APPENDIX A : STANDARD SPECIFICATIONS
SPECIFICATION FOR RING MAIN UNIT SWITCHGEAR WITH CIRCUIT BREAKERS, FROM 3 TO 24KV
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Last update: 2018-10-10
1. General conditions

These specifications apply to factory-built, RMU type, metal-enclosed indoor switchgears. The equipment to be supplied shall come in the form of a compact switchboard and shall meet the following requirements:
- Compact
- Safe and easy to operate
- Low maintenance
- Easy to install

The supplier shall be capable of proving that he has extensive experience in the field of MV switchgears and shall provide proof that he has already supplied equipment of the equivalent type and brand which has been in operation for at least three years.

Upon the request, units shall be available either in standard compact range or in extensible versions. Details for extensibility design shall be provided including the basic principle and operations. Extensibility shall be easily possible on site by the customer, without SF6 handling, without any particular floor preparation and specific tools. When the switchgear is assembled, extensible units shall respect integral insulation and insensitivity to environment.

2. Standards

Requirements and performances are expressed by reference to the following standards except where specifically defined otherwise:

- IEC 62271-1 - Common specification for high voltage switchgear and control gear
- IEC 62271-200 - AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
- IEC 62271-103 - Switches for rated voltage above 1 kV and less than 52 kV
- IEC 62271-105 - Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV
- IEC 62271-102 - High voltage AC disconnectors and earthing switches
- IEC 62271-100 - High voltage AC circuit breakers
- IEC 60529 - Degrees of protection procured by enclosures (IP code)
- IEC 60255 - Electrical relays

3. Service conditions

The RMU shall be suitable for continuous operations under the basic service conditions indicated below:
- Altitude: maximum 1000 m above sea level
- Ambient air temperature: - 25 °C to + 40 °C
- Maximum ambient temperature average value during 24 h: 35 °C
- Maximum relative humidity: maximum 95%

As in conditions beyond above 'basic service condition', manufacturer shall declare whether current de-rating is necessary.

The RMU shall be capable of being exposed to high relative humidity and ambient air pollution.

The RMU shall be capable of being installed in either concrete indoor substations or in compact metal substations and kiosks with an IP54 rating. Manufacturer shall give all details regarding its solution for free-standing outdoor installations when requested.

4. System parameters

<table>
<thead>
<tr>
<th>Type of construction</th>
<th>Metal enclosed switchgear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulating gas</td>
<td>SF6</td>
</tr>
<tr>
<td>Expected operating lifetime</td>
<td>30 years</td>
</tr>
<tr>
<td>Switchgear partition class</td>
<td>PM</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----</td>
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<tr>
<td>Loss of service continuity class</td>
<td>LSC2</td>
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</table>

<table>
<thead>
<tr>
<th>Degree of protection</th>
<th>IP67</th>
<th>IP3X</th>
<th>IP3X</th>
<th>IP2XC</th>
<th>IP2XC</th>
<th>IP54</th>
<th>IK07</th>
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<tbody>
<tr>
<td>High voltage live parts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Front face</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low voltage control compartment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanism</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Cable compartment</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Outdoor enclosure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection against mechanical impact</td>
<td></td>
<td></td>
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<td></td>
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<table>
<thead>
<tr>
<th>Rated voltage</th>
<th>Ur (kV)</th>
<th>12</th>
<th>17.5</th>
<th>24</th>
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<tbody>
<tr>
<td>Rated frequency</td>
<td>f (Hz)</td>
<td>50 / 60</td>
<td></td>
<td></td>
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<tr>
<td>Rated short-time withstand current</td>
<td>Ik (kA rms value)</td>
<td>21</td>
<td>25</td>
<td>21</td>
</tr>
<tr>
<td>Duration tk (s)</td>
<td>1</td>
<td>1 or 3</td>
<td>1 or 3</td>
<td></td>
</tr>
<tr>
<td>Making capacity of switch and earthing switch (by 50Hz)</td>
<td>Ima (kA peak value)</td>
<td>52.5</td>
<td>62.5</td>
<td>52.5</td>
</tr>
<tr>
<td>Short-circuit breaking capacity of circuit breaker</td>
<td>Isc (kA)</td>
<td>21</td>
<td>25</td>
<td>21</td>
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<tr>
<td>Industrial frequency withstand voltage (50 Hz 1min)</td>
<td>Insulation Ud (kV rms value)</td>
<td>28</td>
<td>38</td>
<td>50</td>
</tr>
<tr>
<td>Phase-phase, phase-earth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolation Ud (kV rms value)</td>
<td>32</td>
<td>45</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Across isolating distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lightening Impulse withstand voltage (1.2/50μs)</td>
<td>Insulation Up (kV peak value)</td>
<td>75</td>
<td>95</td>
<td>125</td>
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<tr>
<td>Phase-phase, phase-earth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolation Up (kV peak value)</td>
<td>85</td>
<td>110</td>
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<td>Across isolating distance</td>
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<table>
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<tr>
<th>Number of phases</th>
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<tr>
<td>Rated Current</td>
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<tr>
<td>Switch</td>
<td>400 or 630 A</td>
</tr>
<tr>
<td>Transformer feeder</td>
<td>Depends on the fuse installed</td>
</tr>
<tr>
<td>Branch circuit breaker feeder</td>
<td>630 A</td>
</tr>
<tr>
<td>Rated current cable charging on switch</td>
<td>110 A</td>
</tr>
<tr>
<td>Rated current no-load transformer breaking capacity on switch</td>
<td>16 A</td>
</tr>
<tr>
<td>Internal arc class</td>
<td>A-FL up to 20 kA 1 s (with option)</td>
</tr>
<tr>
<td>Number of mechanical cycles</td>
<td></td>
</tr>
<tr>
<td>Switch and earthing switch</td>
<td>1000</td>
</tr>
<tr>
<td>Circuit breaker</td>
<td>2000</td>
</tr>
<tr>
<td>Number of electrical cycles at rated current</td>
<td>100</td>
</tr>
<tr>
<td>Number of operations at rated short-circuit current on circuit breaker</td>
<td>3 breaking operations</td>
</tr>
</tbody>
</table>

5. Function requirements

The following functions shall be available for the RMU:
- Switch-disconnector
- Disconnecting circuit breaker 630 A for network points
- Transformer protection feeder by disconnecting circuit breaker 200 A
- Transformer protection feeder by fuse-switch combination
- Bus coupler by switch-disconnector
- Bus coupler by disconnecting circuit breaker
- Direct cable connection to busbars
6. General stipulations regarding design and development of switchgear

a) Introduction

Maximum 5 MV function units could be combined in one metallic enclosure, extensible or compact, for connection, power supply and protection of transformer.

b) Switchboards

The switchgear and busbar shall all be contained in a stainless steel enclosure filled with SF6 at maximum 0.3 bar relative pressure to ensure the insulation and breaking functions. This compartment is a sealed pressure system, in accordance with the IEC 62271-1 standard, with a service life time of 30 years. In addition, manufacturer shall confirm that maximum leakage rate is lower than 0.1 % per year. No refilling of the gas shall be required during the whole service life time.

It shall provide full insulation, making the switchgear insensitive to the environment (temporary flooding, high humidity...). Assembled, the active parts of the switchgear shall be maintenance-free.

