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TABLES

1. INTRODUCTION

This document contains information regarding the Requirements for Control and Power Cables for Power Stations Standard.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document has been prepared to assist those involved in the designing and installation of cables at the power station. All cabling and associated work shall be designed and executed in accordance with approved standards, codes of practice and the manufacturer's recommendations

2.1.1 Purpose

The purpose of this document is to define the requirements with regard to the selection, design and execution of cabling by the cabling Contractor and other contractors carrying out work at the power station

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs. The latest revision and amendments of the following documents shall be read in conjunction with this specification. However, in cases of conflict the provisions of this specification shall take precedence

2.2.1 Normative

[1] ASTM E814 Fire Test of through Penetration Fire Stops

[2] ESKARAAG 4 Operating Regulations for High-Voltage Systems

[3] ESKSCAAB8 Specification for corrosion protection of mechanical items of plant

[4] GGR 0992 Plant Safety Regulations

[5] GGP 0184 Performance guidelines for fire barrier seals

[6] GGS 0183 Fire Barrier Seals for Cable Installations in Power Stations

[7] GGS 0224 Fire protection at coal fired power stations

[8] GGS 0386 Requirements for Power and Control Cables for Power Stations

[9] GGS 0445 Drawing numbering system.

[10] IEC 60529 Degrees of protection provided by enclosures.

[11] IEEE 634 Testing for Fire Rated Penetration Seals

[12] NRS 028 Cable Lugs and Ferrules for Cu and Al Conductors preferred requirements for the application in the Electrical Supply Industry

[13] NWS 1220 Specification for Cable Junction and Reduction Boxes for Power Stations

[14] NWS 1527 Eskom Specification for the Installation of Cables and Cable Racks at Power Stations

[15] OHS Act no 85 of 1993 Electrical Installation Regulation under Occupational Health and Safety.

[16] H.V. TEST CC A handy guide to the safe over voltage pressure testing , and condition monitoring of cable installations

[17] SANS 97 Impregnated-paper-insulated metal-sheathed cables for rated voltages from 3.3/3.3 kV up to 19/33 kV

[18] SANS 791 Unplasticized poly(vinyl chloride) (PVC-U) sewer and drain pipes and pipe fittings

[19] SANS 1091 National colour standards for paint.

[20] SANS 1213 Mechanical cable glands

[21] SANS 1339 Electric Cables–Cross-linked polyethylene (XLPE) insulated cables for voltages from 3.8/6.6kV to 19/33kV.

[22] SANS 1411 Materials of insulated electrical cables and flexible cords, Parts 1 to 6

[23] SANS 1507 Electric cables with extruded solid dielectric insulation for fixed installations

[24] SANS 1520-2 Flexible electric trailing cable for use in mines. Part 2: High voltage (3.8/6.6kV to 19/33kV) cables.

2.2.2 Informative

[25] SANS 1574 Electric cables-flexible cords

[26] SANS 9000 to 9004 Quality management systems and standards.

[27] SANS 60269 Low-Voltage Fuses

[28] SANS 10142-1 The wiring for premises Part 1: low-voltage installations.

[29] SANS 10177-2 Fire testing of materials, components and elements used in buildings Part 2: Fire resistance test for building elements.

[30] SANS 10198-1 The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 1: Definitions and statutory requirements, South African Bureau of Standards, Pretoria.

[31] SANS 10198-2 The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 2: Choice of cable type and methods of installation, South African Bureau of Standards, Pretoria.

[32] SANS 10198-3 The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 3: Earthing systems - general provisions, South African Bureau of Standards, Pretoria.

[33] SANS 10198-4 The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 4: Current ratings, South African Bureau of Standards, Pretoria.

[34] SANS 10198-5 The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 5: Determination of thermal and electrical resistivity of soil, South African Bureau of Standards, Pretoria.

[35] SANS 10198-6 The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 6: Transportation and storage, South African Bureau of Standards, Pretoria.

[36] SANS 10198-7 The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 7: Safety precautions, SABS of Standards, Pretoria.

[37] SANS 10198-8 The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 8: Cable laying and installation, South African Bureau of Standards, Pretoria.

[38] SANS 10198-9 The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 9: Jointing and termination of extruded solid dielectric insulated cables up to 3,3 kV, South African Bureau of Standards, Pretoria.

[39] SANS 10198-12The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 12: Installation of earthing system, South African Bureau of Standards, Pretoria.0.00/10335 Power and control wiring terminations

[40] 0.00/1310 Standard Power and Control Cable Code

[41] 0.00/2713 Instrument Cable Code

[42] 0.54/393, C12 Earthing: Metal cladding

[43] 0.54/393, C16 Earthing: Tanks and bases

[44] 0.54/393, C19 Earthing: All single core cable sealing ends

[45] 0.54/393, C20 Earthing: Switchboards with thermoplastic insulated cables

[46] 0.54/393, C21 Earthing: Switchboards with paper insulated cables

[47] 0.54/393, C22 Earthing: Armoured multi-core control and power cables

[48] 0.54/393, C23 Earthing: Gland plate earthing details0.54/393, C26 Earthing: Bolted connection between copper strap and copper rods

[49] 0.54/393, C22 Earthing of process control computers

[50] 0.54/393, C30 Earthing of electrical enclosures

[51] 0.54/393, P1 Earthing of oil type transformers in power stations

[52] 0.54/393, P2 Earthing: Motors fed by XLPE or thermoplastic cables

[53] 0.54/393, P3 Earthing: Motors fed by MICC, conduit or PILCSWA cables mounted on earthed material

[54] 0.54/393, P4 Earthing: Motors fed by MICC, conduit or PILCSWA cables mounted on un¬earthed material

[55] 0.54/393, P5 Earthing: Steel enclosures mounted on earthed material and connected with un-earthed cables

[56] 0.54/393, P6 Earthing: Control equipment and local motor starters

[57] 0.54/393, P7 Earthing: Power station auxiliary bay signal earth terminal box

[58] 0.54/393, P9 Earthing of smaller 3-phase consumer without neutral with 4-core cable

[59] 0.54/393, C1, C2 & C3 Earth mat and details

[60] 0.66/3355 Cable route marker

[61] 0.66/3356 Typical section of cable trenches

2.3 DEFINITIONS

Definition	Description
Drives	Drives are all mechanical or electrical prime movers, e.g. actuators, fans, pumps, etc
Export system	The power system from the generator terminals to the 400 kV bushings of the generator transformer and the unit transformer 11 kV bushings and includes the busbars, circuit breakers, earth switches and transformers
Generator transformer	The 22/420kV step up transformer that connects the generator to the transmission system
Maintenance function	Maintenance is the function of restoring failed/worn components to a state where it is capable of meeting its design intent and performance expectations, by repair or rework achieved through the application of material and human resources in an efficient and cost effective manner
Major plant	Machinery e.g. feed pumps, turbine, mill, air heater, etc
Station or Power Station	Medupi Power Station
Unit	Boiler, turbine, generator, unit cooling water system, fabric filter plant and including all auxiliary plant and systems associated with the unit
Unit transformers	The 22/11.5 kV step down transformers that connects the export system to the unit boards

2.3.1 Classification

a. **Controlled Disclosure:** Controlled Disclosure to External Parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
P	Process control Open- (racks) and covered (trays). All control, instrumentation and telephone cables below 60 V AC or DC
L	Low Voltage Power supply cables 24 V and 220 V DC, control cables 220 V DC and 230 V AC, power cables, 230 V, 400 V and 660 V AC
S	Low voltage trefoil Power cables 400 and 660 V in trefoil (and neutral for 400 V) configuration
M	Medium Voltage Power Cables 6.6 and 11 kV three core
T	Medium Voltage trefoil

2.5 ROLES AND RESPONSIBILITIES

None

2.6 PROCESS FOR MONITORING

None

2.7 RELATED/SUPPORTING DOCUMENTS

None

3. COMPLIANCE WITH STANDARDS

3.1 COMPLIANCE WITH STANDARDS

The installation of cables and cable racking shall be in strict accordance with the law, SABS codes of practice and standards as well as the reference documents detailed under section 3.

