channel iron chassis covered with minimum 1,6 mm galvanised sheet metal panels, and shall be vermin and dust-proof.
- 4.2 The equipment shall be mounted on an angle iron frame work within the panels to give a flush front panel.
- 4.3 The front and back panels shall be removable for access to wiring and equipment, shall be held in position by chromium plated captive coin slot screws and shall be well ventilated.

5 EQUIPMENT ON PANEL(S)

- 5.1 The following equipment shall be fitted on the power factor correction panel/s:

Protective relays and associated CT's as specified in the Technical Schedule.

An isolator switch as specified in the technical schedule

A selector switch for selecting manual/off/automatic operation incorporating set time delays to ensure that when switched by hand or auto the contactor is held open for a preset time to ensure specified discharge of the capacitor bank.

Multi-stage relay/s as specified in the technical schedule.

Contactors as specified in the technical schedule.

Pilot lights for each step and indication that the contactor is closed together with a separate indication that HT is present.

Three individual ammeters and associated CT or ammeter and selector switch.

High rupturing capacity fuses as specified in the technical schedule.

Busbars and interconnecting cabling.

6 CABLES

- 6.1 The main cables feeding the power factor correction equipment shall be of a size to allow for future expansion as specified. All cables feeding capacitors shall have a current carrying capacity of 1,43 times the normal current required by those capacitors. The connection between the two banks

necessitated by the space limitation, to be in sheet metal encased overhead busbars or overhead cable on rack, which must be stated in the tender.

## 7 CAPACITORS

- 7.1 The capacitors shall comply with IEC 70.
- 7.2 Protection against thermal overload and internal over voltage shall be provided. This protection device shall be insensitive to harmonics and incorporate a time-delay attachment to prevent unnecessary operation due to transient closing over-currents.
- 7.3 Each bank of capacitors shall be connected through a set of high rupturing capacity fuses. The rating of these fuses shall be 1,5 times the normal current drawn by the capacitors.
- 7.4 The capacitors shall not contain any Polychlorinated Biphenyls (PCB's).
- 7.5 A bank of series reactors to limit the inrush currents to be fitted in adjoining enclosure attached to the capacitor bank.  
  
The series reactors are to be designed to limit the peak inrush currents to the capacitor banks.
- 7.6 The capacitor banks to be made of standard kVAR units in either single phase or three phase configuration to suit the manufacturer and to allow for a star point for connection to a unbalanced protection relay.
- 7.7 The capacitors shall be of lightweight construction with either a paper film or all film dielectric and of low loss design.
- 7.8 Each capacitor element shall have separate internal fuses, and have built in discharge resistors to reduce the terminal voltage to 50 V within 5 minutes of disconnection.

## 8 RELAYS

- 8.1 The relay to sense reactive power shall be of the multistage type with a minimum of stages as indicated. The unit to be integral with a No volt coil to ensure that after switch off, power failure or severe voltage dips, the steps are brought in one at a time to the required kVAR limit.
- 8.2 The relays are to have time delays incorporated in the design to avoid excessive hunting.

## 9 DISCHARGE DEVICES

- 9.1 Capacitors shall be fitted with discharge devices of such a nature that the capacitors will be discharged in the time between switching operations to such a level that the rating of the protective devices will never be exceeded when the capacitors are connected to the circuit. The discharge device ensures that the safe voltage of 50 volts after 5 minutes is achieved.
- 9.2 If discharge devices other than high ohmic resistors are used, the discharge device shall be disconnected when the capacitors are switched into the circuit.



10 PROTECTION EQUIPMENT

- 10.1 The protection equipment on the distribution board to which the power factor correction equipment is connected, shall be as follows:
- (a) of such a make and type that uniformity of the board is maintained,
  - (b) have the necessary rupturing capacity to safely break the maximum fault current that could exist at that point of the circuit,
  - (c) be of a fault current limiting type that will limit the fault current to such a level that the fault level capacity of the other protection devices on the board will not be exceeded under any fault condition,
  - (d) have the necessary rating to carry at least 1,43 times the current required by the power factor correction equipment under normal conditions.
- 10.2 Each capacitor bank to be protected by a overload and unbalance voltage and current relays with the associated saturable core CTS and protection CTS.

11 ISOLATOR SWITCH

- 11.1 The isolator switch shall be of the triple pole, hand operated panel mounting air break type, unless otherwise stated, having a continuous current rating high enough to carry 1,43 times the current that might be required by the power factor correction equipment under normal conditions. It shall be suitable for operation at the specified voltage. The contacts shall be of silver alloy and the switch mechanism shall be of the quick make-break type. The switch is required to open and close a circuit carrying a current up to the full current rating of the switch. The isolator to be interlocked with the panel door to ensure that the door can only be opened in the isolator off position.
- 11.2 The switch shall be housed in a panel integral with the control suitable for panel mounting.
- 11.3 The control isolator to be interlocked with the main isolator to ensure that the main isolator is not normally operated on load. This unit to incorporate a feature whereby all control circuits may be broken while operating the main isolator handle, but it would be possible to reclose the control circuit isolator in the off position.
- 11.4 The isolator to have the live contacts and hinged blades fully shrouded and to have visual indication of isolation.

14 EARTHING

- 14.1 All non-current carrying metal parts of the equipment shall be effectively earthed.

15 TESTS

- 15.1 All the power factor correction equipment shall be set correctly by the Contractor to the approval of the Engineer before any circuit is energised and tests carried out. The Electrical Contractor shall provide all the material and instruments required for testing and bear all the expenses incurred.

16      **GUARANTEE**

- 16.1      The tenderer shall give a 12 months guarantee to replace free of charge any portion of the power factor correction equipment in which manufacturing defects may develop during this period. Such period shall commence from the date on which the power factor equipment is accepted by the Engineer.

**E221      VOLTAGE TRANSFORMERS**

1      **GENERAL**

- 1.1      Voltage transformers shall be suitable for use with measuring instruments and protective relays.
- 1.2      Voltage relays shall comply with BS 3941.

2      **GUARANTEE**

- 2.1      Tenderers shall give a 12 month guarantee to replace the voltage transformers free of charge if any manufacturing defects develop within that period. Such period will commence from the date on which the voltage transformers are accepted by the Engineer.

**E222      MV SWITCHGEAR**

1      **GENERAL**

- 1.1      This Specification covers the manufacture, testing, supply, and delivery of MV indoor switchgear and accessories which shall comply with I.E.C. Publication 56.
- 1.2      Switchgear to standards other than I.E.C. may be considered provided it is clearly indicated in which respect the equipment offered does not comply with the relevant I.E.C. standard.
- 1.3      All materials supplied shall comply with the requirements of the Republic of South Africa's Factories, Machinery and Building Work Act No. 22 of 1941.
- 1.4      The switchgear will be connected to a 3 phase alternating current system operating at the rated voltage and frequency.
- 1.5      The equipment offered shall comprise the manufacturer's standard equipment, the reliability of which has been thoroughly proved in service. All components of the switchgear shall have passed such type tests as are laid down in I.E.C. Publication 56.
- 1.6      All primary components of the switchgear shall be made and assembled by the same manufacturer.

2 TERMINOLOGY

- 2.1 a "Switchgear Panel" shall mean a panel housing either a circuit breaker, an isolator or a switch-fuse.
- b "Breaker panel" shall mean a switch panel housing a circuit breaker.
- c "Isolator Panel" shall mean a switch panel housing an isolator.
- d "Fuse-Switch Panel" shall mean a switch panel housing a fuse-switch.

3 INFORMATION REQUIRED AT TENDER

- 3.1 Tenderer are required to submit copies of the following with their tender.
- a Results of all type tests and certificates of rating covering the switchgear included in his tender. Certificates covering maximum operating current, making capacity, breaking capacity and short-time carrying capacity shall have been issued by a recognised testing authority and shall cover the switchgear housing as well as the switchgear itself.
- b Certificates of the rated operating sequence, making time, opening time and breaking time for circuit breakers.
- c Drawings showing the general arrangements of each type of the switchgear offered which shall clearly indicate all principal dimensions, masses and floor loadings as well as the positions of mountings and cable entries.
- d A detailed price list of the spare parts and tools which is recommended to be carried for each type of switchgear included in the tender.
- 3.2 Submission of insufficient technical data and diagrams to enable the characteristics and merits of the equipment to be ascertained may invalidate a tender.

4 SWITCHGEAR PANELS

- 4.1 The switchgear panels shall be of the metal-clad, fully insulated type. Each switch panel shall be a self-contained unit which shall include busbars, instruments, transformers, cable boxes, supporting framework, instruments and relays, and the circuit breaker isolator or fuse switch with its operating mechanism and supports.
- 4.2 Where specified the electrical connection between switchgear and the panels shall be by means of plug and socket contacts so that the moveable portion can be isolated from the fixed portion. Withdrawal of the moveable portion from the panel shall be accomplished horizontally. The design of the plug connections shall be such as to prevent the accumulation or ingress of gas, dirt or moisture.
- 4.3 The busbars and circuit connections shall be air-insulated and shall be capable of withstanding the full service voltage and fault and load current.
- 4.4 The switchgear panels shall be designed in such a way that when made up into switchboards, the switchboards can readily and safely be extended by the addition of further panels.

- 4.5 Each switchgear panel shall be provided with auxiliary contacts for inter-tripping and alarms as noted.
- 4.6 Unless otherwise specified each switch panel shall be equipped with an integral earthing arrangement for earthing either the circuit or the busbars associated with the panel.
- 4.7 If specified the Contractor shall provide each panel with padlocks for locking the shutters giving access to live conductors and for any other purposes that the Engineers deem necessary. A padlock case fitted with a cylinder type lock to suit the specified standard key shall be supplied with each switchboard.
- 4.8 Each panel shall be fitted with labels indicating the circuit designation both on the front and on the rear of the panel. Labels shall be removable and made of plastic sandwich board engraved in accordance with the schedule in Part 7.
- 5 ISOLATOR PANELS
- 5.1 Each panel unit shall contain a withdrawable or non-withdrawable, as specified, load break fault make isolator with a separate system of interlocked switch blades for the earthing switch. It shall be complete with busbars, cable box, supporting framework and with all components easily accessible for maintenance.
- 6 FUSE-SWITCH PANELS
- 6.1 Each panel shall contain a withdrawable or non withdrawable as specified, load break fault make isolator and three high rupturing capacity striker pin fuse. The fuses shall be so arranged that in the event of any fuse or fuses rupturing the isolator will open thereby disconnecting all three phases from the supply. It shall not be possible to reclose the isolator until ruptured fuses have been replaced.
- 6.2 The operating mechanism shall be interlocked with the fuse carriage cover to allow access to the fuse carriage only when the operating mechanism is in the "off" position.
- 6.3 Automatic shutters shall be provided to safeguard against inadvertent contact with live parts when the fuse carriage is removed.
- 6.4 An integral interlocked earth shall be provided to earth the cable side of the fuse-switch.
- 7 CIRCUIT BREAKERS PANELS
- 7.1 Circuit breakers shall have rated capacities as noted. They shall be fitted with an approved design of arc control device and shall be trip-free.
- 7.2 Each draw-out circuit breaker shall be interchangeable with other circuit breakers of the same current rating, and shall not be interchangeable with circuit breakers not of the same current rating. They shall be mounted on an integral truck capable of carrying, raising and lowering the circuit breaker.
- 7.3 The circuit breaker operating mechanism shall be an integral part of the circuit breaker. Circuit breakers having an operating mechanism divorced from the circuit breaker will not be considered.