The tank shall be made of ≥2 mm AISI 304 unpainted stainless steel and be able to withstand an accidental internal overpressure of ≥ 2.1 bars (relative). The colour shall be RAL 9002 for the enclosure and RAL9005 for the mimic panel.

The switchboards shall be suitable for mounting on a trench or base. Each switchboard shall be identified by an appropriately sized label which clearly indicates the functional units and their electrical characteristics.

The switchgear and switchboards shall be designed so that the position of the different devices is visible to the operator on the front of the switchboard.

The switchboards shall be designed so as to prevent access to all live parts during operation without the use of tools.

c) Dielectric medium

SF6 gas is the preferred dielectric medium for MV RMUs. Oil filled switchgear will not be considered. SF6 gas used for the filling of the RMU shall be in accordance with IEC 60376.

It is preferable to fit an absorption material in the tank to absorb the moisture from the SF6 gas and to regenerate the SF6 gas following arc interruption.

The SF6 insulating medium shall be able to be constantly monitored via analog manometer or pressure switch. Pressure switch shall provide 2 levels of indication that are low level and critical level. Auxiliary contacts shall be provided with the pressure switch for remote indication or local electrical interlocking.

d) Earthing of metallic parts

There shall be continuity between the metallic parts of the switchboard and cables so that there is no electric field pattern in the surrounding air, thereby ensuring the safety of people. The main earthing connection point shall be designed for connection to substation frames without dismantling any bars.

e) Earthing of the main circuit

The cables shall be earthed by an earthing switch with short-circuit making capacity, in compliance with IEC 62271-102 standard. The earthing connection can only be operated when the switch is open.
The earthing switch shall be fitted with its own operating mechanism and manual closing shall be driven by a fast-acting mechanism, independent of operator action.

The **moving contacts of the earthing switch** shall be **visible** in the closed position through **transparent covers**.

**f) Switch-disconnector**

They shall be maintenance-free with breaking in low pressure SF6 gas. The position of the contacts shall be clearly visible on the front of the switchboard. The position indicator shall provide positive contact indication in accordance with IEC 62271-102 standard.

The switches shall be of the extended mechanical endurance in accordance with IEC 60265-162271-103 standard. The switch shall have 3 positions, open-disconnected, closed and earthed, and will be constructed in such a way that natural interlocking prevents unauthorized operations.

They shall be fully mounted and inspected in the factory. Manual opening and closing will be driven by a fast-acting mechanism, independent of operator action.

Each switch can be fitted with an electrical operating mechanism in a special reserved location, without any modification of the operating mechanism and without de-energizing the switchboard.

**g) Transformer Protection**

The MV/LV tee-off transformer shall be protected by **circuit-breaker**, or by switch-fuse combination.

**h) Circuit breaker**

The circuit breakers shall be low pressure SF6 or vacuum interrupter type.

It shall be maintenance free. The position of the power and earthing contacts shall be clearly visible on the front of the switchboard. The position indicator shall provide positive contact indication in accordance with IEC 62271-102 standard.

The circuit breakers shall have 3 positions: open-disconnected, closed and earthed and shall be constructed in such a way that natural interlocks prevent all unauthorised operations.

They shall be fully mounted and inspected in the factory. They shall be fully mounted and inspected in the factory.

The rated current of circuit breaker as network points shall be of 630 A. The rated current of circuit breaker as transformer feeder shall be of 200 A.

An operating mechanism can be used to manually close the circuit breaker and charge the mechanism in a single movement. It shall be fitted with a local system for manual tripping by an integrated push button. There will be no automatic reclosing.

**i) Circuit-Breaker Protective Relay**

The circuit breaker shall be associated with an integrated electronic/ micro-processor type protection unit. The system shall be self-power (from current sensors) for the basic overcurrent protection; ie. phase-phase and phase-earth overcurrent.

The **current sensors, SE brand, shall be mounted on the bushings**, in order to protect cable termination, and be independent of the MV cables. The **minimum activation current** of the relay shall be:

- 15A for 630A feeder
- 10A for 200A feeder
- 5A for special application on small size transformer feeders

Each relay shall have following features:

- Phase-phase overcurrent protection
- Phase-earth overcurrent protection
- Display with indication of flow current, peak current
- Feature to neutralize the inrush current of power transformer (so as not to trip the phase-earth current)
- Trip indication, with origin of the fault

The complete system shall have Trip circuit supervision (ANSI 74TC). The protection system shall be all mounted, wired, tested at factory.

As option the relay can have:
- Communication link (Modbus RS485)
- Thermal overload (ANSI49)
- Load history
- Breaking current history
- Event history
- External trip input
- Very sensitive earth fault
  It is accepted that relay is dual powered for these additional options (ie self power for basic protections and auxiliary powered for the options).

**Protection relay and CT should be provided with same brand as cubicle.**

**j) Transformer protection feeder by switch-fuse combination**

The switches in switch-fuse combination shall be of the maintenance-free, low pressure SF6 gas type. The position of the contacts shall be clearly visible on the front of the switchboard. The position indicator shall provide positive contact indication in accordance with IEC 62271-102 standard.

The switches shall have 3 positions, open-disconnected, closed and earthed, and will be constructed in such a way that natural interlocking prevents unauthorised operations.

The switches shall be fully mounted and inspected in the factory.

An operating mechanism can be used to manually close the switch and charge the mechanism in a single movement. It shall be fitted with a local system for manual tripping by an integrated push button.

Fuses shall be installed in 3 individual sealed chambers metallised on the outside and detachable. They shall be mounted in series with the switch with the following operating mode: blowing of a fuse releases a striker pin which causes three-phase opening of the switch and prevents reclosing. The fuse chamber shall be able to be changed when needed.

**k) MV Metering**

MV Metering shall be carried out by a factory assembled air insulated cubicle with type-tested design.

This unit shall be totally closed, without any ventilation. Connection with adjacent cells will be direct through bus bar and MV cables shall not be used.

VTs could be plugged upstream or downstream of CT’s and a fuse protection shall be possible.

The following configuration shall be available:
- 2 VTs phase-phase, 2 VTs phase-earth, 3 VTs phase-earth
- 2 or 3 CTs

**l) RMU bushings**

It is preferable to have all bushings accessible from the front of the RMU. Bushings along the sides or the rear of the RMU are not acceptable. The bushings should be conveniently located for working with cables specified and allow the termination of these cables in accordance with the instructions supplied.

The profiles of the cable connection bushings shall be in compliance with EN 50181 standard.

**m) RMU cable clamps**
A non ferro-magnetic cable clamp arrangement must be provided for all network cables terminated on the RMU.

n) Padlocking facilities

Circuit breakers, switches and earthing switches can be locked in the open or closed position by 1 to 3 pad locks.

o) Voltage indicators and phase comparators

Each function shall be equipped with a Voltage Presence Indicator System on the front cover to indicate whether there is voltage in the cables. The voltage indicator shall be in compliance with IEC 62271-206 standard. The capacitive dividers will supply low voltage power to the lamps. The lamps shall be of high performance LED technology to insure high visibility and long life duration. Three inlets will be used to check the phase concordance. As an option, the voltage Presence Indicator shall be able to provide an analog output signal. For all models, the lamp visibility shall not be altered by a fault on the connection to the phase concordance unit, even a short circuit.