3.1.1 LIFE EXPECTANCY:

The design, equipment selection and the installation of the cables and the associated equipment shall be performed in such a way to have a 50 year life expectancy

3.1.2 CABLE IDENTIFICATION

3.1.2.1 Plant systems and cable schedules

a. Block diagrams and cable schedules for construction cables shall be prepared and maintained by the Employer.
b. Cable block diagrams and system cable lists for all permanent installations shall be prepared by the contractor responsible for providing the plant (in accordance with another specification). These schedules shall then be issued to the cabling Contractor for the final design, routing, installation and testing of the required cables.
c. The Employer shall also issue cable schedules (and block diagrams in selected areas) to the cabling Contractor for areas of plant where the interface design of the installation is performed by the Employer. The cabling Contractor shall perform the final design, routing, installation and testing of these cables.
d. Separate cable schedules shall be issued for each distinct board, system etc.

3.1.2.2 Cable identification code

Cable coding is the identification of cables according to the origin of the cable. The cable number format shall be as follows:

Table 1: Cable Identification Code

Classifying Element	**Numbering Element**
Process Related Code	Cable Number
NNAAA i.e. 00ETK	NNNN i.e. 8001
OR	
Point of Installation Code	Cable Number
NNAAA i.e. 00EYG	NNNN i.e. 8001

3.1.3 Cable number tag details

All cables shall be labelled with standard UV resistant PVC K Type flexible cable markers on nine digit carrier strips and attached on both ends with suitable cable ties (T18R or T30R depending on cable thickness) as follows:

Figure 1: 10BBA1003

a. Cable number tags shall be fixed to the cables as follows:

- One tag inside a floor mounted cubicle, switchboard etc. visible through open door.
- One tag below the cubicle, switchboard etc. to permit identification of the cable from below the fire barrier or other seal of the floor opening above which the board is mounted.
- One tag at the cable entry into the field mounted equipment (for cubicles with top or side entry or where a cable enters an enclosure from an open run only one tag just below the cable gland is required).

b. Cable numbers for application in chemical corrosive environments or outside buildings e.g. coal and ash conveying plant shall be stainless steel with engraved black letters and numbers and fixed with stainless steel wire.

3.1.4 Standard cable codes

The cable types shall be designated in accordance with the codes detailed on the following drawings:

0.00/1310 Standard power and control cable code

0.00/2713 Instrument cable codeThe 31/2 core cables are designated with a Z instead of a 0 in the otherwise numerical portion of the cable code, i.e. BVVZ4SCM.

3.2 CABLE TYPES AND SPECIFICATION

3.2.1 General

a. The tables at the end of this document list the cables selected for use at the power station. This listing has been compiled to optimise the number of different types of cable to be used at the power station. No further types shall be introduced without prior consultation with the Engineer.

b. The Contractor shall indicate basic information with regard to the compounds used in the cable construction of each type of cable as per Schedule B.

3.2.2 Medium voltage power cables

3.2.2.1 Unarmoured 6.6 kV and 11 kV power cables (DXG and EXG cables)

a. In the power station buildings unarmoured Type B cables with copper conductors (class 2 in terms of SANS 1411-1) shall be used. These cables shall be installed in protected runs on cable trays and do not require armouring.

b. The cables shall be XLPE insulated with flame-retardant reduced halogen emission PVC outer sheath (emit a mass of not more than 15% halogen). Acceptance criteria for insulation shall be in accordance with SANS 1411-2.

c. Single and three core cables shall be with the cores individually screened with copper tape. Cables shall be manufactured in accordance with SANS 1339 and SANS 1411 Parts 1, 2, 4 and 7.

3.2.3 Armoured 6.6 kV and 11 kV cables (DXE and EXE cables)

a. For outdoor installations where mechanical damage is possible, installation in concrete trenches or direct burial in ground the cables shall be round steel wire armoured Type A (BVXnnCV) with copper conductors (class 2 in terms of SANS 1411-1).

b. The cables shall be XLPE insulated with flame-retardant reduced halogen emission PVC outer sheath and bedding (emit a mass of not more than 15% halogen). Acceptance criteria for insulation shall be in accordance with SANS 1411-2.

c. Single and 3-core cables shall be with the cores individually screened with copper tape. These cables shall be manufactured to SANS 1339 and SANS 1411 Parts 1, 2, 4, 6 and 7.

3.2.4 Single core 6.6 kV and 11 kV cables application

a. Single core cables shall only be used on major power distribution circuits where the current rating is such that multi-core cables are not practical.

b. Where trefoil clamps are used for single core cables in trefoil configuration, these clamps must be capable of withstanding the forces generated by short circuits as shown in paragraph 11.3.

c. All armoured single core cables in trefoil groups shall be earthed on one side only in order to prevent armour circulating currents flowing through closed circuits. Single point earthing shall be carried out on the feeding side of board to board feeders or on the normal side of supply in a ring feeder section.

d. On feeds from a board via a transformer to another board (typical example: 11 kV board to transformer to 6.6 kV board) the cable armouring shall be earthed in the boards only.

3.2.5 Voltage rating

For XLPE insulated cables no voltage over rating is required (the reticulation system is high resistance earthed) and the rated cable voltages shall be as follows:

- For the 6.6 kV system the rated cable voltage is 3.8/6.6 kV.
- For the 11 kV system the rated cable voltage is 6.35/11 kVFor paper insulated cables over rating of the voltage level is required and the rated cable voltages shall be as follows:
- For the 6.6 kV system the rated cable voltage is 6.35/11 kV.
- For the 11 kV system the rated cable voltage is 12.7/22 kV.

3.2.6 Low voltage power cables

3.2.6.1 Unarmoured low voltage power cables

a. The cables shall be PVC insulated with flame-retardant reduced halogen emission PVC outer sheath (emit a mass of not more than 15% halogen).

b. This type of cable shall be applied for control cables (i.e. 220 V DC, and 230 V AC) and AC power cables (i.e. 230 V, 400 V, 660 V).

c. Low voltage 600/1000 V cables shall be manufactured to SANS 1507 as amended and SANS 1411 parts 1 and 2.