- 7.4 The circuit breakers shall have mechanisms designed for closing as specified or, if not specified by means of either.
- a Solenoid energised at the rated voltage and interlocked by means of an anti-pumping relay fitted to the circuit breaker.
  - or
  - b Manually charged spring.
  - or
  - c Spring charged by a motor. The motor shall operate at the specified voltage. Where AC operation is specified, the motor shall be single phase and have a continuously rated starting winding and shall not have centrifugal switches. It shall comply with SANS 1189. It shall be readily removable without rendering the circuit breaker inoperable. The spring shall be capable of being charged by hand and any necessary handles therefor shall be supplied with the equipment.
- 7.5 The circuit breaker operating mechanism shall be arranged so that the breaker can be opened immediately after closing and shall be provided with "slow closing" features to facilitate maintenance work. It shall be provided with both electrical and mechanical breaker and spring status indication (where applicable) ie SPRINGS CHARGED and ON/OFF.
- 7.6 Tripping and closing mechanisms shall operate independently so that the failure of one mechanism shall not affect the other.
- 7.7 All circuit breakers shall have closing and tripping circuits of the specified voltage.
- 7.8 Circuit breakers shall be capable of closing on to and breaking without sustaining damage all currents up to the rated currents specified.
- 7.9 Three phase auto-reclosing facilities shall be provided where specified.
- 7.10 A set of test plugs shall be supplied suitable for high voltage, insulation resistance or current injection testing.
- 7.11 One spare set of normally open and one spare set of normally closed auxiliary contacts terminated at the circuit breaker secondary terminal strip shall be provided on each circuit breakers.
- 8 INTERLOCKS
- 8.1 Interlocks shall be provided as follows:-
- a Earths can only be applied when the circuit is isolated.
  - b The circuit can only be restored when the earth has been removed.
  - c Operation of protection shall not disconnect the earth.
- 9 NAMEPLATES

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- 9.1 Nameplates shall be provide for the complete identification of each item of high voltage switchgear. All nameplate inscriptions shall be made by deep engraving or stamping.
  - 9.2 Nameplates shall be clearly readable without subjecting the person attempting to read them to any undue danger, they shall be permanently attached to the relevant equipment by means of rivets and shall contain such information as may be necessary to fully and unambiguously specify the equipment.
  - 10 PROTECTION
  - 10.1 Each circuit breaker panel shall at least be equipped with:-
    - a 1 - current transformer per phase, each 15 VA output, Class 10P10.
    - b 1 - trip coil fitted on the circuit breaker for operation from protective relays.
  - 11 INSTRUMENT TRANSFORMERS
  - 11.1 Current transformers shall comply with I.E.C. Publications 185, shall be of the resin encapsulated type and shall be mounted in a metal-clad chamber. Current transformers in switchgear panels shall be fitted on the side of the circuit breaker, fuse-switch or isolator remote from the busbars.
  - 11.2 The secondary windings of the current transformers shall be earthed in an approved manner at one point only.
  - 11.3 Voltage transformers shall comply with I.E.C. Publication 186, shall be of the resin encapsulated type and shall be mounted in a metal-clad chamber and connected on the side of the circuit breaker, fuse switch or isolator remote from the busbars.
  - 11.4 Voltage transformers shall be connected to the fixed portion of the switchgear panels by plug and socket isolating contacts incorporating high voltage HRC fuses and shall be so arranged that they can readily be withdrawn from the fixed portion in a horizontal or vertical direction. The voltage transformers shall be of class B and have ratios and outputs per phase as noted.
  - 12 TERMINATION OF MAIN CABLES
  - 12.1 A single cable box shall be fitted to each panel. The cable box shall be suitable for making off cable as specified. It shall be complete with all fittings and cable lugs.
  - 12.2 Where single core cables are to be installed insulated glands shall be provided.
  - 13 MULTICORE AND LOW VOLTAGE CABLE INSTALLATIONS
  - 13.1 All cables shall be made off with glands as approved by the cable manufacturers. The glands shall be of the correct size and shall firmly clamp the armouring between substantial taper sections to give a proper earth connection. Each gland shall be provided with neoprene rubber shroud.
  - 13.2 Each and every cable core shall be terminated in a screw type terminal block.
  - 13.3 Each and every terminal block shall be clearly and indelibly marked in accordance with the wiring diagrams and schedules.

- 13.4 All cable cores shall be marked at each end by means of numbered ferrules, in accordance with the wiring diagrams and schedules.
- 13.5 All cables shall be permanently and indelibly marked by means of flag labels at each end.
- 13.6 The following circuits shall be considered independent and shall be accommodated in separate cables:
  - a Current transformer circuits
  - b Voltage transformer circuits
  - c Direct current circuits
  - d Alternating current circuits
- 14 RELAYS
  - 14.1 Each breaker panel shall be fitted with Red and Blue phase overcurrent relays with a 50-200% setting range and a residually connected earth fault relay with a 20-80% setting range, and shall be of the inverse definite minimum time lag type having a "10-3" characteristic. Additional relays shall be as specified elsewhere.
  - 14.2 All relays shall be contained in dust-proof withdrawable type cases finished in an approved colour. Each relay shall be provided with an indicator of the hand-resetting type to show when the relay has operated and a protective label to indicate its function.
  - 14.3 For test purposes the rear terminals of the fixed portion of the relay of any panel forming part of a switchboard shall be readily accessible without the necessity for climbing on to the switchgear. To facilitate this, relays shall be mounted on approved hinged swing frames.
  - 14.4 All relays shall comply with BS142.
- 15 INSTRUMENTS
  - 15.1 All instruments shall be back connected and shall comply with I.E.C. Publication 50(441) for industrial instruments.
  - 15.2 An ammeter shall be fitted on every panel equipped with current transformers. Ammeters shall comply with the requirements of the attached Part 5 section AN sub-section 5, shall not have a burden exceeding 5 VA, and shall be connected on the white phase only.
  - 15.3 Ammeter dials shall be scaled in an approved manner and shall be clearly marked with the current transformer ratio in use.
  - 15.4 Ammeters shall be fitted with saturating current transformers to prevent damage under fault conditions.
- 16 INSULATING OIL AND CABLE BOX COMPOUND

- 16.1 Insulating oil complying with the requirements of S.A.B.S. No. 555 and suitable compound or resin oil for filling cable boxes will be supplied by the manufacturer of the equipment.
- 16.2 Polychlorinated Biphenyls shall not be used in the switchgear.
- 17 INSTRUCTION BOOKS AND DRAWINGS
- 17.1 Three copies of erection, operating and maintenance instructions covering each type of equipment shall be supplied with the switchgear.
- 17.2 Unless otherwise specified two sets of final "as commissioned" drawings shall be supplied within 3 months of commissioning of each item of equipment.
- 18 INSTALLATION
- 18.1 The equipment must be complete with all items necessary for installation and shall include the following:
  - a Busbars, busbar clamps or fish-plates, and nuts, bolts, spring-washers as appropriate.
  - b Busbar end shields
  - c Interconnection wiring, panel clamping bolts and interconnection wiring protection where passing through panels sides.
  - d Charging, racking, slow closing or operating handles as appropriate.
  - e Earthing extensions if appropriate.
  - f Panel levelling components.
- 18.2 The equipment shall be supplied such that it can be installed and shall be installed with all panels accurately aligned in all respects.
- 19 PAINTING AND FINISHING
- 19.1
  - a Steel nuts, bolts, runners, etc., used in the construction of the switchgear shall be cadmium or otherwise protected as approved by the Engineer.
  - b All other metal surfaces of the switchgear shall receive, after being thoroughly cleaned and prepared, at least two coats of oil resisting paint of approved quality and colour
- 20 INSPECTION AND TESTS
- 20.1 During manufacture and prior to despatch the switchgear may be inspected by the Engineer(s) at the manufacturer's works who will call for such tests as they may consider necessary.
- 20.2 The installation shall be tested by the Electrical Contractor as the installation work progresses and upon completion or as required by the Engineer. The final test before the taking over of the installation shall be made in the presence of the Engineer and the supply authority, and shall include such tests as the Engineer or supply authority considers necessary.



21 GUARANTEE

- 21.1 Tenderers shall give a twelve months guarantee to replace, free of all charges, any portion of the switchgear in which any manufacturing defect may develop within that period, such period to commence from the date the switchgear is put into commission.

**E223 CIVIL WORKS ASSOCIATED WITH THE INSTALLATION OF UNDERGROUND CABLES**

1 SCOPE

This specification covers

- the excavation and backfilling of trenches
- the provision of ducts at road crossings
- the reinstatement of road surfaces

2 WAYLEAVES, PLANS AND DRAWINGS

- 2.1 The Engineer will arrange for the procuring of the necessary wayleaves from the road authorities, municipalities or other authorities concerned, unless otherwise agreed.
- 2.2 The Engineer shall provide the Contractor with copies of all wayleaves and shall draw his attention, in writing, to any special conditions which may be stipulated therein.
- 2.3 The location of pipes/ducts/cables along the roads/streets specified in relation to the road/street centre line or boundary fence/building line shall be in accordance with the wayleave drawings and conditions stipulated by the authorities concerned.
- 2.4 The Engineer will provide the Contractor with such plans/drawings as are necessary for the proper execution of the work. All plans/drawings shall be returned to the Engineer on completion of the work.

3 CORRECTNESS OF PLANS AND DRAWINGS

- 3.1 The Contractor shall carefully examine all plans and drawings and if any inaccuracy, discrepancy or inconsistency is detected, he shall immediately bring it to the notice of the Engineer and obtain a decision.

4 MAINS AND SERVICES

- 4.1 The recorded position of sewers, drains, gas and water-mains, electricity cables and conduits, telephone and telegraph cables, or such services or their appurtenances as exist within the limits of an order will be shown on the wayleave or services plan. The accuracy of the services plan is not guaranteed, and the Contractor shall not make any discrepancy in the information given the basis of a claim against the Engineer.
- 4.2 The Contractor shall be solely responsible for contacting the authorities concerned whenever any work on or in the vicinity of services is required to be done.
- 5 CLASSIFICATION OF EXCAVATION
- 5.1 Excavated materials shall be treated as falling under one or other of the following classifications :
- Class A material (rock) will be held to be any material possessing characteristics of hardness and geological structure which, in the opinion of the Engineer, necessitates the use of explosives for excavation.
- Class B material (hard) will be held to be any material which possesses characteristics of hardness and geological structure which, in the opinion of the Engineer, requires two separate operations for excavation, one for breaking by pneumatic or hydraulic means and one for removing the material from the excavation. The operations may be performed by one or more items of plant or equipment.
- Class C material (earth) will be held to be all material other than Class A and Class B material as defined above and shall include boulders of individual volume up to 0,25 m<sup>3</sup> and which constitute less than forty percent (40%) by volume of the material excavated.
- 5.2 The Contractor shall be at liberty to use blasting where possible to dislodge material other than Class A material and pneumatic or hydraulic breaking tools on material other than Class B but in such cases the classification as defined above by the Engineer shall apply.
- 5.3 Material shall only be classified as Class A or Class B material when the Engineer has given his agreement in writing.
- 5.4 Should the Contractor consider that any material encountered in the excavations is Class "A" or Class "B" he shall immediately notify the Engineer in writing. Failing such notification the excavation shall be assumed to be in Class "C" material and shall be measured and valued accordingly. Wherever practicable all excavation in ground other than Class "A" material and/or Class "B" shall be carried out first after which levels will be taken of the exposed Class "A" material and/or Class "B" and agreed upon by the Engineer and the Contractor.
- 5.5 In the event of any dispute regarding the classification of material, the Engineer's decision in this connection shall be final.
- 5.6 Where blasting is necessary, the contractor shall make all arrangements regarding the acquisition, storage, conveyance and use of explosives and shall comply with all relevant regulations regarding the use of explosives. No blasting shall be carried out within 3 m of pipes, cables or structures. The Contractor shall be liable for any damage arising out of his use of explosives.
- 5.7 Where the actual quantity of excavation in each of the ground conditions specified deviates from the estimated quantities, payment shall be adjusted in accordance with the respective unit prices per

cubic metre as per contract. The onus shall be on the Contractor to prove to the satisfaction of the Engineer the actual quantities involved.