It shall be possible to replace the voltage presence indicator while unit remains energized, guaranteeing the safety of people. Manufacturer shall provide the phase concordance checking unit.

p) Fault Passage Indicators

Load break switch functions shall be equipped with a fault passage indicator (FPI), in order to detect and localise the faulty part of the network.

The FPI shall indicate short circuit and earth faults with a high performance red LED on the front panel. It shall indicate permanently the load currents of each phase and memorise the maximums of each phase with a resolution of 1 A and the accuracy of 2%.

It indicates both phase-to-phase and phase-to-earth faults. In order to guarantee a fault validation on cable with low load value, a validation by voltage presence shall be provided. In case of low value of earth fault current (compensated network), the FPI will discriminate the capacitive backward current.

The FPI shall be delivered with automatic setting mode. Nevertheless specific setting shall be possible.

The FPI fault detection core function shall be self-powered. Dual power device with external power supply or built-in batteries, provide additional functionalities.

The FPI shall provide an output for external lamp gathering short circuit and earth fault remote indication as well as a relay or transistor output for SCADA interface.

The FPI degree of protection against mechanical impact shall be IK07.

The current sensors will be mounted onto the RMU bushing. Split core sensors shall be also available for retrofitting RMUs.

As an option, it shall be possible to add a serial line for communication in Modbus protocol.

The FPI shall indicate permanently that it is in operation, it could be by means of the permanent load indication.

q) Load management
Load break switch functions could be equipped with an ammeter to display permanently the load currents and memorise the maxi meters with a resolution of 1 A and the accuracy of 2%. The ammeter shall be self-powered, or it could be integrated into the FPI.

r) Voltage detection

Load break switch shall be able to be equipped with voltage detection device to provide information of the presence and the absence of voltage with 2 relays. The voltage signal shall be taken from the Voltage Presence Indicator System. The voltage detection device shall display the MV network voltage in percentage of the network service voltage. It is not allowed to use a voltage measuring tool to calibrate the device.

Presence of voltage is used for safety function such as earth switch locking, and absence of voltage is used for Automatic Transfer function.

Various combination of voltage detection shall be possible: Ph-N or Ph-Ph voltage and unbalanced voltage.

In case both fault passage indication and voltage detection functions are required, one single device integrating both functionalities shall be used.

s) Safety of people

Any accidental overpressure inside the sealed chamber will be limited by the opening of a pressure limiting device in the lower part of the enclosure. Gas will be released to the rear of the switchboard away from the operator.

t) Operating lever

An anti-reflex mechanism on the operating lever shall prevent any attempts to reopen immediately after closing of the switch or earthing switch. All manual operations will be carried out on the front of the switchboard.

The effort exerted on the lever by the operator should not be more than 250 N for the switch and 250 N for the circuit breaker.

u) Front plate

The front plate shall have an IP3X degree of protection. The front shall include a clear mimic diagram which indicates the different functions. The position indicators shall give a true reflection of the position of the main contacts. They shall be clearly visible to the operator. The lever operating direction shall be clearly indicated in the mimic diagram. The manufacturer's plate shall include the switchboard's main electrical characteristics.

v) Cable insulation testing

It must be possible to test the core or the sheath insulation of the network cables while RMU remains energized at rated voltage, without access to cable compartments. It shall be possible to carry out the phase by phase testing through a built-in facility. The maximum test voltage shall be 42 kV DC for 10 minutes.

w) Remote control of the RMUs

Remote operation of the RMUs must be possible using motors fitted to the operating mechanism. It shall be possible to fit the motors either directly in manufacturing plant or on site when required. Installation on site shall be possible with the RMU fully energised and manufacturer should provide detailed instructions for installation to the control mechanism. Auxiliary contacts for remote indication of switch status are also required.
The fitting of the motors to the mechanism must not in any way impede or interfere with the manual operation. An auxiliary contact to prevent motorised operation of the mechanism while the operating handle is inserted into the operating point must also be provided.

The tenderer may wish to advise of options and cost for remote telecontrol units of the RMU and MV network telecontrol system.

x) Automatic Transfer System (ATS)

ATS switchgear shall give automatic control and management of medium voltage sources using switch functions. The transfer time from one source to the second source shall be less than 10 s that would be adjustable. There shall be ATS system for 3 possible combinations:
- 1 of 2 lines switch between 2 line feeders
- 1 of 2 line/Genset: switch between 1 line feeder and 1 generator feeder
- 2 of 3: 2 line feeders, 1 bus section ➔ switch between faulty line and bus section

y) Dimensions

The overall dimensions shall not be greater than the followings:

**RMU standard non-extensible:**

<table>
<thead>
<tr>
<th>Function(s)</th>
<th>Height</th>
<th>Depth</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1150 mm</td>
<td>720 mm</td>
<td>580 mm</td>
</tr>
<tr>
<td>2</td>
<td>1150 mm</td>
<td>720 mm</td>
<td>840 mm</td>
</tr>
<tr>
<td>3</td>
<td>1150 mm</td>
<td>720 mm</td>
<td>1200 mm</td>
</tr>
<tr>
<td>4</td>
<td>1150 mm</td>
<td>720 mm</td>
<td>1630 mm</td>
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<tr>
<td>5</td>
<td>1150 mm</td>
<td>720 mm</td>
<td>2100 mm</td>
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**RMU standard extensible:**

<table>
<thead>
<tr>
<th>Function(s)</th>
<th>Height</th>
<th>Depth</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 double</td>
<td>1150 mm</td>
<td>720 mm</td>
<td>640 mm</td>
</tr>
</tbody>
</table>

For RMU with 2, 3, 4 or 5 functional units: 30 mm more than non-extensible range on each extensible side.

**RMU non-extensible with free choice of each functional unit:**

<table>
<thead>
<tr>
<th>Function(s)</th>
<th>Height</th>
<th>Depth</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1150 mm</td>
<td>720 mm</td>
<td>1060 mm</td>
</tr>
<tr>
<td>3</td>
<td>1150 mm</td>
<td>720 mm</td>
<td>1540 mm</td>
</tr>
</tbody>
</table>

For RMU with 2 or 3 functional units: 30 mm more than non-extensible range on each extensible side.

z) Finishing

The device shall be low-maintenance. All metallic parts shall have rust protection. Operating mechanisms shall be able to operate after a 200 hours salt fog test as defined in IEC 60068-2-11. Two lifting rings shall be installed on the top of the switchboards for handling.

7. Routine tests

The routine tests carried out by the manufacturer shall be backed by test reports signed by the factory's quality control department. They shall include the following:
- Conformity with drawings and diagrams
- Measurement of closing and opening speeds
- Measurement of operating torque
- Checking of filling pressure
- Checking of gas-tightness
8. Quality and sustainable development

When requested by the customer, the supplier shall provide proof of application of a quality procedure in compliance with the standard. This means:

- Use of a quality manual approved and signed by a top management representative
- Regular updating of the manual so that it reflects the quality control procedures in effect
- ISO 9001 certification
- Product Environmental Profiles file
Specification for three-phase Cast Resin Transformers – MV/LV Power 160 to 3150 kVA
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1. General

Three-phase transformers of cast resin type, class F insulation system with natural (AN) cooling for indoor installation, destined for use in three-phase MV/LV distribution systems. If required forced cooling (AF) to increase the rated power up to 40%.