3.2.6.2 Armoured low voltage power cables

a. The cables shall be PVC insulated with flame-retardant reduced halogen emission PVC outer sheath and bedding (emit a mass of not more than 15% halogen).

b. This range of cables shall be round steel wire armoured for burial in ground and for installations where mechanical stresses are expected and shall be used for control cables (DC: 220 V, AC: 230 V) and power cables (230 V, 400 V AC).

c. The cables shall be manufactured to SANS 1507 and SANS 1411 Parts 1, 2 and 6. 8.3.3 Unarmoured and armoured power cables application

d. In the cable size range of 35 mm2 to 185 mm2 31/2 core cables with a neutral core approximately 1/2 of the cross sectional area of the phase conductors shall be used.

e. Where unarmoured cables are used for the interconnection between lead acid batteries and chargers, separate cables shall be used for both the positive and negative connections. Depending on the current rating the use of parallel cores in a two, three or four core cable shall be acceptable for such connections provided the installation of a 630 mm2 single core cable is not warranted. Red and blue sleeving shall then be used on all parallel cores when terminating the positive and negative cables respectively (insulation tape shall not be acceptable).

f. At the battery side the cables shall be terminated onto take-off plates away from the batteries and busbar connections shall be provided for connecting from the take off plates to the battery terminals. The take off plates shall be provided by Others.

g. Where Nickel Cadmium batteries are mounted separately from the charger cubicle the interconnections shall be made by two (2) core cables or using two (2) parallel cores in a four (4) core cable, depending on current rating and available cable sizes. Standard core insulation shall be covered by red and blue sleeving, where necessary, to indicate positive and negative, pole connections respectively.

3.2.6.3 Colour coding of low voltage cable cores and terminations

a. Normal colour coding of cable cores to SANS 1507 Table 1 shall be used for cables with:

- 2 cores: red – black.
- 3 cores: red - yellow – blue.
- 4 cores: red -yellow - blue – black (green/yellow).
- 7, 12, 19 and 37 cores: numbers 1 to 7, 12, 19 or 37 respectively.

b. For termination purposes it may become necessary to code cores by coloured sleeves:

- AC phase colours: red - yellow - blue
- Neutral: black
- DC positive: red
- DC negative: blue
- DC battery midpoint: black
- Earth: green/yellow (plain green sleeving is not permissible).

3.2.6.4 Use of fourth cable core as earth continuity conductor

a. For three wire circuits fed by four core cables up to 16 mm2 phase conductors shall be colour coded red - white-blue as per the SABS specifications. The fourth, black conductor shall be fitted with a neatly fitting green-yellow sleeve before any lug is crimped onto it to indicate its use as earth conductor.

b. In switchboards all earth continuity conductors shall be terminated onto the earth bar provided by the switchboard supplier with predrilled 7 mm holes. The Contractor shall provide the M6 bolt, spring washers, washers and nuts for such terminations (also refer to clause 8.4).

3.2.7 Control, protection and instrumentation cables

3.2.7.1 Cable type BVXnnCM

a. Multi-core thermoplastic insulated cables shall be used for all current transformer and voltage transformer, secondary circuits and protection, tripping and closing circuits. These cables shall have a voltage rating of 600/1000 V and current ratings dependent on the cross sectional area (details are given in tables 11 and 12).

b. The minimum conductor size used for generator protection current transformer circuits shall be 2.5 mm2. For other applications the minimum size used shall be 1.5 mm2. All voltage transformer circuits shall be run in dedicated cables with a minimum conductor size of 2.5 mm2 in the HV yard and inside the power station.

c. Note that current sensors may be used in the MV switchgear and these shall then be cabled with braided screen type cables.

d. Armoured or unarmoured cables for certain sensitive applications shall be laid in a protected run separated from the normal cable installation in order to increase mechanical protection and fire survivability. In general armoured cables shall be laid where armouring is essential for physical protection e.g. for burial in ground or in positions with an increased danger of mechanical damage either during installation or in service. Properly earthed steel wire armouring also provides a degree of protection against electromagnetic interference in areas with a high disturbance signal level.

e. Cables shall have numbered cores except for 2, 3 or 4 core cables, which are colour coded. All cores shall be ferruled with the lead numbers shown on the cabling drawings.

3.2.7.2 Cable type BVSnnCM

Multi-core thermoplastic insulated overall screened (not armoured) cables of the BVS series shall be used for non-conventional control circuits where low impedance electronic circuitry is employed. This cable type shall only be used when requested specifically by the Employer.

3.2.7.3 Cable type UVGnnACM

a. For all digital and analogue signals where low level signals apply, thermoplastic insulated overall screened twisted pair UVG control cables shall be used except for cables in this category which run, over long distances outside of buildings or are buried in ground. Conductor pairs in this series shall be identified by a colour code system of orange, violet and turquoise rings.

b. The individual cores shall not be numbered or ferruled and shall be terminated in sequence as set out by the Engineer.

c. Type UVG cables shall have a voltage rating of 300/500 V with a rated conductor area of 0.5 mm2 and a signal level of 1 A shall not be exceeded.

d. Screens and drain wires shall be terminated at both ends in accordance with instructions provided by the respective supplier. In some cases, screens are earthed at one end only, usually the point of cable source e.g. cables to temperature or vibration sensors of a motor with insulated bearing pedestals.

3.2.8 Mineral Insulated cables

a. Mineral insulated cables shall only be used in exceptional circumstances where route temperatures are high. They shall not used where vibration could result in failure due to metal fatigue. Where mineralinsulated cable is used for motor supplies, it shall be terminated in a junction box near the motor and the final connection made with special cable suitable for the high ambient temperature i.e. silicon insulated cable or equivalent.

3.2.9 Flexible connections

Where electrical equipment is mounted on the boiler face which is subject to vertical movement due to heat expansion the connection between the equipment and the static steelwork shall be made by means of high temperature flexible cables in a flexible conduit. This cabling shall be supplied and installed by the Contractor.

3.2.10 Marking and information on cable sheaths

a. All cable sheaths shall be black with colour coding traces or printing as follows:

Table 2: Marking and information on cable sheaths

CABLE TRACE COLOUR	IDENTIFYING CABLE AS HAVING
Red	Flame retardant PVC sheath only (LOI >27%)
Orange	Flame retardant PVC bedding and sheath
Blue	Low halogen emission PVC bedding and sheath (See note 1)
White	Halogen free cable

3.2.10.1 NOTES:

a. The emission of HCL gases in a fire situation is reduced from approximately 30% of the weight for standard PVC to below 15%.

b. This industry coding shall be given preference above that of the Employer's code. The trace colour codes shall be indicated in Schedule B for the respective cable manufacturers to be used as suppliers.

c. If the cable is identified by a colour coding trace extruded into the sheath which in the manufacturer's opinion weakens the sheath and if the cable manufacturer cannot guarantee the mechanical properties of such sheathing under all conditions e.g. abuse during installation and UV radiation over extended periods, the Employer will desist from requesting such coding traces. It is then preferred to have the required information embossed into or invariably printed in colour code onto the cable sheath in the process of extruding the sheath onto the cable. This information includes:

- voltage level,
- name or trade-mark of cable manufacturer and
- SABS specification to which the cable is manufactured, even if some portions of the cable make-up deviate from the specification such as SANS 1507.

d. Cable manufacturers may find it convenient to divide or duplicate this information by means of two embossings or printing rollers on opposite sides of the cables up to 15 mm diameter. For cables above 15 mm diameter two (or more) lines shall be required. The height of the characters shall not be less than 15% of the cable overall diameter.

e. The Contractor shall indicate in writing which cable sheath compounds are provided for and which method of marking and information (colour traces or coloured printing) shall be used.

3.2.11 Dimensions of cables

Tables 1, 2, 3, 4, 5 and 6 indicate the nominal overall diameter of the cables to be selected for the power station. Reference is made to Schedule B of the Contract for guaranteed dimensions, where these are required.

3.2.12 Special cables

Special cable types which may be required for thermocouple leads, high temperature/high flexibility applications, or heavy current high frequency applications such as turbo generator excitation circuits are not covered by this standard. The supply and installation of such cables shall be the responsibility of the supplier of the associated Plant.