## 6 TRENCHING

- 6.1 Trenches for pipelines, ducts and cables shall be excavated in a straight line between manholes in accordance with the wayleave plan except where obstructions or other conditions require bends as permitted by the Engineer.
- 6.2 The width of trenches shall be no greater than is necessary for satisfactory execution of the work. The onus shall be on the Contractor to satisfy the Engineer of the necessity where a trench, wider than that called for in the schedule of quantities associated with the order, is excavated. Any reinstatement costs arising from the excavation of an unnecessarily wide trench shall be borne by the Contractor. Trench widths shall be noted on the drawings.
- 6.3 Underground plant such as gas, telephone cables and ducts, water or sewerage mains, electricity supply cables and stormwater drains which obstruct the construction of the pipe/duct lines shall be brought to the notice of the Engineer. Where there is no other alternative, these must be moved at the employer's expense in consultation with the owning authority.
- 6.4 Where removal of services is necessary but cannot be undertaken by the owning authority, the work shall be undertaken by the Contractor or as the Engineer may decide.
- 6.5 Any warning of protective material encountered in the course of excavation shall be carefully opened up to avoid damage and, where necessary, removed. Services which are exposed shall be protected against damage and, where necessary, shall be supported to avoid subsidence.
- 6.6 Trigonometrical and other survey beacons or pegs may not be removed or altered. Where this becomes necessary the Engineer must be advised in order that suitable action may be taken.
- 6.7 Tree roots exposed in the course of trenching shall not be cut unless this is unavoidable.
- 6.8 The trench in which cables and/or ducts are laid shall have a minimum depth to provide a cover between the cable duct and finished grade of not less than for :
- |   |   |        |
|---|---|--------|
| Cables between 1 100 volts and 11 000 volts | - | 800 mm |
| Cables below 1 100 volts                    | - | 600 mm |
| Post Office ducts and cables                | - | 600 mm |
| Television ducts and cables                 | - | 600 mm |
- 6.9 Where this depth cannot be maintained owing to the nature of the ground, the depth may be varied at the discretion of the Engineer, or as otherwise noted. In all cases where the cable and/or duct has coverages less than that stated in this clause, it shall be covered by means of concrete slabs having a minimum thickness of 40 mm and a width equal to 400 mm plus the diameter of the duct and/or cable it protects unless otherwise noted or directed by the Engineer.
- 6.10 Where trenches are excavated in rocky ground, the base of such trenches shall be covered with a 50 mm layer of soft soil to ensure that cables/pipes/ducts will not come into direct contact with sharp projections.

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- 6.11 The trench shall be excavated in such a position that cables/pipes/ducts may be laid at least 300mm from power cables. Where this is not possible, cables/ducts/pipes shall be separated from power cables by concrete or paving slabs placed vertically or as otherwise directed.
  - 6.12 The base of all trenches shall be suitably levelled before pipes/ducts are laid to ensure that they are supported along their full length.
  - 6.13 If the trench is to contain pipes/ducts, the base of the trench shall slope in order that water may drain from the pipes/ducts. The level of the base of the trench shall fall at least 75 mm per 30 m.
  - 6.14 Grading shall be either from one manhole/handhole to the next or from the centre between two manholes/handholes towards each manhole/handhole.
  - 7 SAFETY OF BUILDINGS AND FOUNDATIONS
    - 7.1 The Contractor shall ensure that excavation of trenches will not endanger the foundations of adjacent buildings and shall, where necessary, take such action as may be necessary to prevent any subsidence of soil which could result in damage to foundations.
  - 8 DUCTS AT ROAD CROSSINGS
    - 8.1 All ducts shall be laid to have a minimum depth to provide a cover of not less than 800mm between the top of the pipe and the surface of the road.
    - 8.2 All duct crossings shall be continued at least 500mm behind the kerb face.
    - 8.3 All duct crossings are to be marked with paint on kerb faces with the code as indicated on the drawings. In addition, duct markers shall be installed in the soil.
    - 8.4 Ducts shall have the dimensions shown and shall be asbestos cement class "T" (SANS 819) or uPVC Class 4 (SANS 791) unless otherwise noted.
    - 8.5 All duct ends are to be blocked off with rubber end caps to prevent the ingress of water and mud.
    - 8.6 Particular care shall be taken to keep the ducts clear of concrete or any substance during the course of construction.
    - 8.7 A draw wire shall be provided in each duct.
  - 9 BACKFILLING
    - 9.1 Backfilling shall be consolidated in layers of not more than 200mm at a time. Filling around and over the pipes/ducts/cables to a depth of 50mm shall be carefully carried out with fine materials, and the Contractor shall ensure that the pipes/ducts/cables are not damaged in any way by such backfilling and consolidation.
    - 9.2 Where, in the opinion of the Engineer, there is no material excavated suitable for use, even after screening, as bedding and the first layer of backfill, the Contractor shall obtain suitable material and deliver it to the trench side for use. The onus shall be on the Contractor to prove to the satisfaction of the Engineer the actual quantities required.

- 9.3 For purposes of payment, the quantity of material refilled shall be taken as being equal to the amount excavated and no allowance shall be made for increased bulk due to excavation.
- 9.4 All surplus spoil from any excavation that cannot, in the opinion of the Engineer, be spread evenly over the surface, shall be removed by the Contractor at no extra cost to the employer.
- 10 REINSTATEMENT
- 10.1 Where work requires the installation of ducts/cables under tarred or made-up sections of roads, streets or side-walks, reinstatement of the surface the work shall be carried out as directed by the authorities concerned. Full reinstatement costs shall be borne by the Contractor. The Contractor shall execute and maintain interim restoration.
- 10.2 Where ducts or cables are laid in the slopes of road cuttings or in the fill of embankments, the surface and slope shall be restored to the satisfaction of the responsible Roads Engineer.
- 11 PIPE/DUCT ENTRIES TO BUILDINGS & MANHOLES
- 11.1 Holes required to be made in the walls of existing buildings or manholes to provide a new pipe/duct entry shall be neatly made without cracking or otherwise damaging the surrounding structure.
- 11.2 The point of entry of underground pipes/ducts into buildings, manholes or jointing pits shall be effectively closed and sealed with cement to prevent ingress of water between the pipe/duct and the wall of the structure.
- 12 DEGREE OF COMPACTION
- 12.1 All layers shall be compacted by plant approved by the Engineer and the Contractor shall satisfy the Engineer that all the specified requirements regarding compaction can be achieved.
- 12.2 Compaction shall only be carried out when the material in a layer contains the specified moisture content evenly distributed throughout the entire layer, subject to an allowable tolerance in moisture content of plus or minus 2%.
- 12.3 After compaction the mean dry density of the section or layer shall be equal to or exceed the specified values.
- 12.4 In addition, if in the opinion of the Engineer there is excessive scatter in any group of consecutive test results, the section or layer may not be accepted even though the mean dry density equals or exceeds the specified value.
- 12.5 When the Engineer is satisfied with the degree of compaction obtained he will authorize the construction of the following layer, but in no case shall any materials be placed on the approved layer without the prior written authority of the Engineer.
- 2.6 The degree of compaction in open ground for each completed and compacted layer of filling shall conform to the following requirements :

Depth of Filling below final surface level (mm)	% Mod. AASHO Density
0 - 450	95
Greater than 0 - 450	90

- 12.7 The degree of compaction in roadways for each completed and compacted layer of filling and foundation material shall conform to the following requirements :-

Layer	% Mod. AASHO Density
Gravel wearing course	98
Basecourse	98
Subbase	95
Selected Subgrade	93 (100)
Filling if less than 300 mm below top of subgrade	93 (100)
Filling if more than 300 mm below top of subgrade	90 (98)

- 12.8 Where the material is on a non-plastic 'single sized' sand the degree of compaction for the layer shall be not less than 98% and the figures shown above in brackets shall apply.
- 12.9 The moisture content of the material at the time of compaction shall be the optimum moisture content for the material as determined from the Modified AASHO Compaction Test, within the allowable tolerances. The moisture content for compaction may be altered subject to the approval of the Engineer.
- 12.10 Should the material be too wet due to rain or any other cause, it shall be allowed to dry out to the correct moisture content before compaction is begun, and the Engineer may instruct the Contractor to harrow the layer to ensure that there is not unequal evaporation.

## **E224 VARIABLE SPEED DRIVES (VSDs)**

### **1. GENERAL REQUIREMENTS**

This section provides general requirements for pulse-width modulated (PWM) Adjustable Frequency Drives, herein referred to as VSD Drives, for use with NEMA design AC motors, or standard IEC motors.

The VSD Drive is a system for controlling the rotational speed of an AC motor and providing on demand the right torque to the application.

The fitting of the drive to the motor is the key factor to ensure an optimized motor control energy efficiency wise. Consequently the VSD Drive must have the capability to measure automatically the parameters of the motor to fine tune the control.

The system architecture must be flexible enough to have an additional embedded programmable card and added optional I/Os as well to cope with future application process enhancement.

Shortening the downtime increases the operational performance of any facility and reduces the operating expenditures. Maintenance functions such as fault monitoring and diagnostic shall be built-in in the drive and used for trouble shooting. Moreover an additional user-friendly PC software must enable the configuration management, commissioning and remote maintenance functionalities.

## 2. APPLICABLE STANDARDS

The VSD is qualified to address all the major economic area standards.

The VSD Drives shall be :

CE marked, conforming to European Low Voltage (2006/95/EC modified from 7303/EEC and 93/68/EEC and EMC (2004/108/EC modified from 89/336/EEC) Directives, and Machinery directive NO 98/37/EC modified by 98/79/EC.

UL recognised

CSA recognised

GOST recognised (Baltic and Russian area)

C-Tick marked to comply with Australian Communication Authorities.

ATEX Certified according to 9419/EC directive

It shall comply with the specific standards listed in the table below:

<i>Standard</i>	<i>Title</i>
<i>IEC 60068-2-3</i>	<i>Environmental testing; Part 2-3: Tests - Test Ca: Damp heat, steady state</i>
<i>IEC 60068-2-6</i>	<i>Part 2-6; Vibration Resistance (sinusoidal)</i>
<i>IEC 60068-2-27</i>	<i>Part 2-27: Shock Resistance</i>
<i>IEC 60204-1</i>	<i>Safety of machinery - Electrical equipment of machines - Part 1: General requirements</i>
<i>1IEC 60529</i>	<i>Degrees of protection provided by enclosures OP Code)</i>
<i>IEC 60721-3-3</i>	<i>Classification of environmental conditions - Part 3-3: Classification of groups of environmental parameters and their severities - Stationary use at weather protected locations</i>
<i>1IEC 61508-1</i>	<i>Functional safety of electrical/electronic/programmable electronic safety-related systems - Part I: General requirements</i>

<i>IEC 61800-3</i>	<i>Adjustable speed Electrical Power Drive Systems; Part 3: EMC requirements and specific test methods</i>
<i>IEC 61800-5-1</i>	<i>Part 5-1: Safety requirements - Electrical, thermal and energy</i>
<i>EN 13849-1</i>	<i>Safety of machinery - Safety related parts of control systems - Part I: general principles for design.</i>
<i>UL508C</i>	<i>Power Conversion Equipment</i>
<i>CSA C22.2 No. 14-05</i>	<i>Industrial Control Equipment</i>
<i>SEMI F47</i>	<i>Semiconductor industry standard for voltage sag immunity</i>

### 3. PROTECTION

The following functions shall be available to minimise the risk of equipment damage as a result of component failures.

- The VSD Drive shall be protected against short circuits, between output phases and to ground.
- The VSD Drive shall have under-voltage power-loss ride through performance per the SEMI F-47 voltage ride through standard and certified by a third party.
- The VSD Drive shall integrate a protection against over temperature in addition to the heat sink overheat protection. The output frequency shall be software enabled to fold back when the motor is overloaded.

Upon loss of the analog process follower reference signal, the VSD Drive shall be programmable to display a fault. Three skip frequency ranges that can be programmed to a bandwidth of  $\pm 10$  Hz

### 4. HARMONIC DISTORTION

Both front end and back end harmonic distortion shall be limited to a maximum of 5% THD in accordance with IEEE 519.

This shall be achieved by means of one or more of the following methods:

- Front end passive filter
- Front end active filter
- Active front end
- 18 pulse front end
- Back end choke



#### 4. KEYPAD DISPLAY INTERFACE

A keypad display interface shall offer the modification of VSD Drive adjustments through a touch keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, and adjustment storage, and diagnostics shall be accessible.

The VSD Drive model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall be listed on the drive identification portion of the LCD display.

A worldwide class standardized wireless link is mandatory for non accessible environment.