This specification in conjunction with the Transformer Data Sheet provides the technical requirements for the design, manufacture and test & supply of transformers.

2. Reference Standards and conformity assessment

The following documents are used as reference for performances definition and conformity assessment, as far as relevant for a given transformer.
The manufacturer will provide Declarations of Conformity, as per ISO 17050, for the performances listed in this specification.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60076-1</td>
<td>Power Transformers General</td>
</tr>
<tr>
<td>IEC 60076-2</td>
<td>Temperature Rise</td>
</tr>
<tr>
<td>IEC 60076-3</td>
<td>Power transformers insulation levels, dielectric tests and external clearances in air</td>
</tr>
<tr>
<td>IEC 60076-4</td>
<td>Power transformer guide to the lightning impulse and switching impulse testing power transformers and reactors</td>
</tr>
<tr>
<td>IEC 60076-5</td>
<td>Power transformers ability to withstand short circuit</td>
</tr>
<tr>
<td>IEC 60076-11</td>
<td>Power transformers dry-type transformers</td>
</tr>
<tr>
<td>IEC 60076-16</td>
<td>Transformers for wind turbine applications</td>
</tr>
<tr>
<td>EN50588-1</td>
<td>Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV</td>
</tr>
<tr>
<td>IEC 60076-12</td>
<td>Load guide for dry-type power transformers</td>
</tr>
</tbody>
</table>

2.1. Electrical tests

2.1.1 Routine tests

These tests will be carried out on all the transformers after the manufacturing, enabling an official test certificate to be produced for each one:
- measurement of windings resistance
- measurement of the transformation ratio and vector group
- measurement of impedance voltage and load loss
- measurement of no load loss and no load current
- applied voltage dielectric test at 10kV
- induced voltage dielectric test
- measurement of partial discharges. For this measurement, the acceptance criterion will be:
  partial discharges less than or equal to 10 pC at 1.30 Un, or
  partial discharges less than or equal to 5 pC at 1.30 Un (Special test)

All these tests are defined in the IEC 60076-11 and IEC 60076-1 to 60076-3 standards.

When transformers are equipped with a protection enclosure, they will be tested in their enclosure.
2.1.2 Type tests or special tests

These tests are optional and are subject to prior agreement with the supplier:
- temperature rise test carried out in accordance with the simulated loading method as defined by the IEC 60076-11 standard
- lightning impulse test in accordance with IEC 60076-3
- short circuit test in accordance with IEC 60076-5
- noise level measurements in accordance with IEC 60076-10.

All these tests are defined by the IEC 60076-11 and IEC 60076-1 to 60076-5 standards.

2.2. Climatic and Environmental classifications

These transformers will be of environmental class E3 and of climatic class C2 as defined in IEC 60076. E3 and C2 classes will be indicated on the rating plate.

The manufacturer must produce a test report from an official laboratory for a transformer of the same design as those produced. The tests must have been performed in accordance with IEC 60076-11 for C2 climatic class and IEC 60076-16 for E3 environmental class.

Although, IEC60076-11 proposes the extreme lowest temperature as -25°C for C2 class, the temperature behaviour at -50°C will be requested and will be applicable for transportation, storage and running of the transformer. This will be stated as C3 class in the transformer documents.

The manufacturer needs to present a test report from an official laboratory for the transformer tested at -50°C.

2.3. Fire behaviour classification

These transformers will be of class F1 as defined in IEC 60076-11. F1 class will be indicated on the rating plate.

The manufacturer must produce a test report from an official laboratory on a transformer of the same design as those produced and on the same transformer which have initially passed the here above Climatic and Environmental tests.

This test must have been performed in accordance with IEC 60076-11.

3. Transformer design

3.1. Magnetic core

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

In order to reduce the power consumption due to transformer no-load losses, the magnetic core is stacked using overlapping-interlocking technology.
3.2. LV windings

The LV winding is produced using aluminium or copper foils (according to the manufacturer’s preference) in order to cancel out axial stress during short circuit; this foil will be insulated between each layer using a heat-reactivated class F pre-impregnated epoxy resin film.

The ends of the winding are protected and insulated using a class F insulating material. The whole winding assembly will be polymerised throughout by being autoclaved for 2 hours at 130°C, which will ensure:
- High level of resistance to industrial environments
- Excellent dielectric withstand
- Very good resistance to radial stress in the instance of a bolted short circuit.

3.3. MV windings

They will be separated from the LV windings to give an air gap between the MV and LV circuits in order to avoid depositing of dust on the spacers placed in the radical electrical field and to make maintenance easier.

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

The MV windings will be vacuum cast in a class F fireproof epoxy resin casting system composed of:
- an epoxy resin
- an anhydride hardener with a flexibility 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. The interior and exterior of the windings will be reinforced with a combination of glass fibre to provide thermal shock withstand.

3.4. MV winding support spacers

These will provide sufficient support in transport, operation and during bolted short circuit conditions as well as in the case of an earthquake.

These spacers will be circular in shape for easy cleaning. They will give an extended tracking line to give better dielectric withstand under humid or high dust conditions.

These spacers will include an Elastomer cushion that will allow it to absorb expansion according to load conditions. This Elastomer cushion will be incorporated in the spacer to prevent it being deteriorated by air or UV.
3.5. MV connections

The transformer MV 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 transformer MV connection bars will be in rigid copper bars protected by heat shrinkable tubing.

The transformer MV connections in cables are not allowed, in order to avoid all risk of contact, due to cables flapping.
The transformer MV connections will be in copper.

3.6. LV connections

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

The output from each LV winding will comprise a tin-plated aluminium or copper connection terminal, enabling all connections to be made without using a contact interface (grease, bi-metallic strip: out of scope of supplying).

These will be assembled according to current practices, notably using spring washers under the fixings and nuts.

Transformers in the 630 to 3150 kVA range will be easy to connect using factory-built electrical ducting through an optional interface. Stress withstand in the instance of a bolted short circuit on the connector will be guaranteed by the manufacturer.

3.7. MV 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 MV coils.

4. Accessories and standard equipment

4.1. Accessories

These transformers will be provided with:
- 4 flat bi-directional rollers
- lifting lugs
- haulage holes on the undercarriage
- 1 earthing terminals
- 1 rating plate
- 1 "Danger Electricity" warning label, W012 according to ISO 7010
- 1 routine tests report
- 1 instruction manual for installation, commissioning and maintenance in English.

4.2. Thermal protection
These transformers will be equipped with a thermal protection device which will comprise:

- 3 thermal detection systems (1 by phase), installed in the active part of the transformer. The sensors 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 electronic converter will be installed away from the transformer.
- A plug-in terminal block for connection of the sensors to the electronic converter.

The 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.

4.3. Metallic enclosure
On request specified in the annex, these transformers can be supplied mounted equipped with protective metallic enclosure:
- either for indoor installation, with degree of protection IP 31 (except the bottom which may be IP 21),
- or for outdoor installation with degree of protection upto IP 44. This outdoor installation will require some adjustments related to weather and environmental extreme conditions of the place.