3.3 LAYOUT, RACKING AND LAYING

3.3.1 Drawings

a. The Employer shall provide drawings showing cable servitudes and the cable layout along the servitudes.

b. The cabling contractor shall provide a cable racking system vertically, horizontally and horizontally in a vertical plane as called for in the specification and in the drawings issued by the Employer. Details of the racking system and/or supplementary steelwork shall be submitted to the Engineer for acceptance before installation. Where necessary the Employer shall obtain approval from Others responsible for major structures to which racking should be fitted.

3.3.2 Cable racks

a. Cable racks shall be provided such that every cable is adequately supported throughout its run. Racking for power cables and control cables shall be designed to support the cables at least every 375 mm. Control cables may have to run on cable trays or in ducting so that they are supported over their entire length.

b. The minimum spacing between open telephone, control and instrumentation cable racks and power cable racks shall be 1000 mm. This may be reduced at crossings, which is at right angles. Where limited space makes it necessary to bring power and control cable racking closer than 1000 mm, control cable trays shall be installed and closed by means of a suitable cover to create a Faraday cage around the control cables.

c. Separate racks or trays shall be installed for cables of the following voltage levels:

d. Power cables 6.6 kV and 11 kV in trefoil configuration

e. Cables in trefoil configuration shall be clamped with non-magnetic clamps capable of withstanding forces generated by short circuit currents in accordance with paragraph 11.3. The normal centre line distance between clamps shall be 750 mm but clamps shall be fixed to the racking only every 3000 mm.

f. For field mounted runs, in particular for small power and control cabling, cable trays manufactured from high tension wire mesh shall be acceptable. These trays are less prone to collection of dust.

3.3.3 Reduction of fire hazards along racking routes

a. Where practical, cable racks shall be routed away from fire exposure or hazards or shall be protected from such exposures. Where cable racks are subject to oil spills, they shall be designed to prevent the spread of oil spill fires (see paragraph 9.9, Sun and dust shields).

b. Under-floor and concealed cable spreading areas which have a height of more that 800 mm and total floor area exceeding 300 m2 shall allow for the provision with a fire detection system (by Others). Refer also to the standard GGS 0224, Fire Protection at Coal Fired Power Stations.

3.3.4 Loading of cable trays and ladder racks

a. The laying of cable onto racks shall conform to the following requirements:

- Two MV or LV trefoil groups per 450 mm wide rack.
- Three MV or LV trefoil groups per 600 mm wide rack•Three LV trefoil groups plus two neutral cables per 60
- All three core MV and multi-core LV cables above 16 mm2 rated area are laid in a single layer per rack only.
- LV cables up to 6 mm2 rated area are laid in a double layer on crowded rack routes, otherwise also only in single layers.
- Stacking of control and telephone cables up to the top edge of the side member is permissible.

b. The following worst case loads for horizontal cable racks in kg per linear metre of racking shall apply:

Table 3: Loading of Cable Trays and Ladder Racks (A)

LOADING OF HORIZONTAL RACKS						
Parameter	Rack width [mm]					
	150	300	450	600	800	1000
Dead weight cable load	30 kg	60 kg	90 kg	120 kg	150 kg	190 kg
Safety factor 1.6 for dead weight	50 kg	100 kg	150 kg	200 kg	240 kg	305 kg
Live weight (2)	115 kg	145 kg	175 kg	205 kg	235 kg	275 kg
Safety factor 1.2 for live weight	140 kg	175 kg	210 kg	245 kg	280 kg	330 kg
Resultant design load	150 kg	180 kg	220 kg	250 kg	300 kg	350 kg
Notes: 1000 mm wide rack is used generally for cable risers only. In individually approved and exceptional cases only, it may be used for horizontal runs.						

c. The distance of support columns shall be selected in such a way that a horizontally installed rack shall be deflected not more than 1:150 at the midpoint between two supports when subjected to the design load shown above i.e. 5 mm at the midpoint between supports 1500 mm apart.

d. Where support columns carry more than one rack or tray the centre line distance shall be selected according to the design load of the rack carrying the greatest design load.

e. A cantilever arm may not deflect more that 1:150 at the front when supporting a rack with a load equal to the design load shown above evenly distributed over its width i.e. 5 mm approximately for a cantilever arm carrying a 800 mm wide rack.

f. The following worst case loads for perforated cable trays in kg per linear metre of tray shall apply:

Table 4: Loading of Cable Trays and Ladder Racks (B)

LOADING OF PERFORATED CABLE TRAYS					
Parameter	Rack width [mm]				
	150	300	450	600	800
Dead weight cable load	60 kg	80 kg	100 kg	120 kg	150 kg
Safety factor 2,5 for dead weight	150 kg	200 kg	250 kg	300 kg	375 kg
Design load (1) and (2)	60 kg	80 kg	100 kg	120 kg	150 kg

g. Note that for (1) both cable trays and weldmesh racks shall not normally be expected to carry live weight of persons climbing on to the trays for installation or maintenance purposes (must be positioned so as to avoid ready “step functions”) and (2) the weights indicated above are based on a centreline distances of supports of 1500 mm.

3.3.5 Separation of power and control cables at outside plant buildings and substations

In order to minimise problems inside and outside buildings with routing and laying of cables and also noise interference in control cables, separate power and control cable entry into buildings shall be used. Where possible two or more separate cable entry openings shall be provided or made use of. This will also facilitate early separate closing of openings when cable laying is completed (in stages).

3.3.6 Use of racking by Others

The Employer shall advise the Contractor on racking requirements of Others. The Contractor shall install racking for such purposes at the rate prices of the contract. The Engineer shall advise the Contractor with regard to exact requirements as well as the required completion dates for the racking.

3.3.7 Supporting of cables on racks

a. Armoured and unarmoured multi-core cables shall be supported every 375 mm in the horizontal position where racks are provided. Where cables leave the racks or descend or ascend vertically, they shall be clamped every 750 mm at clipping points to be provided by the Contractor.

b. Single core cables shall be clamped by clipping points at intervals not exceeding 750 mm in the horizontal position but, although fixing holes are provided in the supporting steelwork at each clipping point, they shall be fixed to the supports every 3000 mm only. Alternative fixing points shall be offset against each other by about 100 mm along the racking route in order to create a basic snake formation along which the cable can expand and contract on heat cycling. Single core cables shall be clamped by clipping points at intervals not exceeding 750 mm in the vertical position.

3.3.8 Clipping points

Clipping points are defined as all points at which cables are secured to racking, trays, walls or ceilings by means of cleats, straps or saddles, made of nylon, stainless steel or another approved material.

3.3.8.1 General

a. On cable risers cables shall be fixed to cable ladders or inside trays at 750 mm intervals.

b. On vertical cable runs in (galvanised) conduit adequate space between separate conduit lengths shall be left to allow strapping of the cable to a support structure to take up the weight of the cable for each conduit length.

c. On horizontal racks installed in a vertical plane cables shall be strapped every 375 mm to ensure a neat appearance.

3.3.8.2 Single core cables

a. Clipping points for trefoil groups of/or single core cables comprise a non magnetic portion or is of non magnetic material to prevent the creation of eddy currents in the clamp. Hardwood shall not be acceptable. Clamps shall be the correct size for the cables.

b. Clamps shall be capable of withstanding the forces generated by the through fault current specified in clause 11.3 when installed in accordance with this specification.