#### 5. CONTROL CONNECTIONS

The control power for the digital inputs and outputs shall be 24Vdc.

The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs shall be current limited and shall not be damaged if shorted.

Removable terminal strips shall be used on all logic and analog signal connections in the power converter.

Two voltage-free relay output contacts shall be provided. One of the contacts shall indicate VSD Drive fault status. The other contact shall indicate a drive run status. These relays shall be configurable for other status indicators.

As interoperability with the whole system is critical One relay must have NO or NC contacts. The logic inputs must be able to cope with positive or sink source logic as well.

The VSD Drive shall have a safety logic input to de-energize the drive . The drive shall not allow the motor to operate until this input is closed. If this input is opened while the connected motor is running, the VSD Drive shall stop applying power to the motor. This power removal function shall be certified by an independent agency.

The control section of VSD Drive shall be supplied separately if necessary with 24V DC, to keep the network communication always available even if the power supply is OFF. Thus the remote failure diagnosis shall still be available in case of mains power shutdown.

When the equipment is connected to an IT system network, the built-in RFI filter shall be disconnected removing jumpers.

#### 7. SERIAL COMMUNICATION

The VSD Drive shall have an integrated RJ45 port, selectable for Modbus. The following protocols shall be supported :

- Modbus TCP
- DeviceNet
- Ethernet/IP
- InterBus
- M0dbus Plus
- Profibus DP

## 7. PROGRAMMING APPLICATION EXTENT

The VSD Drive shall have built-in basic functions for pump, fans, aerator and mixer application such as PID Set-up, Flow limitation, No flow detection, Sleep/Wake up, No load law for energy saving, Damper management, Multi motors configuration management.

The VSD Drive shall be able to manage an optional snap-on controller board that must fit inside the drive enclosure. This board shall carry out flexible application control extent such as multi-pump facility management. More functions such as night and day algorithm, pressure boost mode, pipe file algorithm, staging and de-staging algorithm, cavitation protection, over pressure protection, low water level protection, pipe burst and pipe blockage protection and cycling protection. Data fault time stamping shall be delivered within the drive. The dedicated application menu shall be displayed automatically on the graphic keyboard display upon the drive's power up.

The programming tool shall comply to IEC 61131-3 standard.

## 8. OPERATION RATINGS

The VSD Drive shall be designed to operate at the input line voltage and power rating range indicated below. This uniqueness provides a consistent system interface for the whole solution.

Voltage	Phases	Power rating
380V -15% to 480V +10%	three-phase	0.75 kW to 630 kW

The VSD Drive shall operate from an input frequency range of 50Hz - 5% to 60Hz + 5%. The efficiency of the VSD Drive at 100% speed and load shall not be less than 97%.

The variable torque rated VSD Drive overcurrent capacity shall not be less than 110% of the nominal current for one minute.

## 9. ENVIRONMENTAL RATINGS

Operating	surrounding	air	-10°C up to 50 °C
Maximum range with derating	operating	temperature	60°C
Storage	ambient	Temperature	-25°C up to 70 °C
Maximum operating altitude			1000 m without derating 1% 1000...3000m: current per derating of additional 100 m.

Max. Relative Humidity (IEC 60068-2-3)	5....95% without dripping water
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The VSD Drive shall be able to give a 100 % output current continuously in the above specified conditions. The derating factor must not have an impact on the lifetime of the VSD Drive, the unit's performance, overload capability included, and the reliability of the VSD Drive.

## 10. MAINTENANCE

### BUILT-IN FUNCTIONALITY

Upon power-up, the VSD Drive shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-charge circuit.

The VSD shall be able to restart automatically if the fault disappears and the operating conditions permit the restart. A user-friendly PC software workshop is used as a commissioning, configuration set-up and troubleshooting tool.

### MANUFACTURER

The VSD Drive Manufacturer must have a minimum of 20 years experience in world-class drive design and manufacturing. The installed base product quantity must be large enough to be credible in its capability to be an edge company continuously enhancing its product management process.

### LOCAL SUPPORT

The Supplier shall have a permanent representative office with a trained and skilled support staff, in the country where the goods are delivered. The support team must be able to attend to site problems on site within 24 to 48 hours with fair notice from customer.

The most common spare parts shall be available on site or within 8-12 hours after a positive identification has been made of the spare part that is required to repair the drive.

### WARRANTY and AFTER-SALES

A factory test report shall be delivered by the VSD Drive Manufacturer on request.

A 24-month parts warranty shall be provided on materials and workmanship from the date of purchase.

Services (spare part and repairing) are provided (spare part and repairing) for 5 years after the end of commercialization.

## 11. SUSTAINABLE DEVELOPMENT

The manufacturer of the VSD Drive shall be qualified as a ISO 14001 facility.

The materials used in the VSD Drive shall be recyclable, non-toxic and flame retardant. The VSD Drive shall comply with the European directive RoHS (Restriction Of Hazardous Substances) 2002/95/EC.

The Product Environmental Profile (PEP) analysis must be performed in conformity with standard ISO 14040 "Environmental management: life cycle assessment, principle and framework".

## **Part 1: Description**

### **1.1 General Description**

- 1.1.1. The soft start unit shall be provided by the manufacturer in a configuration suitable for panel mounting. The component must be suitable for mounting in a pollution degree 3 environment. All power devices must not be accessible during routine maintenance or set-up.
- 1.1.2. The soft start unit shall utilize a thyristor (SCR) bridge consisting of at least two SCR's per phase to control the starting and stopping of industry standard motors. The thyristors will be controlled by the "current limit/voltage ramp/torque regulation" in such a manner that a smooth and linear acceleration ramp is ensured, independent of motor load.
- 1.1.3. The soft start unit shall be controlled by a microprocessor that continuously monitors and protects the motor and soft start unit.
- 1.1.4. All soft start units, regardless of power rating shall be utilizing the same type of control module.
- 1.1.5. The soft start unit shall be provided with a display and adjustment interface for setting and monitoring, where all settable parameters are accessible without a need for an additional connection to a computer.

### **1.2. Rating**

The soft start unit shall be designed and be capable to operate, as a minimum the following:

- 1.2.1. Safe to operate up to max. of 415/690V continuously, and is able to select the operation voltage within 230-15% to 415 + 10%/ 208-15% to 690 4-10%.
- 1.2.2. Adapt automatically the main frequency of 50 or 60 Hz.
- 1.2.3. At ambient temperature from 0° C to 40° C without derating, operation up to 60° C should be possible with a maximum derating of 1.2% for every ° C. Capability to be in an environment with a relative humidity of up to 93% without condensation.
- 1.2.4. Starting current limitation, adjustable from 150% up to 700% depending on the load requirement.
- 1.2.5. In altitudes up to 1000m. For higher altitudes, derating shall not be more than 2.2% for each additional 100m.
- 1.2.6. Supplying 300% of rated full load current for 10 starts of 23 seconds per hour at ambient temperature (40° C)
- 1.2.7. All soft start units are to be full duty cycle rated without bypass, bypass contactor terminals must be provided for all ratings with the bypass contactor as a separate component, in case of contactor failure.

### **1.3 Interface**

The soft start unit shall be provided with the minimum features of the below operator interface

- 1.3.1. Provides below data in a 3 digit 7 segment red LED display:

- Motor current
- Motor power factor - Motor active power
- Motor torque/load
- Motor thermal status
- Motor operating time
- Phase rotation direction
- Last fault detected

1.3.2. The soft start unit shall come with the following fault detection capability.

- Main phase loss;
- Power supply failure
- Lock rotor fault;
- Prolong starting fault;
- Over current fault
- Motor thermal fault;
- Motor thermal fault detected by PTC
- Starter over heated;
- Underload fault for dry pump protection.
- Line Frequency out of tolerance
- External fault- Control line failure
- Serial link fault

#### 1.4 Adjustment

By factory preset, the soft start unit shall be designed and is capable to start, operate, protect motor and starter, without any adjustment for any standard motors ranging from 5.5kW to 630 kW. However, if modification are needed, the soft start unit shall provide the access to modify the below parameter :-

	Range
- Acceleration	1 to 60 sec
- Deceleration	1 to 60 sec
- Stopping	Free wheel / deceleration / brake
- Voltage boost	50% to 100%
- Current limitation	150% to 700%
- Phase rotation	On / Off
- Under load protection by torque	Off / 20% - 100%
- Time before starts	0— 999 seconds
- Initial torque	0% to 100%

## **Part 2: Protection**

The supplier shall supply in accordance to the recommendation of the manufacturer the proper circuit breaker with magnetic tripping for power protection and complete with contactor for isolation, these components must be according to IEC 947-4-1 type 2 coordinated, sized according to AC3, shall be incorporated into the panel and the soft start unit shall be designed to provide minimum the following build in protections but not limited to :

### **2.1 Motor protection**

#### **2.1.1 Starting protection**

A programmable tripping curves equivalent to IEC 60947-4-1 thermal protection class 2, 10A, 10, 15, 20, 25 or 30 for different type of operation duty shall be provided.

#### **2.1.2 Overload protection**

Continuously monitor and calculate, based on cold and hot state of the motor, follow the protection classes defined in IEC '60947-4-1 and shall be adjustable from 50% up to 130% of the rated current.

#### **2.1.3 Lock rotor protection**

If the motor reached 5 times of the rated current or higher, the soft start shall shut down within 200ms.

#### **2.1.4 Thermal memory**

Shall be capable of memorising the thermal status of the motor at the events of the loss of power at the incoming or control supply. Thermal condition of motor should be modelled according to time event during loss of control supply

#### **2.1.6 Time between starts**

Shall be capable to recognised that a previous stop command had been activated and will only restart the motor after a preset delay, this delay shall be adjustable between 0 to 999 minutes.

#### **2.1.6 Single phasing protection**

Shall shut down the soft start unit after detection of absent for more than 200ms. of any incoming or outgoing phase. The phase lost current threshold is adjustable from 5 to 10% of nominal current.

### **2.2 Soft Start Unit Protection**

2.2.1 Withstand up to 13 times of rated current for 20ms.

2.2.2 Build in thermal protection switch.

2.2.3 Protection against micro interrupt < 200ms to minimise tripping due to voltage dips.

2.2.4 Integrated circulation fan control by auto heatsink thermal on/off switch.

2.2.5 Preheating capability when motor not running

### **2.3 Mechanical protection**

2.3.1 Shall be able to pick-up the spinning load at any speed and any direction and respect the acceleration setting, catch on fly.

2.3.2 Shall provide the possibility of detection of low load torque and provide alarm or shut down the soft start unit. Current detection is not acceptable.

- 2.3.3 Shall provide linear deceleration in order to eliminate water hammering in the case water pump is used;
- 2.3.4 Shall provide self adapt long starting time in case of high inertia fan;
- 2.3.5 On load and off load starting  
The soft starter shall have the capability to have two parameter settings programmed and the user shall have the choice to choose off load or on load starting in case of necessity to start on load.
- 2.3.6 Shall provide detection of phase rotation to avoid operation in wrong direction in case of supply sequence change, especially in case of generator supply.

### **Part 3: Function**

#### **3.1 Control I/O points**

The soft start unit shall be designed to provide, as a minimum, the below I/O for surveillance.

- 3.1.1 1 relay output for safety interlock.
- 3.1.2 1 relay output for end start-up.
- 3.1.3 1 relay output and 2 transistor output  
that can set to
  - Motor thermal alarm
  - Motor powered
  - Motor current alarm
  - Motor underload
  - Motor PTC alarm
  - Second motor parameter selected.
- 3.1.4 2 logic input for start/stop control.

## **E226 LOW VOLTAGE ELECTRIC MOTORS**

### **1 GENERAL**

- 1.1 Single phase induction motors shall comply with SANS 1189, and three phase induction motors with SANS 948. They shall be suitable for operation at the rated voltage on a 50 Hz supply.
- 1.2 Tenderers shall submit full particulars and drawings of the motors offered together with torque-speed curves.

### **2 CONSTRUCTION**

- 2.1 The motors shall be of the squirrel cage or slip-ring type as specified, with enclosures as specified.

### **3 INSTALLATION**

- 3.1 The motors shall be installed by the Electrical Contractor or the Specialist Contractor, as specified in the Contract.