These enclosures will not be dismantled (if requested, it can be dismantled) and will be provided 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 MV connections and to the tapping. This will be fitted with handles; it will have one "Danger Electricity" warning label (W012 according to ISO 7010), a rating plate and a visible braid for earthing.
- blanked off holes for further locking device installation if requested.
- 2 undrilled gland plates on the roof: one on the MV side, one on the LV side (drilling and cable gland not supplied).
- 1 plate at the right MV side on the bottom of the enclosure for the MV cables for connections from the bottom.
- as an option, a MV cables clamping system shall be provided when the cables are coming from the bottom

5. Environment
Production site organisation shall be non polluting and certified to comply with ISO 9001 and ISO 14001 standards. Both certified by an official independent organisation.

Supplier shall deliver End of Life Instructions, REACH declaration and Product Environmental Profile documentation upon request.
6. Technical Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For each requested transformer, the supplier will give the following data:</td>
<td></td>
</tr>
<tr>
<td>Rated power</td>
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</tr>
<tr>
<td>Cooling</td>
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<tr>
<td>Quantity</td>
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<tr>
<td>Rated frequency</td>
<td>Hz</td>
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<tr>
<td>Rated primary voltage</td>
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<tr>
<td>Highest Primary Voltage for equipment (Um)</td>
<td>kV</td>
</tr>
<tr>
<td>Primary Applied voltage or line terminal AC Withstand</td>
<td>kV</td>
</tr>
<tr>
<td>Rated Lightning Impulse Withstand Voltage</td>
<td>kV</td>
</tr>
<tr>
<td>Off-circuit tapping</td>
<td>%</td>
</tr>
<tr>
<td>Secondary voltage at no load</td>
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</tr>
<tr>
<td>- between phases</td>
<td>V</td>
</tr>
<tr>
<td>- phase to neutral</td>
<td>V</td>
</tr>
<tr>
<td>Highest Secondary Voltage for equipment (Um)</td>
<td>kV</td>
</tr>
<tr>
<td>Secondary Applied voltage or line terminal AC Withstand</td>
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</tr>
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<td>Load losses at 120°C</td>
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<tr>
<td>Rated impedance voltage at 120°C</td>
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<td>Acoustic power $L_0(A)$</td>
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<tr>
<td>LV winding temperature class</td>
<td>F</td>
</tr>
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<td>Temperature of insulation system</td>
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<tr>
<td>Climatic classification</td>
<td>C3*</td>
</tr>
<tr>
<td>(*) C2 Climatic test carried out at -50°C. See 2.2</td>
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</tr>
<tr>
<td>Environmental classification</td>
<td>E3</td>
</tr>
<tr>
<td>Fire behaviour classification</td>
<td>F1</td>
</tr>
<tr>
<td>Minimum temperature (transportation, storage and operation)</td>
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<td>Enclosure</td>
<td>Yes / Non (1)</td>
</tr>
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</tr>
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<td>Length</td>
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<td>Width</td>
<td>mm</td>
</tr>
<tr>
<td>Height</td>
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</tr>
<tr>
<td>Total weight</td>
<td>kg</td>
</tr>
<tr>
<td>Thermal protection relay, electronic converter type</td>
<td>Yes / No(1)</td>
</tr>
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</table>

(1) Delete as appropriate
STANDARD SPECIFICATION E1

GENERAL REQUIREMENTS

FOR

ELECTRICAL WORKS
# STANDARD SPECIFICATION E1

## GENERAL REQUIREMENTS

FOR

ELECTRICAL WORKS

## INDEX

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<th>Description</th>
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<td>Tools, Materials, etc. to be Provided by Electrical Contractor</td>
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<td>18.0</td>
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<td>Quality of Conduit and Conduit Accessories</td>
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<td>20.0</td>
<td>Conduit Installation Practice</td>
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<td>21.0</td>
<td>Wall Boxes</td>
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<td>22.0</td>
<td>General Position of Switches and Sockets</td>
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<td>Standard Lighting Switches</td>
</tr>
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<td>24.0</td>
<td>Standard Switched Socket Outlets</td>
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<tr>
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<td>Location of Lighting Outlets</td>
</tr>
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</table>

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26.0  Connection of Lighting Fittings and Appliances
27.0  Lamps
28.0  Connection of Domestic Type Stoves
29.0  Connection of Geysers
30.0  Connections to Console Type Air-Conditioning Units
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33.0  Flexible Conduit
34.0  Installation of Distribution Boards
35.0  Single Core Cables
36.0  Multi-Core, Armoured Cables
37.0  General Cable Laying Requirements
38.0  Earth Wires
39.0  Reference to Acts/Regulations/Codes of Practice/Standards
1.0 DELIVERY AND STORAGE

The Electrical Contractor must make his own arrangements regarding transport and off-loading of labour and materials and shall provide his own plant. The Electrical Contractor will be responsible for the safe storage of all equipment, materials and plant and will be held responsible for loss by theft or damage in any way, whether installed on the contract or not.

2.0 DRAWINGS

The Electrical Contractor shall make adequate arrangements, to the Engineer's satisfaction, for the proper and orderly storage of drawings on site, and for keeping comprehensive records of drawings issued to him. The Tenderer is to allow for the marking up of one set of drawings showing the installation as actually carried out. This set of drawings is to be handed to the Engineer before the final Completion Certificate will be issued.

3.0 WORKMEN ON PREMISES

Under no circumstances are workmen to be allowed to sleep or deposit any kit on the premises either during or after building operations.

4.0 QUANTITIES

The Electrical Contractor shall take his own quantities, dimensions and particulars of material required to complete the contract as specified, unless a detailed Bill or Schedule of Quantities accompanies this document, in which event quantities shall be determined in accordance with the clauses preceding the Bill or Schedule of Quantities.

5.0 INNOVATIVE WIRING SYSTEMS AND DEVIATIONS FROM SPECIFICATION

This specification covers wiring systems of the conventional type in which continuous metal or rigid plastic conduit of circular cross section is used.

No deviation or alteration from the requirements of the specification, schedules or drawings shall be made without first obtaining the approval of the Engineer.
Should the Engineer permit or specify the use of innovative wiring systems such as surface mounted mini-trunking with removable covers, prewired conduit, T&E (Twin and earth) cable or any other authorized innovative wiring system, such an installation shall comply with the latest amendment of SANS 0142.

6.0 PRIME COST ITEMS

All prime cost items shall be expended as directed in writing by the Engineer.

The acceptance of any offer of any nominated supplier for the supply of equipment against PC sums shall be with the concurrence of the Engineer. The equipment accepted by the Electrical Contractor must comply with the guarantee clause, contained in the applicable conditions of contract.

The Tenderer shall insert, in the Form of Tender or where required in the Bill or Schedule of Quantities, his percentage profit required on the PC sums expended. For the purposes of all tenders the percentage amount to be inserted shall be based on the PC sums shown, and will be adjusted according to the actual sums expended.

7.0 MAKING GOOD

On completion of the contract, any damage which may have been done to finished plasterwork, floors, ceilings, wood and paintwork, etc., during the progress of the electrical installation, shall be repaired and make good to original finishes by the Electrical Contractor, to the satisfaction of the Engineer.

8.0 STATUTORY REQUIREMENTS

Tenderers shall include for everything required for a complete and satisfactory installation in accordance with the drawings and specification and for any item not specifically mentioned, but obviously necessary for the proper completion of the contract.