3.3.8.3 Multi-core cables

a. Clipping points for multi-core cables shall be applied at positions in accordance with clause 9.7 and include the supply of materials, drilling of concrete and steelwork, painting if required, and the installation of the cleats.

b. For indoor and outdoor installations protected from direct sun radiation nylon strapping shall be used for all cables up to 30 mm diameter.

c. Stainless steel strapping shall be used for cables above 30 mm diameter for indoor installation. For all cables installed outdoors only stainless steel strapping shall be acceptable. Stainless steel strapping shall be strapped over a plastic bedding strip to prevent damage to the cable sheath. Alternatively coated stainless steel strapping shall be used.

d. Approved galvanised “K-clamps” with rubber or plastic inserts to protect the cable shall be used for terminating unarmoured cables in floor mounted indoor switchboards. The switchboard manufacturer shall provide suitable C-profile rails.

e. All clipping and strapping material (and methods) shall be approved by the Engineer before installation is undertaken.

3.3.8.4 Control cables

Where a large number of control cables are accommodated in a limited space, they may be bunched and fixed to racking or trays by means of an approved strap. Not more than 12 cables shall be accommodated under one strap.

3.3.9 Sun and dust shields

a. Where cabling is subject to direct sun radiation, oil spills or severe dust accumulation, shields shall be provided. The shields shall be designed to protect the cables against sunlight or against oil, dust and other foreign matter, as required for the particular case and does not obstruct air flow past the cables or diminish the thermal rating of the cables in any way.

b. Sun shields shall be designed to protect cable racks against direct sun radiation at angles not less than 35º from the vertical plane and if slotted for ventilation, gives not less than 75% coverage.

3.3.10 Sleeve pipes for cables

Sleeve pipes shall be provided to carry cables under roadways, foundations, aprons and certain floors. Details of all permissible types of cable pipes are provided in Table 7.

3.3.11 Cable chases

Cables shall only be buried in chases in concrete floors or walls where no alternative arrangements are possible. Floor chases shall be filled with sand and screeded over. This arrangement is avoided in areas where oil spillage is possible.

3.3.12 Cable laying in ground

a. The details of the depth of laying and spacing of all types of cable used is as shown in Table 9. The dimensions stated are the minimum permissible and shall not be reduced without investigating current loadings in detail (refer also to drawing number 0.66/3356). Where cables are laid in ground, such runs shall be shown in detail on appropriate drawings for reference purposes and protected by concrete slabs or yellow plastic cover plates and marker tapes.

b. Every effort shall be made to run cables either in tunnels, trenches or sleeve pipes, should they have to be laid below ground level.

3.3.13 Cable route markers

Concrete cable route markers as per drawing 0.66/3355 shall be provided to mark all cable servitudes and the general location of buried cables. The route markers shall be located at 50 m intervals and wherever a route changes direction, to mark buried joints and where cables cross roads, railways or any other servitudes.

3.3.14 Cable laying in air from great heights

a. In the boiler house area it is usual practice to lay cables from drums transported to the highest floor level required. Extreme care shall be taken when lowering cable for laying from a drum to ensure that the cable weight is countered by a suitable braking means (e.g. weight of 100 m, 4 x 70 mm2 armoured cable is 510 kg). Assuming the total unarmoured cable weight is taken up by the conductors only, the weight of 100 m is about 10% of the ultimate tensile strength only. This method shall be acceptable, provided that clipping is performed promptly.

b. Attempts shall be made to limit the pulling force required to a minimum to avoid stretching the outer layers of the cable. The cable manufacturer's maximum allowable mechanical forces on cables during installation shall not be exceeded.

3.4 TERMINATION OF CABLES AND CORES

3.4.1 Termination through gland plates

a. Where cables enter enclosures through gland plates, mechanical cable glands of the armour or cable gripping type to SANS 1213 shall be used. Glands shall be of the correct size for the cable. Weatherproof shrouds shall be required only for exposed positions indoors and for all field mounted terminations.

b. The quality of cable gland terminations shall be in line with and may not be lower than the degree of protection (IP rating) of the enclosure against ingress of dust and water.

c. For MV cables where cable glands are required, split gland plates shall be provided to enable removal of the cable without removal of the gland plate.

d. For single core cable terminations the gland plate and both gland and lock nut shall be of non-magnetic material.

e. Cables shall be installed from the back to the front on the gland plate to enable cables to be added without difficulty at a later stage, if required. Low voltage and control cables shall be grouped separately on the gland plate.

f. Outdoor cables shall not enter at the top of a distribution board and where cables enter on the side, care shall be taken to prevent water ingress.

3.4.2 Termination of cables in switchboards

a. Where cables (larger than 70 mm2) enter switchboards or other cubicles through floor openings, which will later be closed by adequately fire rated material to make them also vermin proof, gland plates shall not be considered as essential. In that case the switchboard manufacturer is held responsible for providing unistrut or similar rails to which cables can be securely clamped by the cable contractor by means of “K-clamps” or approved equivalent. Non magnetic clamps shall be used for single core cables.

b. Where space within the switchboard is limited, the unistrut shall be installed below the floor level and the cables shall be fixed to this unistrut with K-clamps.

3.4.3 Cable entry into enclosures with non-standard threads

Certain imported equipment is supplied by Others with enclosures having cable entries with other than metric threads. To permit fitting of cable glands to SANS 1213 the Contractor shall supply and fit the correct reducers from one type and size of thread to the other.

3.4.4 MV Terminations and earthing of single core cables

a. Approved termination kits for terminating MV cables shall be supplied. Care shall be taken to ensure that the dimensions and procedures issued with the kit are adhered to.

b. Single core cables connecting between boards shall be single-point-earthed on the feeder side. Cables connecting transformers to boards are single point earthed at the switchboard. Trefoil earth tails shall be bonded together with the shortest possible earth strap to the earth bar.

c. Cable earth tails shall be long enough to connect directly to the earth bar without jointing.

3.4.5 LV Power cable terminations

Cables of larger rated areas terminated straight onto the terminals of the lowest drive compartment in a MCC may give problems due to heat expansion. An S-bend or a complete loop shall be provided near the termination so that expansion due to temperature changes does not stress the cable or terminal.

3.4.6 Battery terminations

Cables shall not be terminated directly onto terminals of larger batteries. All such battery connections shall be terminated on approved wall-mounted battery termination stand-off plates. These copper plates shall be mounted on stand-off insulators designed to take the weight and strains of the cable terminations. The interconnection from the wall-mounted stand-off plate to the battery terminal shall be made by means of solid copper bars.

3.4.7 Multi-core thermoplastic insulated cable terminations

Terminations shall as a minimum requirement comply with the drawing 0.00/10335. Spare cores (those not connected to any terminal) shall be left long enough to reach the furthest terminal and is neatly fastened, ferruled with the cable numbers and earthed on one side only, usually the outgoing side of the cable. Lug/terminal combinations different from those shown on the standard drawing shall not be not used without approval.

3.4.8 Mineral-insulated cable terminations

Cable terminations for mineral-insulated cables shall be made with a cold-seal compound and all cores shall be insulated throughout their length with continuous neoprene or nylon sleeving. Terminations

having jointed or PVC sleeving shall not be acceptable. The termination shall be suitable for operation up to 80ºC.