### **4 GUARANTEE**

- 4.1 Tenderers are required to give a twelve month guarantee to replace free of charge any part of the motors in which any manufacturing defects may develop during that period, such period to commence from the date on which the motors are accepted by the Engineer.

## **E227 AIR CIRCUIT BREAKERS**

### **1 GENERAL**

- 1.1 The circuit breakers shall be quick break with adjustable trips, manufactured by an approved manufacturer, or size and type as shown on the drawings. They shall comply with BS 861.
- 1.2 The complete circuit breaker and its electrical and mechanical constituents and accessories must be the standard product of a single manufacturer.
- 1.3 A description and illustration of the circuit breaker, trip curves and copy of the test certificates of breaking capacity shall be submitted by the Tenderer.
- 1.4 The necessary high breaking capacity of the circuit breaker must be inherent in the design, fusible current limiting devices are not acceptable.

### **2 CONSTRUCTION**

- 2.1 The circuit breakers shall be of the triple pole manually operated free handle type, having a nominal current rating and breaking capacity as specified in the schedule.
- 2.2 The circuit breakers shall either be:-
- a fixed air circuit breakers
  - or
  - b of the horizontal withdrawable type, mounted on slide-rails, and suitable for cubicle mounting. It shall be possible to remove the complete breakers from their cubicles.
- 2.3 Interlocks shall be provided to prevent the breakers being withdrawn or inserted in the closed position. Lockable safety shutters shall be provided for rapid extinguishing of the arc. The main contacts shall give a rolling, wiping action on opening or closing.
- 2.5 Thermal overload releases shall be provided and shall be adjustable over the trip range required. In addition, instantaneous magnetic short circuit trips shall be fitted and shall be adjustable above or below the normal setting. Provision shall exist for the addition, if required, of a source side undervoltage lockout, interlocking release, shunt trip, sounding alarm and indicating lamps.
- 2.6 The operating mechanism fitted to the circuit breaker shall be one of three types as specified.
- 2.6.1 Independent manual operated (direct manual)



- 
- 2.6.2 Spring assisted (quick make)
  - 2.6.3 Electrically operated/spring assisted
  - 2.7 All closing/opening operations shall be carried out from the front of the circuit breaker with all controls mounted on the escutcheon plate.
  - 2.8 In the case of spring assisted and electrically operated air circuit breakers, both a close and an open button shall be mounted in the escutcheon plate. With independent manual circuit breakers the close button will be omitted and opening shall be achieved by either operating the open button or by moving the operating handle in the opposite way to closing.
  - 2.9 A visual indicator showing whether the circuit breakers are either in the closed or open position shall be provided. In addition, indication shall be incorporated showing whether the circuit breaker's closing mechanism is either in the charged or uncharged position (the latter being applicable to spring assisted and electrically operated circuit breakers only).
  - 2.10 An external target type breaker position indicator "ON", "OFF" and "TRIP" shall be provided.
  - 2.11 All air circuit breakers shall be fitted with a minimum of four auxiliary contacts adjustable on site to either normally open or normally close.
  
  - 3 **GUARANTEE**
  - 3.1 Tenderers shall give a 12 month guarantee to replace free of charge any part of the air circuit breakers in which any manufacturing defects may develop within that period. Such period will commence from the date on which the air circuit breakers are accepted by the Engineer.

**E228 MOULDED CASE SWITCHGEAR**

- 1 **GENERAL**
- 1.1 Moulded case circuit breakers and isolators shall be of the triple, double or single pole, hand operated, panel mounting air break type, and shall comply with SANS 156. They shall have continuous current ratings as specified and shall be suitable for operating at the rated voltage. Earth leakage relays shall comply with SANS 767.
  
- 2 **MOULDED CASE CIRCUIT BREAKERS**
- The circuit breakers shall have :
- 2.1 Temperature compensated thermal-magnetic or hydraulic magnetic type operation.
- 2.2 Individual trip elements enclosed and sealed in units of approved moulded composition.

- 
- 2.3 A quick-make and break mechanism, insuring full contact pressure to time of opening and tripping free.
  - 2.4 Non-welding type contacts.
  - 2.5 Automatic tripping : Clearly indicated by handle automatically assuming position distinctive from normal "on" and "off" positions.
  - 2.6 Inverse time-overload characteristics to prevent tripping on momentary overloads, but shall trip before dangerous current values are reached.
  - 2.7 Interrupting capacities referred to are asymmetrical values.
  
  - 3 MOULDED CASE ISOLATORS
  - 3.1 The contacts are to be silver alloy and the switch mechanism shall be of the quick-make quick-break type.
  - 3.2 The switches are required to open and close circuits carrying currents up to the full current rating of the switch, and shall be fitted with arc chutes.
  - 3.3 To distinguish the switches from circuit breakers the operating handle shall have a distinctive colour, preferably red or green, or other clear indelible indication.
  
  - 4 EARTH LEAKAGE RELAYS
  - 4.1 The condition of service of the earth leakage relays, as regards methods of connection, number of outlets, whether for single phase or three phase use, and the rating of the associated circuit breaker tripping coil shall be as specified.
  - 4.2 The relays shall operate on the core balance principle to energise the trip coil of the associated circuit breaker by means of a static switching device or magnetic amplifier of simple design.
  - 4.3 The sensitivity and response of the relay shall be such that instantaneous tripping will occur at total earth leakage of 25 milli-amperes where portable tools will be used.
  
  - 5 GUARANTEE
  - 5.1 Tenderers shall give a 12 month's guarantee to replace free of charge any part of the moulded case circuit breakers, moulded case circuit breakers, moulded case isolators or earth leakage relays in which any manufacturing defects may develop during that period. Such period will commence on the date when the equipment is accepted by the Engineer.

**E229 AIR BREAK SWITCHGEAR (FUSE SWITCHES AND FUSES)**

1 GENERAL

- 1.1 The fuse-switches shall comply with SANS 172 and 173, and shall be suitable for operation at the voltage and current specified.

2 CONSTRUCTION

- 2.1 The fuse-switches are to be of the double pole or triple pole with neutral link type, and current rating stated. The fuse links shall be fully isolated when the switches are in the open position, and interlocks shall be provided to prevent the covers being opened when the switches are closed and to prevent the switches being operated with the covers open.
- 2.2 50% Spare fuses of each size with a minimum of 3 fuses of each size shall be provided in suitable accommodation on each switchboard.
- 2.3 Fusegear claimed to conform to this specification shall be supported by certificates of making capacity issued by a recognised short circuit testing laboratory or by the standards authority.
- 2.4 The fuse-switches are to be clearly labelled as specified.

3 GUARANTEE

- 3.1 Tenderers shall give a 12 month guarantee to replace free of charge any fuse-switch unit in which manufacturing defects may develop within that period. Such period will commence from the date on which the fuse-switches are accepted by the Engineer.

Fuse-isolator Units with High Rupturing Capacity Fuses

4 FUSES

- 4.1 The fuse-isolators shall comply with SANS 152 and shall be suitable for operation at the voltage and current specified.

5 CONSTRUCTION

- 5.1 The fuse-isolators are to be of multipole type. Fixed contacts shall be shrouded, and arc chutes provided to minimise the danger resulting from inadvertent closure onto a fault.
- 5.2 50% Spare fuses of each size with a minimum of three fuses of each size shall be provided in suitable accommodation on each switchboard.
- 5.3 The fuse isolators are to be clearly labelled as specified.

6 GUARANTEE

- 6.1 Tenderers shall give a 12 month guarantee to replace free of charge any fuse-isolator units in which manufacturing defects may develop within that period. Such period will commence from the date on which the fuse-isolators are accepted by the Engineer.

## **E230 ARMoured LOW VOLTAGE CABLES**

### **1. GENERAL**

- 1.1 600/1 000 Volt PVC SWA and PVC sheathed cable shall comply with SANS 150 with particular reference to tables L,Q,R and S.
- 1.2 The conductors shall be of high conductivity copper or aluminium as specified insulated with one layer of PVC.

### **2 CONSTRUCTION**

- 2.1 The cores shall be twisted together, bedded, sheathed with PVC (preferably black) armoured with a layer of galvanised steel wire, sheathed with PVC (preferably black).
- 2.2 All insulation shall be for general service 600/1 000 volt grade.

### **3 INSTALLATION**

- 3.1 Glands shall be suitable for PVC SWA and PVC sheathed general purpose 600/1 000 volt cable.
- 3.2 The non-watertight glands shall be easily converted to watertight glands by means of sealing rings and waterproofing shroud.
- 3.3 The glands shall be Pratley, Captive Cone or other approved type. The gland shall be fitted with an earth terminal.
- 3.4 On the cable entry side of the barrel, a groove shall be provided, to accommodate a rim of the waterproof shroud.
- 3.5 The shrouds shall be made of non-deteriorating neoprene or synthetic rubber, and shall be resistant to water, oil and sunlight. The shrouds shall fit tightly around the glands and cable.
- 3.6 Epoxy-resin jointing materials shall be "Scotch-Cast" Splicing Kits or approved alternative and shall be used strictly in accordance with the supplier's recommendations.
- 3.7 Copper cables shall be terminated either by crimped or soldered lugs. Termination of aluminium cables are to be made by a method approved by the Engineer.
- 3.8 The earth terminal shall be connected to the earth bar by a suitable bonding strip.

### **4 LAYING CABLES IN PREPARED TRENCHES (WHERE APPLICABLE)**

- 4.1 Before the cables are laid, the bottom of the trench shall be covered with a 75 mm layer of earth which shall have been passed through a sieve with a maximum mesh of 12 mm.
- 4.2 The cables shall be laid on the prepared bed carefully to avoid cuts and damage. Dragging along the ground shall be avoided wherever practicable. Cable rollers shall be used.
- 4.3 Where more than one cable is laid in a trench, the cables shall be spaced apart at a nominal 75 mm centres, and in straight run trenches, cable crossing will not be permitted except where cables may have to branch from the main run. At every draw-in point or joint box, the cables shall be snaked.
- 4.4 The trench shall be back-filled as soon as possible after cable has been laid. To prevent theft and possible damage, long lengths of cable shall not be left exposed in an open trench overnight.
- 4.5 Water shall not be allowed to accumulate at any part of the works. The Electrical Contractor shall ensure that no cable laying is carried out until the trenches are free from water.
- 4.6 All side channels, sumps or temporary excavations for dewatering purposes shall be filled in after use.
- 4.7 Cables shall be covered with a layer of minimum thickness 75 mm of earth which shall have been passed through a sieve with maximum mesh of 12 mm.
- 5 CABLE WARNING TILES (WHERE APPLICABLE)
  - 5.1 Where noted, cables shall be covered with concrete tiles 600 mm long x 225 mm wide x 50 mm thick of approved design.
  - 5.2 The routes of all underground cables and duct ends shall be marked by means of approved concrete markers having cast insert the words "Electric Cables" positioned at every change of direction, and every point of crossing another cable, or service, and not less than one per 30 metres of straight run.
- 6 PLASTIC CABLE WARNING SHEETING (WHERE APPLICABLE)
  - 6.1 Unless otherwise noted, all cables shall be covered with a light yellow plastic warning sheet of approved design with the skull and cross bones insignia together with the words "DANGER, GEVAAR, INGOZI" printed in black at regular intervals. The warning shall be placed 300 mm above the top of the cable.
- 7 TESTS
  - 7.1 During manufacture and before despatch the cables may be inspected by the Engineer at the manufacturer's works or when installed and subjected to such tests as may be deemed necessary.
- 8 GUARANTEE
  - 8.1 Tenderers shall give a 12 month guarantee to replace free of charge any cable in which manufacturing defects may develop during this period. Such period shall commence from the date on which

the cable is accepted by the Engineer.

**E231      POWER SKIRTING TRUNKING SYSTEM**

**1          GENERAL**

- 1.1      The power skirting trunking system shall meet the requirements of the Standard Regulations, and the Post Office.