Wherever applicable, the whole installation shall be carried out in accordance with the latest revisions of:

(a) The Code of Practice for the Wiring of Premises (SANS 0142) issued by the South African Bureau of Standards (hereinafter referred to as the “Code of Practice”).

(b) The Occupational Health and Safety Act, Act 85 of 1993, as amended to date.

(c) Any special requirements of the local authorities of the area or district concerned and will take preference where contradictory to the requirements specified herein.


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9.0 TESTING OF INSTALLATION

During the course of and on completion of the work, the whole of the installation shall be tested in accordance with the Code of Practice and the applicable by-laws of the local authorities concerned. The Electrical Contractor will be required to attend upon the Supply Authority's inspectors and shall give all assistance required and provide such tools, materials, implements and instruments as are necessary for the tests. Where the Supply Authority places the responsibility of the testing of the installation on the Electrical Contractor, the Electrical Contractor shall carry out the tests required in terms of the Occupational Health and Safety Act, and shall furnish the Engineer with a copy of the completed "Certificate of Compliance for Electrical Installations". In the abovementioned circumstances the Electrical Contractor shall advise the Engineer of the name of the installation electrician who will act as responsible person in this regard.

The Engineer reserves the right to be present at any tests to be carried out and the onus will be on the Electrical Contractor to inform him at least 48 hours prior to the time set for the tests to commence.

In addition the Electrical Contractor shall furnish the Engineer with a Test Report detailing particulars of the test executed, in the format acceptable to the Engineer, the following tests being a minimum requirement:

(a) Routine tests on all switchboards as called for in Standard Specification E2.
(b) 1000V insulation resistance test of all circuits external to the switchboards.
(c) Earth loop resistance test on all earthed equipment.
(d) Earth-leakage test on all earth-leakage protected circuits to prove the soundness of the wiring and protection.
(e) Checking of polarity of all switched socket outlets.
(f) Operational check on all equipment to certify execution of the works in accordance with the relevant drawings and specifications.

Failure of Works, Site or Commissioning Tests

Should the Engineer be notified to attend official tests as laid down and should the installation not be ready or fail the tests for any reason whatsoever, such that the Engineer is required to re-witness the tests, the time, transport and disbursements incurred by the Engineer, or his Deputy, in so doing will be for the Electrical Contractor's account which amount may be deducted (at the option of the Employer) from monies due to the Electrical Contractor.

10.0 SERVICE CONNECTION

Where a new or altered electrical connection is required, the Engineer would already have made certain arrangements with the Supply Authority.
The Electrical Contractor is required to acquaint himself with such arrangements, and shall finally arrange for the installation to be connected to the network of the Supply Authority. He shall comply fully with the requirements of the Authorities having jurisdiction, and shall give all notices and furnish all certificates required by the Authorities. The Electrical Contractor is also required to make his own arrangements, allow for, and pay the fees necessary for installation tests.

Unless otherwise specified, the Electrical Contractor shall also pay all costs for the service connection, which amount will be refunded to him on submission of the official receipt issued by the Supply Authority.

11.0 BALANCING OF LOAD

The Electrical Contractor will be required to balance the load as equally as possible across multiphase supplies. (See also schematic diagrams).

12.0 QUALITY CONTROL, QUALITY OF MATERIALS AND WORKMANSHP

The Electrical Contractor shall be responsible to institute and maintain a suitable quality management system complying with SANS 0157:1979, as amended, to ensure that only materials and equipment meeting the requirements of this specification are used during the execution of the work.

All materials and equipment shall be of the best quality and un-used and suitable for the purpose for which they are employed. The arrangement of the equipment, when installed, shall be in accordance with the best current practice.

Special care shall be taken to ensure neatness in all parts of the installation.

Unless otherwise specified or approved, the materials and equipment shall comply with the appropriate South African Bureau of Standards Specification, or, where these do not exist, the relevant British or European Standard Specifications and shall bear the relevant certification mark. The Electrical Contractor shall furnish an appropriate certificate of compliance when called upon to do so.

All material and equipment shall be obtained from suppliers listed in the latest SABS "Guide to Components for Use in Electrical Installations".

13.0 TOOLS, MATERIAL, ETC. TO BE PROVIDED BY CONTRACTOR

The Electrical Contractor shall provide all the correct tools, materials and appliances and all sundries necessary for the proper execution of the contract, whether mentioned in the specification or not.

14.0 WIRING OF CONDUIT

The wiring of any circuit shall only be carried out after the whole of that particular circuit's conduit 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.
It should also be possible for wires to be drawn or threaded through the completed conduit installation without any undue strain.

The terminal ends of the wires shall be of sufficient length to facilitate the connecting of apparatus, fittings, appliances, etc.

Lighting circuits shall be wired with 2.5mm² and plug circuits with 4.0mm² conductors, except where otherwise specified.

All circuit wiring is to be carried out on the loop-in system and no joints in the conduit or boxes will be allowed. Where joints are unavoidable, due to alterations or extensions, these shall only be located at draw boxes and shall only be of the insulated crimping ferrule type. Not more than four 2.5mm² or three 4.0mm² wires together with earth wires where applicable will be allowed in 20mm conduit, except where otherwise specified. Not more than four conductor ends plus two earth wires shall appear at any ceiling outlet box except where specifically approved.

All conductors shall be in colours selected to facilitate identification of the circuit and switch wiring, black being reserved for neutral conductors, and green or green/yellow combination for insulated earth conductors. Three phase circuits shall be colour coded to identify phases.

15.0 EXPANSION JOINTS

Where conduit installed in concrete crosses a building expansion joint, an expansion joint in accordance with the detail shown in the detailed drawings shall also be provided in the conduit run. The Electrical Contractor must ensure that the earth continuity of the installation is not impaired.

16.0 TERMINAL WIRES

The end strands of all wires, whether single or looped, which are to be connected to the connection terminals of switches, plugs, holders, ceiling roses or fittings are to be securely connected to the terminals. All terminal screws shall be properly tightened and care shall be exercised not to cause undue damage to the conductor strands. The cutting away of wire strands will NOT be allowed. Crimping lugs must be used on cable ends for connections to busbars or circuit breakers, except where box terminals are employed.

17.0 INSPECTION OF WIRING

To ensure that wiring may be easily withdrawn from any circuit run, the Engineer may, at his own discretion, direct that wires be withdrawn and the Electrical Contractor shall withdraw the wires concerned. If the wires are withdrawn easily and without showing damage, the costs of the withdrawal and replacement will be borne by the Employer. If, however, it is found that it is not possible to withdraw wires without damage, the cost of the withdrawal test, and the cost of rectifying the work shall be borne by the Electrical Contractor.
18.0 EARTHING

The installation shall be effectively earthed in accordance with the latest edition of the Code of Practice, and to the requirements of the Local Supply Authority. All metal hot and cold water and waste pipes are to be effectively bonded by means of 13mm x 1.5mm copper tape (not wire) clamped round the pipes. Galvanised mild steel or brass bolts and nuts are to be used for clamping and the tape shall be so formed that the clamp will fit firmly around the bare metal pipe without additional packing.

Lighting circuits installed inside channels or support steelwork, must be provided with a separate earth wire of at least 2.5mm² securely bonded to light fittings directly fixed to this steelwork. Where conductors to switch outlets in partition walls are run in copper braided shrouds, the braiding must be securely fixed to the switch outlet box.