3.4.9 Process control cable terminations

a. Control and instrument cable terminations shall comply with the drawing 0.00/10335.

b. The termination of control cables onto delicate control equipment shall be performed in accordance with the special instructions from the respective process control equipment supplier.

c. Process control cable shall generally be terminated by using screw clamp type connections at the field equipment end. Pre-insulated lugs shall be crimped onto stranded cores for screw clamp type terminations, e.g. on line-up terminals.

d. Termination of cables onto line-up terminal strips

e. Wire trunking for internal wiring and for the safe routing of incoming cable cores to the terminal strips shall be used in switchboards and large distribution boards. When trunking is not available or economical, control (and smaller power) cabling shall be harnessed and secured in a neat manner.

f. Identification of cores by means of approved ferrules sized to suit the core diameter shall be provided.

3.4.10 Earthing of equipment and cables

For detailed instructions on the earthing methods when terminating cables, screens etc, refer to the standard, 36-131/132, “Earthing and lightning protection” as well as the earthing standards, 0.54/393.

3.4.11 Panel jumper wires

With certain items of equipment it may be necessary to interconnect terminals in the same, adjacent or nearby panels using jumper wires of rated area up to 4 mm2. The necessary jumper wires complete with ferrules and suitable lugs or terminating pins where necessary shall be supplied and installed. Lugs and terminating pins and the crimping tool used to fix them to the wire shall be reviewed and approved by the Engineer.

3.4.12 Cable lugs and crimping tools

a. The size of cable lugs shall be selected to fit the bare copper conductors on which they are used. For conductors 0.5 to 6 mm2 pre-insulated crimping lugs as per drawing 0.00/10335 shall be used. All small lugs shall be crimped by means of the correct crimping tools. Crimping tools shall either be of the manual or hydraulic type. Only standard pre-fabricated crimp lugs shall be used. Cutting, re-drilling and other site modifications shall not be allowed. Pre-insulated crimp lugs with unbrazed barrels shall not be crimped sideways.

b. Larger cable lugs shall be to the SABS specification and drawing 0.54/5609, i.e. the material body of lugs shall not be less than the rated area of the conductor. For carrying out compressed joints or terminations on cables above 16 mm2 rated area a suitable hydraulic compression unit complete with the necessary dies, compression head, hose and pump shall be used. Crimping dies shall produce a hexagon shaped crimp. Crimps with a deep central indent in the lug shall not be acceptable. The hydraulic pump unit and compression head must feature an interlocked valve system which can only be released when the compression operation has been fully executed.

c. For high fault current applications above 40kA heavy duty lugs with double crimps shall be used.

d. Cable cutters shall be used to strip flexible stranded cable, not a hack saw as this creates distortion in the cable.

3.4.13 Supply of bolts and nuts

a. In many cases the equipment supplier shall provide only termination points without any other hardware. In that case, the Contractor shall supply correctly dimensioned bolts, washers (contact, flat and spring washers as required) and nuts.

b. Material for outdoor installations shall be hot-dip or electro galvanised. Material for indoor terminations shall be cadmium plated and passivated.

3.4.14 Connection torque

a. Torque wrenches shall be used to tighten screw-joints of copper bars as well as bolting cable lugs onto copper bars, battery terminating plates and motor terminals to consistent and repeatable values.

b. High tensile bolts of tensile strength 8.8 (class 8G) and nuts of strength 5.5 (class 5D) shall be used. Bolts with tensile strength 5.5 (class 5D) shall not be accepted. The Contractor supplies all bolts, nuts, flat and spring or contact washers for terminating power cables onto boards and other equipment, e.g. transformers.

c. The specified material shall be used for the types of connections as shown in the following table:

Table 5: Connection torque (A)

MATERIALS AND BOLT SIZES FOR DIFFERENT TYPES OF JOINTS		
JOINT	MATERIAL	BOLT SIZES
Copper bar joints	hex bolt, 2 contact washers, nut	M5, 6, 8, 10, 12, 16
Cable lugs onto copper bar	bolt, washer, contact washers, nut	Cheese head: M4, 5, 6 Hex bolts: M5, 6, 8, 10, 12
Copper bar, large transformer bushings	bolt, washer, contact washer	M16, 20, 24, 30, 36
Two cable lugs front and back onto copper bar	bolt, spring washer, washer-washer, spring washer, nut	Cheese head: M4, 5, 6 Hex bolt: 6, 8, 10

d. The torque values for the different bolt sizes are given in the following table:

Table 6: Connection torque (B)

TORQUE VALUES				
Thread Size	8.8 High tensile bolt Original tightening [Nm]	Testing [Nm]	4.6 Brass/copper/copper alloy bolts Original tightening [Nm]	Testing [Nm]
M4	1.8	1.5	-	-
M5	5.0	4.3	2.5	2.12
M6	8.0	6.8	4.0	3.4
M8	20	17	8.0	6.8
M10	40	35	13.0	11
M12	70	60	20	17

M16	155	130	40	34
M20	480	410	-	-
M24	835	710	-	-
M30	1660	1410	-	-
M36	2900	2460	-	-

e. The above values shall be reached to within ± 10% tolerance and be witnessed during erection in accordance with the quality check sheet.

f. For motor terminations with bolts and nuts of a lower tensile strength (4.6 and 4 respectively) of brass and or copper/copper alloys lower torque values shall be used.

3.4.15 Cable lengths and through joints

3.4.15.1 Lengths and through joints

a. Full drum lengths of cable shall be used wherever possible. One through joint shall be accepted as routine per standard drum length of cable or part thereof, measured along the approved route between terminations. All other cases are treated as exceptions and approval is required before through joints may be installed.

b. Through joints in protection cables and secondary CT or VT leads shall not be acceptable. No through joints are permissible under any circumstances with screened instrumentation cables.

c. Where an LV cable run exceeds the maximum drum length, soldered resin encapsulated joints shall be required.

3.4.15.2 Junction and reduction boxes

a. On long low voltage cable runs the volt drop consideration may require the use of cables with rated areas one or more sizes above that which would normally suffice for given motor currents. It may then become necessary to install cable junction boxes near the consumer and to install a short length of cable with the smaller rated area to suit the termination box size of the motor. Such junction (reduction) boxes shall be supplied in accordance with drawing 0.66/55342 for sizes of the larger cable 50 to 185 mm2. The junction boxes shall be rated for the applicable fault current and have the same ingress protection rating of the electrical equipment to which the cable is connected.

b. For cable sizes 35 mm2 and below standard Pratley or CCG through boxes of size three or smaller (depending on cable size) fitted with three or four DIN or C rail mounted line up terminals shall be installed. Details of the application area, size and type of box and the final connection between the box and the electrical equipment shall be provided.

3.5 CABLE RATINGS

3.5.1 General

a. The current ratings shall be based on the requirements of SANS 10198-4 and the recommendations from the cable manufacturers for unarmoured cable with halogen-free, low smoke and fume, fire retardant insulating compounds.

b. For armoured cables with PVC insulation and bedding, steel wire armour and fire retardant PVC sheath separate tables contain the information for the respective current ratings.

c. De-rating for bunching etc. to the conditions stated in Tables 10, 10a, 11, 11a, 12, 12a, 13 and 13a are similarly based on factors given by SANS 10198-4 and the industry.

d. The mineral insulated cable ratings have been calculated from BICC Publication 592 adapting the values given therein to the conditions in Table 4.

e. The Contractor shall submit these tables for the specific cables to be provided and submit this to the Engineer for acceptance one month after contract award.