**2          CONSTRUCTION**

- 2.1      Power skirting trunking shall be manufactured from 1,6 mm galvanised sheet steel with a baked paint finish or extruded aluminium of equal thickness. The trunking shall be rigidly constructed and braced to prevent distortion or twist when placed in position.
- 2.2      A sample shall be submitted to the Engineer for approval provided prior to manufacture.

**3          INSTALLATION**

- 3.1      Power skirting trunking shall be located in place either on finished wall or on wall prior to plaster finishes dependent on whether trunking is surface or flush mounted.
- 3.2      The system shall be suitable for either surface or flush installation as specified and for connecting into underfloor duct systems as required. The layout of power skirting trunking shall be such that partitions, module lines and columns shall not interfere with the removal of access covers.
- 3.3      Power skirting trunking shall be securely fixed to wall and alignment ensured.
- 3.4      Conduit connections through columns, around columns and linking up with underfloor duct systems shall be installed during building construction of columns, floors and walls.
- 3.5      Before any wiring is commenced, all compartments shall be cleaned and all debris and foreign material removed.
- 3.6      Earthing conductors of cross sectional area as specified shall be run throughout the system.
- 3.7      Access covers for power and telephones shall be independent from one another.
- 3.8      All accessories such as underfloor duct trunking connections, couplings, corners, off-sets, conduit connections, etc to make the system complete, shall be provided.
- 3.9      The coverplates shall be manufactured in short lengths in order that a section may be easily removed. In no case shall the coverplate be larger than the building module.
- 3.10     Power and communication compartments shall have separately removable coverplates.

**4          GUARANTEE**

- 4.1 Tenderers shall give a 12 months guarantee to replace free of charge any power skirting trunking in which manufacturing defects may develop during that period. Such period shall commence from the date on which the power skirting trunking is accepted by the Engineer.

## **E232 WIRING TRAYS AND DRAW IN BOXES**

### **1 GENERAL**

- 1.1 The wiring trays shall comply with SANS 1197.

### **2 CONSTRUCTION**

- 2.1 Wiring trays and draw-in boxes shall be galvanised steel. After fabrication they shall be cleaned thoroughly and painted with galvanised iron primer as approved.

### **3 INSTALLATION**

- 3.1 Wiring trays shall be installed in the roof space directly above distribution boards to facilitate the conduit installation. Such trays shall be constructed of minimum 1,60 mm sheet steel with detachable covers and shall be galvanised. The length of the trays shall be equivalent to the width of the board below. The width shall be sufficient to accommodate conduits entering from the sides plus spares at saddle distance apart but not less than 300 mm. Wiring trays shall not be less than 75 mm deep with multiple conduit entries including spare 20 mm and 25 mm wide entry knock-outs or blanked-off entries and they shall be rigidly supported, and installed so that conduits shall enter without offsets. Two spares 20 mm and one spare 25 mm conduit shall be installed between each distribution board and its roof wiring tray.
- 3.2 Draw-boxes shall be provided with suitable sheet steel cover plates fixed to the boxes by means of screws. The cover plates shall be installed before the ceilings are painted by others.
- 3.3 The Electrical Contractor shall arrange his wiring tray layout in conjunction with other trades and no work shall commence until he has verified, by means of co-ordination drawings to the Engineer's approval, that his wiring trays will not clash with the services of other trades. Wiring trays and draw-in boxes shall be located as approved but generally shall not be exposed in finished spaces. Where necessary conduits shall be re-routed or other arrangements for concealment made.
- 3.4 Wiring trays and draw-in boxes shall be fixed independently to the building structure with no weight bearing on conduits.
- 3.5 All covers shall be accessible.
- 3.6 Particular care is to be taken to site draw boxes inconspicuously in order to deface as little as possible the finished surface of the building.

### **4 GUARANTEE**

- 4.1 Tenderers shall give a 12 month guarantee to replace free of charge any wiring trays and draw-in boxes in which manufacturing defects may develop during that period. Such period will commence from the date on which the wiring trays and draw-in boxes are accepted by the Engineer.

## **E233 LIGHTNING PROTECTION FOR BUILDINGS**

### **1 GENERAL**

- 1.1 The supply and installation of the lightning conductor installation shall be carried out in accordance with this specification and the recommendation of the SANS Code of Practice 10313 - "Protection of Structures against Lightning" - where applicable.
- 1.2 Care shall be taken when bonding dissimilar metals to prevent electrolytic corrosion. All bi-metallic joints shall be sealed with an inert, tenacious, waterproof compound.

### **2 CONSTRUCTION**

- 2.1 The component parts of the lightning conductor system shall be as follows:
- 2.2 Air terminals shall be of medium/hard-drawn phosphor bronze rod of 12,5 mm diameter with single or multi point heads, and with suitable means for connecting to the roof conductor. The minimum length shall be 900 mm.
- 2.3 Roof conductors shall be of soft annealed copper strip having cross-sectional area of 20 x 3,2 mm and shall run as directly as possible between the air terminal and earthing system.
- 2.4 Down conductors of soft annealed copper strip having a cross-sectional area of 25 x 3,2 mm are required every 30 m.
- 2.5 The reinforcing steel of the building may be used as a down conductor provided that it is adequately bonded to the earthing system.
- 2.6 The reinforcing system of prefabricated 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.
- 2.7 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 30 metres. The upper ends of the columns should be bonded to the air terminal system and the lower ends to the earthing system.
- 2.8 Each earth termination shall comprise a tinned copper plate of size 900 x 900 x 3,2 mm one of which shall be riveted and soldered to each down conductor, alternatively Copperweld earth spikes 10 x 2 400 mm may be used as noted, or a trench earth comprising 70 mm<sup>2</sup> diameter copper.



2.9 Test clamps shall be phosphor bronze and shall be designed to enable the easy removal of conductors for testing the system.

### 3 INSTALLATION

3.1 The Electrical Contractor shall be responsible for all work on the lightning protection system except for trenching. The Electrical Contractor shall co-operate with the principal contractor in the placing of the earthing cables and the bonds to structural steel.

3.2 Air terminals shall be installed as shown on the drawing and shall protrude not less than 900 mm above the highest point of the building. Air terminals shall be fixed with a suitable saddle provided with anchor straps for fixing to parapet walls, whilst provision shall be made for clamping the air terminal to the roof conductor.

3.3 The roof conductor shall be fixed as shown on the drawings and shall be saddled where necessary. Down conductors shall be connected to the roof conductors and shall be installed that these are connected to earth via the shortest route. Down conductors shall be secured at intervals not exceeding 900 mm with gun-metal caulking-in type holdfasts.

3.4 Holdfasts shall be provided with 5 mm shanks, retaining plates slotted for 25 x 12,5 mm copper tape and retaining bars secured with two brass screws or bolts. Sharp bends in conductors shall be avoided where possible.

3.5 Earth plates shall be installed at a depth of 1 800 mm below finished grade and at a minimum distance of 3 metres from the building or a trench earth described in 2.8 above. The soil shall be reinstated in 250 mm layers and thoroughly mixed with rock salt. Test points shall be provided in each down conductor at a height of 1 500 mm above finished grade. All joints shall have a minimum overlap of three inches and shall be double rivetted and soldered. The earth resistance of each earth termination shall not exceed 200 ohms.

3.6 All metal work in the vicinity of the lightning conductor system shall be bonded to the system with roof conductor tape and shall include roof tanks, pipework on the roof and all other metal work on the roofs.

3.7 Steel to copper and copper to copper-bonds shall be made by means of exothermic welds.

### 4 GUARANTEE

4.1 Tenderers shall give a 12 month guarantee to replace free of charge any parts of the lightning protection system in which manufacturing defects may develop during this period. Such period shall commence from the date on which the system is accepted by the Engineer.

## **E234 PHOTO ELECTRIC CELLS**

### 1 GENERAL

Each unit shall be self-contained and enclosed in a weatherproof housing suitable for mounting either on the top of a pole or by means of a bracket attached to a wall.

The levels of daylight shall be monitored by a hermetically sealed photo conductive cell.

## 2 CONSTRUCTION

The photo-electric switch shall:

- have a minimum contact capacity of 5 A at 230 V

- operate at a nominal voltage of 230 V with +- 10% variation.

- operate at a frequency of 50 HZ

- withstand weather conditions, pole vibrations, hail, corrosion from atmospheric conditions dust and UV radiation

- operate satisfactorily within the temperature range of -10 degrees celcius to +55 degrees celcius.

Switching shall be positive between either "ON" or "OFF" states.

"ON" switching shall occur at 12-18 lux and "OFF" switching at 50-60 lux.

(NB - Illumination is expected in terms of lux measured in the horizontal plane one meter above finished ground level).

The photo-electric switch shall have a time delay of one to two minutes to avoid unnecessary switching.

The photo-electric switch shall be capable of making a minimum of 5000 satisfactory switching operations.

## 3 GUARANTEE

Tenderers shall give a 12 months guarantee to replace free of charge any photo electric cells in which manufacturing defects may develop within that period. Such period will commence from the date on which the photo electric cells are accepted by the Engineer.

## E235 NON MAINTAINED EMERGENCY LIGHTING

### 1 GENERAL

1.1 The voltage and wattage of the lamps shall be as specified.

1.2 Emergency lighting shall be powered from one of the following sources as specified:

- 1 Stand-by generator.
  - 2 Central battery.
  - 3 Self-contained, single point luminaires.
- 2 CONSTRUCTION
- 2.1 Self-contained fluorescent luminaires shall have control gear comprising an inverter, battery charger and battery, and an automatic solid state change-over device, all contained in an aluminium housing acting as a heat sink with facilities for attaching it to the luminaire body. Alternatively luminaires may have tungsten filament lamps, as specified.
  - 2.2 All internal wiring shall be colour coded and shall relate to a circuit diagram to be attached to the inside of the luminaire housing. Connections to terminal wiring blocks shall be clearly identified.
- 3 TESTING
- 3.1 On completion of the installation all emergency lighting luminaires shall be switched on and checked in the presence of the Engineer and the Client or his representative.
- 4 GUARANTEE
- 4.1 Tenderers shall give a 12 month guarantee to replace free of charge any parts of the emergency lighting equipment in which manufacturing defects may develop during that period. Such period shall commence from the date on which the emergency lighting installation is accepted by the Engineer.

**E236 AUTOMATIC EARLY WARNING FIRE AND SMOKE DETECTION SYSTEM**

- 1 GENERAL
- 1.1 The system shall provide protection of all areas indicated on the drawings. The work shall be co-ordinated with the air conditioning installation.
- 1.2 The system shall comprise a 24 volt DC closed circuit, zoned electrically supervised fire alarm system supplied and installed by the Specialist Contractor.
- 1.3 The fire alarm system shall comply with the latest requirements of:
  - (a) SANS 0139
  - (b) Local Municipal Regulations
  - (c) The South African Fire Insurance Council.
- 1.4 The Electrical Contractor shall obtain all required permits and approval in writing for the complete system prior to installation. He shall also notify the Fire Brigade when work on the fire alarm system will commence and, on completion of the work, provide the Engineer with their letter of approval before requesting acceptance of the installation.

- 1.5 The work shall be co-ordinated with all other relevant trades in respect of electrical interconnection and services co-ordination.
- 1.6 The alarm system shall not cause radio interference.
- 1.7 Where there may be high levels of interference from other equipment or external sources such as lightning or power supply transients, special care shall be taken in the design and installation of the fire alarm equipment to reduce the possibility of interference signals affecting the normal operation of the system.
- 1.8 The Electrical Contractor shall be responsible for:
  - (a) Installing all conduit and ducting complete with draw wires, draw boxes, termination boxes and installing power plugs in the positions indicated by the Specialists Contractor.
  - (b) Providing a single phase supply at the rated voltage
  - (c) Giving assistance to the Specialist Contractor of equipment during testing of the system.
- 1.9 The Building Contractor shall be responsible for:
  - (a) Removal, replacement and cutting of ceiling tiles.
  - (b) Temporary power and lighting
  - (c) Cutting and chasing of walls
- 1.10 The Specialist Supplier of the equipment shall be responsible for:
  - (a) Supplying, installing and connecting up all detectors and equipment.
  - (b) The provision of all wiring diagrams and instructions
  - (c) The testing and adjusting of the system including the supplying of smoke material for system testing.
- 2 OPERATION
- 2.1 Operation of any combustion detector shall :-
  - (a) Automatically cause an alarm to be received at the local fire station by means of a dedicated telephone line. Fault signals shall not be transmitted to the local fire station
  - (b) Activate an audible alarm(s) in the position(s) shown on the drawings
  - (c) Switch on a light on the control panel/console indicating in which zone the combustion detector unit has been operated
  - (d) Actuate computer interface contacts
  - (e) Actuate CO<sub>2</sub> gas discharge, or sprinkler system
  - (f) Actuate interlock with forced ventilation fan motor(s).
- 2.2 Fault lights shall be provided on the control panel to indicate :-
  - (a) Open circuit
  - (b) Short circuit
  - (c) Earth leakage.