All fluorescent and other light fittings using discharge lamps, shall be earthed by means of a separate 2.5mm² earth wire connection to the earth bar in the relevant switchboard.

All socket outlets are to be earthed by means of 2.5mm² earth wire, taken back to the distribution board feeding these sockets. Socket outlets in power skirtings shall be bonded by means of an insulated earth wire in standard earth colours. The conductor may not be cut, and connections to the sockets shall be made by means of suitable crimped pin connectors.

When plastic conduit is used, all outlets, whether for light fittings, socket or power connections, shall likewise be earthed by means of separate earth wires.

All metal cable ladders, cable trays, and wiring channels shall be effectively earthed.

19.0 QUALITY OF CONDUIT AND CONDUIT ACCESSORIES

All conduit shall have a minimum internal diameter of 20mm and unless otherwise specified or approved as such by the Engineer, all conduit fittings shall be of the same material as that of the conduit used.

Metal Conduit and Accessories

Metal conduit shall comply with SANS 1065 and shall bear the SABS mark. Except where otherwise stated, all conduit shall be black enamelled. Galvanised conduit shall however be used in all damp locations, and where conduit is exposed to the weather or where conduit is installed in coastal areas within a distance of 6km from the sea.

All cast metal conduit accessories shall be of the malleable iron inspection type.

Metal conduit shall be screwed and socketed, or, where the Local Supply Authority permits, and the Engineer approves the use thereof, an approved system of plain-end conduit and fittings complying with SANS 1065 may be used. All accessories used on plain-end conduit shall be assembled by means of the special fittings and tools produced for this purpose by the manufacturer.

In areas within 6km of the coast all steel conduit connections shall be painted with a red lead based primer complying with SANS 312, as amended, or other approved primer, after the joints have been made.
Plastic Conduit and Accessories

Plastic conduit may only be used where the Local Supply Authority permits, and then only for cast-in or built-in applications. Plastic conduits may be used in roof spaces if secured at intervals not exceeding 900mm.

Plastic conduit shall be of the rigid, heavy gauge plastic type complying with SANS 950: 1985 and shall bear the SABS mark. Special precautions shall be taken during construction to prevent mechanical damage to plastic conduit.

Drawboxes of rigidly moulded plastic may be employed. Where plastic drawboxes are to be used as outlets for light fittings, the special devices, provided by the manufacturer to eliminate undue heat conductance to the box and to provide adequate support for the light fitting, must be used.

Plastic conduit shall be assembled by means of the solvent adhesive supplied by the manufacturer, his instructions being closely followed.

20.0 CONDUIT INSTALLATION PRACTICE

Chasing and Building-In

It is the responsibility of the Electrical Contractor to ensure that conduits, wall boxes, distribution boards, etc., are correctly positioned and built or chased in as the work progresses. Conduits shall generally be installed at such a depth that the outside surface of the conduit is at least 12mm below the finished plaster surface except in areas within 6km of the coast where the depth of steel conduit shall be at least 30mm below the finished surface of an outside wall.

Chasing in face brick will not be allowed.

The entire conduit system is to be electrically and mechanically continuous throughout.

Conduit shall be cast into concrete slabs wherever possible and no conduits will be installed in floor screeds unless approved by the Engineer. Where conduits are cast into beams these shall be located close to the neutral axis of the beam.

General Requirements

Lighting and plug circuit wiring shall generally be run in separate conduits but may, with the approval of the Engineer, and if allowed so by the Supply Authority, be run in a common conduit. More than one circuit may be run in the conduit provided that the number of conductors drawn into the conduit do not exceed the wiring capacity of the conduit as specified in the Code of Practice. Mixed loading of circuits shall be in accordance with the requirements of the Code of Practice.

Likewise, each power point shall be wired through a conduit dedicated to that power point only, except where otherwise specified.

Conduits installed in ceiling or roof spaces shall, where practical, be run parallel and at right angles to roof members and clear spans of metal and plastic conduit shall not exceed 1500mm and 900mm respectively. Conduit installations for confined spaces of less than 900mm clearance, or where the space after completion of the work will
be inaccessible, shall be such that wiring can be carried out from outside such space as would be the case for a conduit installation cast into concrete.

No draw boxes or inspection fees or bends shall be installed in confined roof spaces and where draw boxes are unavoidable, these shall be installed in inconspicuous positions approved by the Engineer.

Where spare, unwired conduits are called for in roof spaces with more than 900mm clearance the conduit shall be terminated in a bend at the correct level above the roof timbers to facilitate future extension of the conduit without further sets. A coupling shall be provided in the vertical run of conduit so that the direction in which the future conduit extension is to be installed can be changed without difficulty.

Metal conduit terminating in boxes, trays, etc., shall be finished off with back nuts and brass bushes, whilst plastic conduit shall be finished off with the manufacturer’s special adaptors.

Conduit terminating in ceiling points are to be taken to the face of the ceiling and shall be terminated on a round conduit box installed against the top surface of the ceiling. The conduit boxes shall be firmly supported at these points and the Electrical Contractor shall arrange for the Ceiling Sub-Contractor to cut openings in the ceiling opposite the outlet boxes and shall allow for payment of this work in his tender price.

All conduit joints are to be tightly assembled. Screwed running joints with long threads are to be provided with a lock nut to ensure a mechanically strong and electrically continuous bonded joint.

**Conduit in Concrete**

Conduit shall be installed as close as possible to the neutral axes of concrete beams or slabs. Conduit and outlet boxes shall be securely fixed to shuttering to obviate displacement during the pouring of concrete.

Conduit shall drop to the lower face of concrete and terminate at outlet boxes only at points where such boxes are to be installed. On existing concrete structures, conduit shall be run only in approved positions and depth of chasing of such structures, where unavoidable, shall only be carried out after approval has been obtained from the Building Contractor.

The Electrical Contractor will be required to liaise closely with the Building Contractor as regards the incorporation of conduit runs with structural steel in reinforced concrete slabs.

Where required, outlet boxes shall be of the deep type to allow structural steel to pass below conduits at outlet boxes. No elbows or bends of radius less than 120mm shall be installed in concrete slabs.

The Electrical Contractor shall be present during the casting process, so as to ensure that no damage or displacement occurs to conduit.

Immediately after each section of shuttering has been stripped, the Electrical Contractor shall, by means of steel tape, establish whether all conduit boxes are accessible and all conduit runs are intact and clear. Any shortcoming detected at this juncture must be immediately rectified in an approved manner.
Conduit on Surface

Where surface work is permitted, conduit runs shall be perfectly straight and plumb or level. Steel and plastic conduits shall be fixed at intervals not exceeding 1500mm and 900mm respectively.

After completion of surface work, no exposed thread shall show, except where running joints occur. The latter shall only be resorted to where absolutely unavoidable, and must be fitted with a sliced coupling as a locknut.

Saddles for all conduits installed on surface shall be fixed by means of expandable tapered plastic wall plugs and corrosion proofed steel round-headed screws. Wood plugs and plugs in mortar joints between bricks are not acceptable. Where surface conduits are installed in conspicuous areas and on steelwork, spacer bar saddles shall be used. Fixing onto steelwork shall be by means of drilling, strapping and screwing or where more practical, by means of stainless steel strapping or conduit clamps. Explosive driven devices which will facilitate easy removal of the saddles may be used provided that the type of fixing device has been approved by the Engineer.