3.5.2 Overload protection of cables

a. Cables with thermoplastic insulation may sustain serious damage when subjected, even for short periods, to temperatures in excess of those permissible for continuous operation. The maximum fuse ratings as per Table 17 for unarmoured and Table 17A for armoured cables shall apply.

b. The full current rating for thermoplastic insulated cables corresponds for most compounds to the continuous operating temperature of the conductors of 70oC. Accordingly, such cables may only be operated at full rating as given in the tables if suitably protected against excess currents arising from abnormal conditions. If the duration of such excess currents does not exceed four hours, protection is considered to be adequate if the minimum current at which it is designed to operated does not exceed 1.5 times the tabulated ratings where cables are laid in air or in ducts, and not more than 1.3 times the tabulated ratings where the cables are laid directly in the ground.

c. Where the circuit protection is such that operation of a cable at full rating is not permissible under the foregoing provisions, the cable required for a given continuous load current shall be selected to have a rating as given in the tables, which is not less than:

- the given continuous load current,
- for cables in air or ducts, 0.67 of the minimum current at which the excess current protection is designed to operate, or
- for cables laid directly in the ground, 0.77 of the minimum current at which excess protection is designed to operate.

d. Most cables with thermoplastic insulation are fuse protected. The fusing factors (defined as the ratio of rated minimum fusing current to the continuous current rating of the fuse) for fuses to SANS 60269, Low-Voltage Fuses, are as follows:

Table 7: Low-Voltage Fuses

CLASS OF FUSE TO SANS 60269	FUSING FACTOR
P	1.00 - 1.25
Q1	1.25 - 1.5

e. Therefore for cables in air, the tabulated current ratings shall be used if the circuit is protected by a Class Q1 fuse of continuous rating not exceeding that of the cable.

f. The following is a calculation as an example for unarmoured cable, Table 17. The installation details are as follows:

- Continuous load - 190 A, 3 phase 400 V.
- Route - Buried in ground, one cable without others in parallel.
- Fuse - 250 A, Class Q1.

g. The minimum cable for the continuous load current as per Table 13 is 70 mm2 (rating of 236 A). The fusing current as per the above table is 250 x 1.5 = 375 A. The minimum current rating of the cable, protected against overloads is 375 x 0.77 = 290 A. It will therefore be necessary to use a 120 mm2 cable with a continuous rating of 322 A.

3.5.3 Fault current ratings

a. The fault current ratings for the different voltage levels used in the auxiliary power system are as follows:

Table 8: Fault Current ratings

SYSTEM FAULT CURRENT RATINGS	
Voltage level	Fault current
11 kV (specific boards)	40 kA
11 kV (general)	31.5 kA
6.6 kV	25 kA
400 V	50 kA
660 V	50 kA
220 V dc	10 kA
24 V dc	25 kA

b. The rated cross sectional areas for cables under the direct control of circuit breakers shall be chosen to withstand a three-phase or DC through fault without damage for the total operating time of the protection and circuit breaker. Where the circuit breaker is fitted with instantaneous over current protection, the cable is suitable for carrying full load (continuously) or short circuit current for 0.2 seconds, whichever requires the larger cable. Note that in some applications i.e. loop supply cables the short circuit current time requirement may be above 0.2 seconds up to 1 second. The Contractor shall clarify this with the Engineer before the cable is designed.

c. Cables protected by fuses shall be fault protected if selected to carry full load current continuously (see Tables 17 and 17A).

d. Table 16 details the heat balance formula used in calculating fault ratings, together with the calculated fault ratings for selected total fault times. The information contained in this table has been calculated in accordance with SANS 1507. The nominal core area has been used in the calculations.

e. The Contractor shall provide data specific to the cables used. 11.4 Voltage regulation

3.5.3.1 Regulation for different applications

a. The different voltage drops that are tolerated depend on the type of consumer that is supplied and are as follows:

- 1.5% - For critical drives like standby jacking oil pumps or turbine barring gear, though operating during start up and shut down only.
- 3% - For all drives, and other consumers operating continuously under normal operating conditions of the station or a unit. This is applicable also for redundancy applications i.e. one out of two situation as for belt drives and for the coal mills which is a four out of five mills requirement at unit MCR.

- 5% - For all drives and other consumers operating intermittently only under normal operating conditions of the station or a unit. This can include drives like actuators, valve drives, shuttle heads, soot blowers and precipitator rapper motors.
- 5% - For all drives operating continuously for a number of hours but during start up and shut down of a unit only and for motor heaters used only at standstill.
- 5% - For all DC operated solenoid circuits with the full continuous solenoid operating current flowing.

b. With regard to the above limits, discretion is used in marginal cases when selecting cables because of voltage drops, in particular with larger rated areas.

3.5.3.2 Voltage drop curves

a. The Contractor shall compile the voltage drop curves and the associated design criteria that shall be used for the sizing of cables. This shall be submitted to the Engineer for acceptance after the Contract has been awarded. The following curves (as a minimum) shall be compiled in an Excel spread sheet and the curves plotted:

Table 9: Voltage Drop Curves

CURVES FOR UNARMOURED LV-CABLES LAID IN AIR:		
SHEET 1	-	1,5% 24 V DC
SHEET 2	-	3%
SHEET 3	-	5%
SHEET 4	-	1,5% 220 V DC
SHEET 5	-	3%
SHEET 6	-	5%
SHEET 7	-	1,5% 230 V AC
SHEET 8	-	3%
SHEET 9	-	5%
SHEET 10	-	1,5% 400 V AC
SHEET 11	-	3%
SHEET 12	-	5%
SHEET 13	-	1,5% 660 V AC
SHEET 14	-	3%
CURVES FOR UNARMOURED HV-CABLES LAID IN AIR:		
SHEET 15	-	1,5% 6,6 kV
SHEET 16	-	1,5% 11 kV
CURVES FOR ARMOURED LV-CABLES LAID IN AIR:		
SHEET 17	-	1,5% 24 V DC
SHEET 18	-	3%
SHEET 19	-	5%
SHEET 20	-	1,5% 220 V DC

SHEET 21	-	3%
SHEET 22	-	5%
SHEET 23	-	1,5% 230 V AC
SHEET 24	-	3%
SHEET 25	-	5%
SHEET 26	-	1,5% 400 V AC
SHEET 27	-	3%
SHEET 28	-	5%
CURVES FOR ARMOURED MV-CABLES LAID IN AIR:		
SHEET 30	-	1,5% 6,6 kV
SHEET 31	-	1,5% 11 kV
CURVES FOR ARMOURED LV-CABLES IN GROUND:		
SHEET 32	-	1,5% 230 V AC
SHEET 33	-	3%
SHEET 34	-	5%
SHEET 35	-	1,5% 400 V AC
SHEET 36	-	3%
SHEET 37	-	5%
CURVES FOR ARMOURED MV-CABLES IN GROUND:		
SHEET 38	-	1,5% 6,6 kV
SHEET 39	-	1,5% 11 kV

b. The following cable design criteria shall be provided by the Contractor and agreed with the Engineer:

- The horizontal portion of the curves is determined by current carrying limitations only, assuming cables are in a single layer.
- The current derating according to derating Tables 10 to 14 must be considered besides the volt drop for all bunched cables, otherwise the maximum permissible operating temperature of cables may be exceeded as a result of restricted heat-loss dissipation. This shall be indicated on the curves.
- The curve portions that mean that the current is limited by volt drop considerations only shall be indicated on the curves.
- For a cable or trefoil group laid in sleeve pipes up to 15 m length current carrying capacity of that cable laid in air or ground, i.e. immediately before or after the sleeved section shall be used in determining current limits.
- For a cable or trefoil group laid in sleeve pipes longer than 15 m the current limit as per derating Tables 10 to 14 must be updated with the specific cable specification and applied.
- For cables laid in trenches in the HV Yard continuous current limits for cables laid in air (at 30°C) must be reduced by 15% as air temperatures in these shallow trenches can reach approximately 40°C.