- 
- 2.3 After an alarm has been given the alarm shall continue until normal conditions have been restored. The operation of a silencing device while an alarm exists shall not cancel the visual indication of the alarm on the control panel/console. Automatic silencing of alarms is not required.
- 2.4 The alarm circuits shall be so arranged that a short circuit or disconnection at a single point in the wiring does not result in the silencing of all the audible alarms in the building.
- 2.5 When audible alarms are provided by intercommunication or public address equipment, it shall be ensured that:-
- (a) the alarm is automatically or simultaneously transmitted to all areas in which the alarm is required, taking priority and overriding every other facility and circuit condition of the equipment.
  - (b) during the fire alarm conditions all microphones shall be automatically disconnected, except one, designated "fire microphone", that is retained in circuit so that it can be used for announcements and instructions relating to the fire.
- 3 EQUIPMENT
- 3.1 A 24 volt DC supply shall be provided by means of a transformer, silicon bridge rectifier, battery, fuses and switching arrangements. All equipment shall be suitably rated and designed to automatically deliver a trickle or boost charge as determined by the battery voltage. The charger shall switch off automatically when the battery is fully charged.
- 3.2 The battery and power supply equipment shall be sited in an area of low fire risk, as specified.
- 3.3 The power supply unit shall have ample capacity to operate the complete control panel, bells, or audible signals, detectors and provide current to charge the batteries from trickle charge (20 - 30 milliamps) to 2,5 amp for restoring a flat battery. The power supply unit shall indicate a fault in the event of a mains failure.
- 3.4 The batteries shall be either of the nickel cadmium type or lead-acid type and shall have ample capacity to supply the system in the event of a mains failure.
- 3.5 Four continuously rated relays, each with a pair of normally open/normally closed contacts rated at 10 amps, 24 volts, shall be included for use as a computer interface.
- 3.6 Alarm bells shall be surface mounted, 150 mm diameter, 24 volt operated.
- 3.7 The combustion detectors shall operate on a 24 V D.C. power supply and be suitable for connection in the circuit to the control panel using twin wire.
- 3.8 The detector base section shall be suitable for easy removal and replacement of the detectors, and shall allow for the interchanging of the different types of detectors without any modifications being necessary. The base to be employed shall depend on the special mounting conditions required, and the bases offered shall be suitable for:
- recess mounting
  - surface mounting
  - mounting in damp rooms
  - suspended mounting

- explosion proof mounting, with intrinsic safety
- 3.9 A visual alarm detection indication lamp shall be incorporated on each detector which shall illuminate or flash on the detector being activated. On installation the detector shall be orientated so that the indication light faces towards the entrance to the room, or to where in can easily be visible on entry to the space in an emergency.
- 3.10 The following types of detectors shall be used to suit the applications described, or as detailed on the drawings:-
- (a) Ionisation Smoke Detector
 

The ionisation chamber type responds to invisible and visible combustion products. It is suitable for most types of fire.
  - (b) Optical Smoke Detector
 

This is the photoelectric cell type which reacts to visible smoke. It is especially suitable in combination with the ionisation and electronic equipment. In areas where PVC cables are prevalent (as in the underfloor void of computer rooms) the smoke detectors shall be installed in the ratio of 3 x ionisation type to 1 x photoelectric type units.
  - (c) Radiation Detector
 

The infra-red type responds to the flickering of flames. It has its special field of application where instantaneous detection of fire is essential (utilising the principle of light travelling faster than smoke or heat). It shall be used in areas containing explosives, etc., in very high rooms where specified, or where specifically specified.
  - (d) Rate-of-Rise Temperature Detector
 

This detector responds to a rapid rise in temperature over a fixed period of approximately 30 secs. It shall incorporate a high temperature set point which will also activate the alarm. This unit shall be employed where other detectors cannot be utilised because of deceptive phenomena, such as in stand-by generator rooms, engine rooms, parking areas etc. where products of combustion are to be expected.
- 3.11 Duct Mounted Detectors
- 3.12 Where required the duct mounted detector unit, with probes to penetrate into the duct, shall be supplied for surveillance of the air flowing within ventilation or air conditioning shafts or ducts.
- 3.13 The detector base section shall be suitable for easy removal and replacement of the detectors, and shall allow for the interchanging of the different types of detectors without any modifications being necessary. The base to be employed shall depend on the special mounting conditions required, and the bases offered shall be suitable for:
- recess mounting
  - surface mounting
  - mounting in damp rooms
  - suspended mounting
  - explosion proof mounting, with intrinsic safety.

- 3.14 A visual alarm detection indication lamp shall be incorporated on each detector which shall illuminate or flash on the detector being activated. On installation the detector shall be orientated so that the indication light faces towards the entrance to the room, or to where it can easily be visible on entry to the space in an emergency
- 3.15 The detectors should have an adjustable sensitivity and a means of measuring the sensitivity.
- 3.16 The detectors should have a means of checking whether air conditioning or air flow factors are affecting the sensitivity or proper operation. Allowance must be made for the fitting of remote visual indicators in the ceiling tile immediately adjacent to the detectors.
- 3.17 The detectors should operate satisfactorily with an air flow rate across the detector chamber of up to 100 m per minute.
- 3.18 The detectors shall operate on a voltage between 20 to 30 volts, and shall have internal voltage regulation.
- 4 CABLES AND WIRING
- 4.1 The following types of cable may be used subject to the approval of the Engineer:-
- (a) M.I.M.S. complying with BS.6207 Part 1. This cable should be suitably protected where it is liable to physical damage.
  - (b) PVC insulated non-sheathed cable complying with SANS 150. The cable should be protected by conduit or trunking, or it should be installed in a duct or channel.
  - (c) PVC insulated and sheathed cable complying with SANS 150. The cable should be protected by conduit or trunking, or it should be installed in a duct or channel.
- 4.2 The minimum permitted conductor size is 1.5mm<sup>2</sup>.
- 4.3 All wiring shall be carried out on the loop-in system to facilitate ease of connection of various apparatus.
- 4.4 All conductors interconnecting various components shall be colour coded.
- 4.5 The conduit system shall be independent of all other systems. Conduits shall be black enamelled unless otherwise stated.
- 5 TESTING
- 5.1 The Electrical Contractor shall carry out working tests of the equipment in the presence of the Fire Department and the Engineer.
- 5.2 The Electrical Contractor shall bear all expenses for labour, material and instruments used in testing.
- 6 DRAWINGS
- 6.1 The Electrical Contractor shall provide one set of as-built drawings on linen or plastic film.

7 SPARES AND TOOLS

- 7.1 The tenderer shall indicate what tools, test equipment and spares he would recommend for the maintenance of the equipment.

8 GUARANTEE

- 8.1 The tenderer shall give a 12 months guarantee to replace free of charge any part of the fire and smoke detection system in which manufacturing defects may develop within that period. Such period will commence from the date on which the equipment is accepted by the Engineer.

9 MAINTENANCE

- 9.1 The tenderer shall quote for an annual maintenance contract to come into operation at the end of the 12 month's guarantee period. It shall comprise a three monthly service when the following shall be checked:-

- (a) Control equipment
- (b) System functions for normal operation
- (c) Fire brigade signalling (if applicable)
- (d) All lamps in visual indicators
- (e) All audible alarms
- (f) Battery, electrolyte level, and charging rate.

- 9.2 A detailed inspection service report sheet shall be prepared showing the inspections to be carried out and the intervals between such inspections to enable records of servicing to be kept. Provision shall be made for the signatures of both the Maintenance Contracts Serviceman and the Client to verify that the maintenance duties have been carried out. Each service shall be carried out in the presence of the Client or his representative.

**E237 CONNECTIONS TO MOTORS**

1 GENERAL

- 1.1 The Electrical Contractor shall:-

- a) Supply angle iron framework and channels as required.
- b) Erect starters on angle iron framework at motors, on walls, motor control centres or floor channels as indicated on the drawings.
- c) Provide wiring from the main LV switchboard to all sub-distribution boards, motor control centres, switches, socket outlets, junction boxes, motors, motor starters and actuating devices.
- d) Accept delivery of starters and control devices at site as directed, and re-assemble them as necessary.



- e) Ascertain exact locations of motor starters, motor control centres and control devices prior to installing and wiring up.
  - f) Provide all control and interlock field wiring.
  - g) Provide isolators, lockout pushbuttons, etc. as noted.
- 1.2 Motors, starters, actuating and control devices shall be supplied by others except as noted.
- 1.3 All the equipment shall be suitable for working at the rated voltage.
- 2 INSTALLATION
- 2.1 The Electrical Contractor shall supply and install PVC insulated conductors in heavy gauge conduit or PVC, SWA & PVC cables on perforated cable trays, with claw type cleats, in ducts and trenches, or MIMS cable as specified.
- 2.2 Final connections to motors shall be made as follows:
- a) Flexible conduit soldered or brazed into brass glands shall be used with an earth wire run through the conduit between the distribution board and the motor terminal box. Where motors are exposed to the weather or are mounted in moist environments eg sump pumps, the flexible conduit shall be of weatherproof quality and PVC taped overall, including the glands.
  - b) Mineral insulated copper sheathed, PVC or aluminium sheathed cable installation shall terminate at the entry to the terminal box with a loop of cable, to enable the motor to be removed without damage to the cable, and also to eliminate cable fractures resulting from motor vibration.
  - c) Where terminal box entries are restricted the conduit may be terminated with a conduit box and the final connection to the motor made by using flexible cable. In these cases one extra core shall be provided in the flexible cable for earthing purposes.
  - d) All motors more than two metres from a distribution board shall be fitted with an isolating switch of the correctly rated capacity, adjacent to the motor, supplied and installed by the Electrical Contractor. When this is exposed to the weather the isolator shall be weatherproof. In the case of interlocked systems i.e. air conditioning, the isolator shall be lockable to prevent unauthorised switching.
  - e) Earth wire shall be run in conduit feeding motors and control gear.
- 2.3 Motor disconnecting devices shall be installed at motor locations where indicated and as required by the "standard regulation". Devices shall not be grouped at central location, except as indicated.
- 2.4 Disconnecting devices shall be provided either by means of a lock-out push button to interrupt the motor control circuit or by means of an isolating switch of ampere rating as noted on the drawings.
- 2.5 The Electrical Contractor shall allow sufficient clearance for removal of the motor(s).

### 3 FIELD CONTROL STATIONS

Unless otherwise stated a field control station shall be installed next to each motor and shall be provided with the following control push buttons:

- Start
- Stop
- Emergency Stop
- Forward (where required in place of Start)
- Reverse (where required)

Field control stations shall be mounted on galvanized steel stanchions and shall be weatherproof to IP 65.

## E238 CAST RESIN TYPE POWER TRANSFORMERS

### 1 - SCOPE

Three-phase transformers of cast resin type, class F insulation system with natural (AN) cooling for indoor installation, destined for use in three-phase HV/LV distribution systems.

If required forced cooling (AF) to increase the rated power up to 40%.

### 2 - Standards

These transformers will be in compliance with the following standards :

- IEC 76-1 to 76-5
- IEC 726 1982 edition + modification nr 1 dated February 1986
- CENELEC Harmonisation Documents :
- HD 464 Si : 1988 + / A2: 1991 + / A3 : 1992 for dry-type power transformers
- HD 538-1 Si : 1992 for three-phase d'y-type distribution transformers 51Hz, from 100 to 2500 kVA with highest voltage for equipment not exceeding 24 kV.
- IEC 905: 1987 - Load guide for dry-type power transformers.