Bends and Draw Boxes

Normal bends or elbows will not be allowed except where specially approved. All sets shall have a radius of at least five times the outside diameter of the conduit and conduit showing signs of flattening or cracking shall be rejected.

Draw boxes shall be installed in approved positions so that not more than two bends occur between one end of a run and a draw box or between boxes. Draw boxes shall be so arranged as to be accessible after the completion of the building and must be provided with cover plates which shall finish neatly and flush with the final surface.

Draw boxes shall, where possible, be located in inconspicuous places allowing for a common cover. Rectangular boxes shall be square with respect to walls.

Reaming

The ends of all conduits shall be cleaned internally by means of a reamer of all burrs and rough edges in compliance with the Code of Practice.

Draw Wires

The Electrical Contractor shall install hot dip galvanized draw wire of at least 1.6mm diameter in all unwired conduits.

21.0 WALL BOXES

Flush mounting wall boxes for socket outlets, switches, isolators, etc., shall be of heavy gauge (minimum 1mm thickness) galvanized pressed steel type, complying with the relevant requirements of SANS 1085 : 1980. Substantial lugs, drilled and tapped or fixing screws, shall be provided. Where the Local Supply Authority so permits, boxes of rigid plastic, bearing the SABS mark, may be employed. The wall thickness of plastic boxes shall be at least 2mm.

Knockout conduit entry holes shall be provided on all sides and at the back.
All flush mounting steel wall boxes installed within 6km of the coast shall be treated with red lead primer before installation, applied by brush or by dipping, as an added rust proofing agent. Before applying the primer, all surfaces shall be cleaned with a suitable emulsion type galvanized iron cleaner.

Cover plates shall comply with the relevant requirements of SANS 1084 : 1976, as amended, and shall have a thickness and finish as specified in the Detailed Specification. Fixing screws shall be rust proofed by plating to suit the cover plate finish. An assortment of fixing screws will not be acceptable.

The nominal dimensions of flush mounting wall boxes shall be as follows:

- Single switch units: 50 x 100 x 50mm deep
- Two switch units on common cradle: 50 x 100 x 50mm deep
- Two single switch units on separate cradles: 100 x 100 x 50mm deep
- Switched socket outlets (single or double): 100 x 100 x 50mm deep
- Socket outlet and special miniature single pole Mccb: 100 x 100 x 50mm deep

Surface mounting boxes shall comply with the relevant requirements of SANS 1085 : 1980. Under no circumstances shall flush mounting boxes be used in a surface installation.

Not more than one circuit shall appear in any one wall box except where otherwise specified. The Electrical Contractor shall supervise the building-in of wall boxes to ensure correct positioning.

Where a number of flush mounting wall boxes are to be installed at the same height adjacent to each other, the Electrical Contractor shall fit two couplings secured by means of male bushes between each pair of adjacent boxes to ensure that the boxes are uniformly spaced and located at the same level.

22.0 GENERAL POSITION OF SWITCHES AND SOCKETS

Sockets with their controlling switches shall be mounted with the centre line 300mm above finished floor level, unless otherwise specified or indicated on the drawings.

Switches for lights are to be mounted with the centre line 1400mm above the floor, except where otherwise specified or indicated on the drawings.

Unless otherwise approved, the switches controlling lights and installed adjacent to doors are to be placed at the lock side of the door at a distance of 200mm from the door jamb to the centre line of the box, in each case. If the lock side of the door is not shown on the drawing, it must be ascertained before the switch is positioned.

The position of the lighting and socket outlet points and their controlling switches are indicated on the drawings.

It will be the responsibility of the Electrical Contractor to check with the Building Contractor to what height walls will be tiled and at height changes in wall finishes occur. On the strength of the foregoing information, the Electrical Contractor shall, where necessary, adjust the height of outlets above floor level to be higher or lower
than the heights specified above, so that the cover plate of any outlet shall be completely on the same type of wall finish. Cover plates which are installed partly over a tiled wall finish and partly over a plastered wall finish will, for example, not be acceptable.

23.0 STANDARD LIGHTING SWITCHES

All flush and surface mounted lighting switches shall be of the standard 16A/250V single pole rocker type operated by means of white piano-type levers. The switches shall comply with SANS 163 : 1978, as amended, and shall bear the SABS mark.

One or more switches may be mounted on a common chassis which shall be suitable for installation in standard 50 x 100 x 50mm or 100 x 100 x 50mm flush wall boxes.

The cover plates shall be punched for the number of switches fitted and shall be of 1.0mm thick pressed mild steel or of moulded PVC of at least 3.0mm thickness. The type of cover plate and finishing colour shall be as called for in the Detailed Specification.

Metal-clad watertight switches shall be fitted in die-cast aluminium enclosures and shall be installed where switches are exposed to the weather or where otherwise called for on the layout drawings.

24.0 STANDARD SWITCHED SOCKET OUTLETS

The switched socket outlets shall be of the standard round, 3-pin, shuttered type, rated at 16A/250V and shall comply with SANS 164 : 1992, as amended, and shall bear the SABS mark. The plastic insulation around each pin-socket shall be annular and raised to protrude through the coverplate which shall be punched with three separate holes for the pin-socket. Alternatively, a single opening may be punched in the cover plate provided that the clearance between the edge of the opening in the cover plate and the live and neutral pin sockets is not less than 3mm. The terminal screws of the live and neutral sockets shall be recessed so that inadvertent contact with the earth conductor will be impossible when the wired socket is pushed back into the wall box during installation.

The socket unit shall be controlled by a 16A/250V single pole switch operated by a white piano-type lever matching the lighting switches specified in Clause 23.0 above.

The socket and switch shall be fitted on a common chassis and the complete unit shall be suitable for installation in a standard 100 x 100 x 50mm flush wall box, or pressed steel industrial type box, or power skirting, or floor turret outlet. The coverplates for flush wall boxes shall be of 1.0mm thick pressed mild steel plate or of moulded or PVC of at least 3.0mm thickness. The cover plates shall be punched to suit the equipment specified. The type of cover plate and colour finish shall be as specified in the Detailed Specification.

25.0 LOCATION OF LIGHTING OUTLETS

The Electrical Contractor shall not attempt to locate lighting outlets before ceiling branding or other supports have been fixed; furthermore, due regard shall be paid to ceiling squares, branding, air-conditioning outlets, etc., in locating lighting outlets, which shall as far as possible be located symmetrically on the ceiling.
The Electrical Contractor must ensure that where fittings are mounted on a ceiling with open roof space over, that both the conduit and the fittings are securely fixed to either bandering or to timber supports fixed to the bandering. These additional timber members shall form part of this contract.

The lowest point of pendant fittings shall not be less than 2.5m above the floor, except where otherwise specified.

Where specially designed lighting fittings are to be provided, they shall be installed in a proper manner in collaboration with the Building Contractor. Where ceiling strips interfere with the mounting of light fittings, a decision on the procedure to be followed will be taken on site by the Engineer.

26.0 CONNECTION OF LIGHTING FITTINGS AND APPLIANCES

Connections to the wiring of lighting or other appliances, where connectors are used, shall be by means of either block type connectors with brass couplers, or of the insulated screwette type. No other type of connector will be accepted.