These transformers will be manufactured in accordance with /

- a quality system in conformity with ISO 9001
- an environmental management system in conformity with ISO 14001, both certified by an official independent organisation.

### 3 - Description

#### 3.1 - magnetic core

This will be made from laminations of grain oriented silicon steel, insulated with mineral oxide and will be protected against corrosion with a coat of varnish.

### **3.2 - LV windings**

These will be made from aluminium or copper foil (according to the manufacturer's preference) with class F interlayer insulation by encapsulation (impregnation) with synthetic alkyd resin or equivalent. At least the upper part of the LV coils will be covered with a coat of epoxy resin or equivalent and the foil will be protected everywhere with an insulation material even in the air ducts.

### **3.3 - HV windings**

These will be independent of the LV windings and will be made of aluminium or copper wire or foil (according to the manufacturer's preference) with class F insulation.

The HV windings will be vacuum cast in a class F fireproof epoxy resin casting system composed of: -an epoxy resin

- an anhydride hardener with a flexibilising additive
- a flame-retardant filler.

The flame-retardant filler will be thoroughly mixed with the resin and hardener. It will be composed of trihydrated alumina powder (or aluminium hydroxide) or other flame-retardant products to be specified, either mixed with silica or not.

The casting system will be of Class F.

### **3.4 - HV connections**

The HV connections will be made from above on the top of the connection bars. Each bar will be drilled with a 13 mm hole ready for connection of cable lugs on terminal plates.

The HV connection bars will be in rigid copper bars protected by heat shrinkable tubing. HV connections in cables are not allowed.

The HV connections will be in copper.

### **3.5 - LV connections**

The LV connections will be made from above onto bars located at the top of the coils on the opposite side to the HV connections.

Connection of the LV neutral will be directly made to the LV terminals between the LV phase bars.

The LV connection bars will be in copper or in tinned aluminium (according to preference of the manufacturer).

### **3.6 - HV tapping**

The tapping which act on the highest voltage adapting the transformer to the real supply voltage value, will be off-circuit bolted links.

Tapping with connection cables are not allowed.

These bolted links will be attached to the HV coils.

## **4 - Accessories and standard equipment**

These transformers will be equipped with :

- 4 flat hi-directional rollers
- lifting lugs
- haulage holes on the underbase
  
- 2 earthing terminals
- 1 rating plate
- 1 "Danger Electricity" warning label (T 10 warning)
- 1 routine tests certificate
- 1 instruction manual for installation, commissioning and maintenance in English.

## **5 – Thermal protection**

These transformers will be equipped with a thermal protection device which will comprise 2 sets of 3 PTC sensors, one sensor for "Alarm 1", one for "Alarm 2" per phase, installed in the coils of the transformer. They will be placed in a tube to enable them to be replaced if ever necessary.

An electronic converter with two independent monitoring circuits equipped with a changeover switch, one for "Alarm 1" the other for "Alarm 2". The position of the relays will be indicated by different coloured indicator lights. A third indicator light will indicate the presence of voltage.

These three indicator lights will be on the front of the converter. The electronic converter will be installed away from the transformer.

A plug-in terminal block for connection of the PTC sensors to the electronic converter.

The PTC sensors will be supplied assembled and wired to the terminal block fixed on the upper part of the transformer. The converter will be supplied loose with the transformer, packaged complete with its wiring diagram.

## **6 - Metal enclosure**

On request, these transformers will be equipped with a metal enclosure for indoor installation comprising an integral IP 31 (except the base which may be IP 21) metal enclosure with

- an anti-corrosion protection in the manufacturer's standard colour

- lifting lugs enabling the transformer and enclosure assembly to be handled.

- a bolted access panel on the enclosure front to allow access to the HV connections and to the tapping. This will be fitted with handles, it will have one "Danger Electricity" warning label (T 10 warning), a rating plate and a visible braid for earthing.

- blanked off holes for fitting Ronis ELP 1 or alternatively Profalux P1 type key locks on the bolted access panel to enable it to be locked.

- 2 undrilled gland plates on the roof : one on the HV side, one on the LV side (drilling and cable gland not supplied).

-1 plate at the right HV side on the bottom of the enclosure for the HV cables for connections from the bottom.

<b>Technical Data</b>
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<b>For each requested transformer, the supplier will give the following data :</b>		
Rated power .....	kVA	
Cooling .....		
Quantity....		Hz
Rated frequency .....		kV
Rated primary voltage .....		kV
Rated primary insulation level .....		kV
Applied voltage to industrial frequency .....		kV
Basic Insulation Level (BM) or impulse .....		V
Off-circuit tapping .....		V
Secondary voltage at no load      between phases .....		kV
phase to neutral.....		kV
Rated secondary insulation level		
Applied secondary voltage to industrial frequency .....		
Vector group.....		
No load losses.....		W
Load losses at 75° C .....		W
Load losses at 120° C .....		W
Rated impedance voltage at 120° C .....		%
Acoustic power Lw(A) .....	dB(A)	
Acoustic pressure at 1 metre Lp(A) .....	dB(A)	
Maximum ambient temperature .....		°C
Daily average ambient temperature.....		°C
Yearly average ambient temperature.....		°C
Maximum altitude .....		m
HV winding temperature class .....	F	
LV winding temperature class .....	F	
Temperature of insulation system .....	155	°C
Climatic classification (HD 464 51) .....	C2	
Environmental classification (I-1D 464 51) .....	E2	
Fire behaviour classification (HD 464 51) .....	FI	

Enclosure .....	YES	NO*
Protection degree.....	IP 31	
Length .....	mm	
Width .....	mm	
Height.....	mm	
Total weight.....	kg	
Measurement circuit supply voltage for the thermal protection electronic converter .....	DC AC	V

\* delete as necessary

## E239 POWER METER

### A. General Provisions

1. All setup parameters required by the Power Meter shall be stored in nonvolatile memory and retained in the event of a control power interruption.
2. The Power Meter may be applied in three-phase, three- or four-wire systems as well as single phase
3. The Power Meter shall be capable of being applied without modification at nominal frequencies of 45 to 65 Hz.

### B. Measured values

1. The Power Meter shall provide the following, true RivIS metered quantities:
  - a) Real-Time Readings
    - 1) Current (Per-Phase)
    - 2) Voltage (L—L L—N )
    - 3) Real Power ( Total)
    - 4) Reactive Power ( Total)
    - 5) Apparent Power ( Total)
    - 6) Power Factor ( Total)
    - 7) Frequency
  - b) Energy Readings
    - 1) Accumulated Energy (Real kWh, Reactive kVarh, Apparent KVAh)
  - c) Demand Readings
    - 1) Demand Current Calculations(Per-Phase):
      - (i) Present
      - (ii) Peak
    - 2) Demand Real Power Calculations( Total ):
      - (i) Present
      - (ii) Peak
    - 3) Demand Reactive Power Calculations( Total):
      - (i) Present
      - (ii) Peak
    - 4) Demand Apparent Power Calculations( Total):
      - (i) Present
      - (ii) Peak

**C. Demand**

1. All power demand calculations shall use any one of the following calculation methods, selectable by the user:
  - a) Block interval, with optional sub-intervals. The window length shall be set by the user from 1-60 minutes in 1 minute intervals. The user shall be able to set the sub-interval length from 1-60 minutes in 1-minute intervals. The following Block methods are available:
    - 1) Sliding Block that calculates demand every 15 seconds with intervals less than 15 minutes and every 60 seconds with an interval between 15 and 60 minutes.
    - 2) Fixed Block that calculates demand at the end of the interval.

**D. Sampling**

1. The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 15<sup>th</sup> harmonic.
2. The Power Meter shall provide continuous sampling at a minimum of up to 32 samples/cycle, simultaneously
  - on all voltage-and current-channels in the meter.

**E. Current Inputs**

1. The Power Meter shall accept current inputs from standard instrument current transformers with 5 amp secondary output and shall have a metering range of 0-6 amps with the following withstand currents: 10 amp continuous, 50 amp 10 sec per hour, 120 amp 1 sec per hour.
2. Current transformer primaries through 327 kA shall be supported.

**F. Voltage Inputs**

1. The Power Meter shall allow connection to circuits up to 480 volts AC without the use of potential transformers. The Power Meter shall also accept voltage inputs from standard instrument potential transformers. The Power Meter shall support PT primaries through 1.6 MV.
2. The nominal full scale input of the Power Meter shall be 277 Volts AC L-N, 480 Volts AC L-L. The meter shall accept a metering over-range of 20%. The input impedance shall be greater than 2 Mohm (L-L) or 1Mohm(L-N).

**G. Accuracy**

1. The Power Meter shall comply with ANSI C12.16 and IEC62053-21 Class 1.
2. The Power Meter shall be accurate to 1% of reading for power and energy. Voltage and current shall be accurate to 0,5% of reading. Frequency metering shall be accurate  $\pm 0.01$  Hz at 45-65 Hz.
3. These accuracies shall be maintained for both light and full loads.
4. No annual calibration shall be required to maintain this accuracy.

**J. Input/Output (PM200P Only)**

1. The Power Meter shall supply 2 pulse outputs as standard.
2. The Power Meter shall be capable of operating a solid state output to provide output pulses for a user definable increment of reported energy. Minimum relay life shall be in excess of one billion operations. The standard pulse output shall operate up to 240 volt AC, 300 volt DC, 96mA max, and provide 2.41 kvolt nns isolation.

**M. Control Power**

1. The Power Meter shall operate properly over a wide range of control power including 110-415 VAC, +1-10% or 125-250 VDC, +1-20%.

**N. Communications (PIV1210 Only)**

1. The Power Meter shall communicate via RS-485 Modbus protocol with a 2-wire connection at speeds up to 19.2 kBaud.
2. It shall be possible to field upgrade the firmware in the Power Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or

changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade

**0. Display**

1. The Power Meter display shall be back lit LCD for easy viewing, display shall also be anti-glare and scratch resistant
2. The Display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system.
3. The Display shall show 3 phase bargraphs
4. The Power Meter display shall provide local access to the following metered quantities:
  - a) Current, per phase rms
  - b) Voltage, phase-to-phase, phase-to-neutral
  - c) Real power, 3-phase total
  - d) Reactive power, 3-phase total
  - e) Apparent power, 3-phase total
  - f) Power factor, 3-phase total
  - g) Frequency
  - 19 Demand current, per phase
  - i) Demand real power, three phase total
  - j) Demand apparent power, three phase total
  - k) Accumulated Energy, (kWh, kVAh, and kVARh)
5. Reset of the following electrical parameters shall also be allowed from the Power Meter display:
  - a) Peak demand current
  - b) Peak demand power (kW, kVar, kVA)
  - c) Energy (MWh) and reactive energy (MVARh)
5. Setup for system requirements shall be allowed from the Power Meter display. Setup provisions shall include:
  - a) CT rating
  - b) PT rating (Single Phase, 2-Wire)
  - c) System type [three-phase, 3-wire] [three-phase, 4-wire] [2 wire]
  - d) Watt-hours per pulse (1<sup>3</sup>1v1200P Only)
  - e) Communication parameters such as address and baud rate(PM210 Only).

**P. Installation**

1. To ensure safety of goods and people, the installation category of the Power Meter shall be III. The communication circuit shall be of SELV type (security extra low voltage) and shall provide a class II insulation level between distribution system connection and communication port. The meter shall withstand a Uimp of 6kV. (Uimp: impulse withstand voltage ).
2. The Power Meter shall be rated for an operating temperature range of 0°C to +60°C.
3. Depth of the Power Meter behind panel with communication port shall be equal or less than 50mm.



BID DESCRIPTION: TENDER FOR THE REFURBISHMENT AND UPGRADE OF PUMP STATION 34, UPGRADE OF RISING MAIN PIPELINE FROM PUMP STATION 2 TO LEEUWKUIL WASTEWATER TREATMENT WORKS, UPGRADE OF WASH WATER PUMP STATION AT LEEUWKUIL, AND REFURBISHMENT OF INLET WORKS OF LEEUWKUIL AND RIETSPRUIT

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