3.6 INTERMEDIATE CABLE STORAGE AT SITE

a. The Contractor shall utilize the allocated site office area. The cable storage area shall be fenced in and used as the secure store. In this area cable drums may be stored for extended periods during the progressing construction of the power station, which takes several years.

b. New and opened drums shall be protected against climatic influences. Drums shall not be stored directly on the ground but rather on wooden or other beams to permit drainage of rainwater and prevent rotting of the drums. Drums shall be rotated through 180o on a yearly basis. To prevent ingress of moisture and therefore corrosion, cable ends on returned drums may not be left open. The sealing of the cable ends shall be by means of heat shrink caps.

c. As protection of the outer cable layer against UV-radiation, slats shall not be removed from unused drums. Drums returned to the store after usage shall be protected again on return against deterioration of the outer cable layer through UV-radiation by means of temporary protection like tarpaulins, partial covering with slats or by moving it indoors.

3.7 SEALING OF HOLES IN FLOORS AND WALLS AND FIRE BARRIERS

3.7.1 Coating of cables in vicinity of fire barriers

To increase the fire survivability of the installation fire retardant coatings shall be applied onto certain critical cable runs as well as at all cable entries though fire barriers or building walls. The coating shall be applied over a distance of five metres from both sides of the barrier or wall.

3.7.2 Fire barriers

a. Fire barriers shall be installed wherever electrical cables pass through wall, floors and ceilings, inside low and medium voltage switchboards, generator protection panels, battery chargers, UPSs' which are boundary elements of a specified fire zone. Fire barriers shall be in accordance with GGS 0183 and SANS 10142-1.

b. Fire barriers have a fire rating of two hours minimum in compliance with the fire resistance criteria for insulation, stability and integrity as specified by recognised testing institutions and their standards.

c. Test certificates are provided with fire barriers in accordance with:

- SANS 10177-2, Fire testing of materials, components and elements used in buildings Part 2: Fire resistance test for building elements.
- IEEE 634: 1978, Testing for Fire Rated Penetration Seals.
- ASTM E814: Fire Test of through Penetration Fire Stops.

3.7.3 Sealing of opening in floors and walls

a. Wherever cables pass through holes or slots in floors and walls or enter or leave sleeve pipes in floors or walls; the openings shall be sealed with vermiculite plaster or other material approved by the Engineer. This material shall be domed or slightly raised towards the centre to prevent the accumulation of water or oil in the seal. The sealing material shall be water resistant and provides a barrier for smoke and toxic fumes.

b. Waterproof fire seals are separately priced and only installed in places indicated by the Employer.

c. In the case where cable sheaths are incompatible with barrier material, the cable shall be protected through the floor or wall by instamatic paint so that the sealing material is not in direct contact with the cable at any point.

3.7.4 Closing of cable entries to buildings and transformer bays

a. Once cabling work is completed the Contractor shall request permission from the Engineer to close up all cable entries leading from inside buildings directly into ground outside, as well as those from transformer bays. These are made watertight by applying bituminous paint over the outside plaster.

b. This prevents ingress of vermin into the cable trenches or cable basement as well as entry of rainwater carrying silt and debris with it. Flooded cable basements can lead to premature failure of electrical equipment.

3.8 TESTING AND COMMISSIONING OF CABLES

3.8.1 Type tests

The Contractor indicates in Schedule B the specific tests performed on the different type of cables and shall provide type test certificates before the first delivery of cables.

3.8.2 Routine tests

The Contractor indicates in Schedule B the specific tests performed on the different type of cables and shall provide test certificates at the delivery of the cables.

3.8.3 Site tests

All tests shall be in accordance with SANS 97, 1507, 1574, 1339, 1411 and other relevant standards. Also refer to the HV cable test guide (see the reference list).

3.8.4 Insulation resistance

a. The insulation resistance of each core to sheath or conduit and between cores of all cables shall be measured and recorded after the cable has been installed and made off.

b. For each cable termination the person carrying out the job shall print and sign his name, enter the date on which the work is carried out and records the insulation readings in the appropriate place on the cable pull card.

c. Cables having 110 V grade insulation or higher shall be tested with a 1000 V megger. For the acceptance of a cable, the insulation readings shall not be less than 50 MΩ.

3.8.5 High voltage tests

a. Cables rated at 6600 V and above shall be high-voltage tested after installation. Unless specifically requested, low voltage cables need not be voltage-tested.

b. Through- or tee-joints which are installed in an existing cable shall be subjected to a high voltage test before being put into service. The cost of such a test is included in the rate price for the joint.

c. The Contractor shall indicate in Schedule B the tests performed on newly installed XLPE cables as well as the recommended tests after maintenance or repair.

3.8.6 Conductor resistance

If required, any completed cable run shall be tested for conductor resistance.

3.8.7 Commissioning procedure

a. The provisions of the power station project commissioning procedure shall be strictly adhered to, as well as the requirements described here below.

b. The Contractor shall certify that the plant is wired in accordance with the schematic wiring and termination diagrams issued to him, updated where necessary, to represent a true record of cabling and terminations as installed.

c. For control interface cables the process control supplier shall certify that the cable terminations are in accordance with standard or special termination information as the case may be.

d. Prior to commissioning, the Employer shall appoint a representative, normally the relevant plant contractor, who co-ordinates the commissioning of all equipment forming an integral part of the units being commissioned. For such commissioning the Contractor shall supply suitably qualified personnel available to carry out changes in cables and terminations to reverse the direction of rotation of drives or complete or change control and protection cable functions in order to assist other main contractors in the commissioning of their plant.

e. The Contractor shall co-operate with Others and the Engineer during the commissioning of the plant for which he supplies the cabling.

Table 10: MV CABLES WITH XLPE INSULATION, LHFR SHEATH - UNARMOURED AND INDIVIDUALLY SCREENED

Code	Number of conductors	Rated area (mm2) per conductor	Mass (kg/m)	Overall diameter (mm)
3.8/6.6 kV				
DXG3MCM	3	50	3.2	47
DXG3PCM	3	95	5.0	55
DXG1UCM	1	300	4.0	38
6.35/11 kV				
EXG3RCM	3	150	6.8	65
EXG1WCM	1	500	6.5	48
EXG01PCM				

Table 11: MV CABLES WITH XLPE INSULATION, LHFR SHEATH AND BEDDING - ARMOURED AND INDIVIDUALLY SCREENED

Code	Number of conductors	Rated area (mm2) per conductor	Mass (kg/m)	Overall diameter (mm)
3.8/6.6 kV				
DXE3MCM	3	50	5.86	55
DXE3PCM	3	95	8.76	64
DXE1UCM	1	300	5.67	46
6.35/11 kV				
EXE3RCM	3	150	11.71	76
EXE1WCM	1	500	7.52	57

Table 12: LV POWER CABLES WITH PVC INSULATION, LHFR PVC SHEATH - UNARMOURED 600/1000 V

Code	Number of conductors	Rated area (mm2) per conductor	Mass (kg/m)	Overall diameter (mm)
BVV02CCM	2	1.5	0.14	9.9
BVV03CCM	3	1.5	0.16	10.4
BVV04CCM	4	1.5	0.19	11.2
BVV02DCM	2	2.5	0.40	11.3
BVV03DCM	3	2.5	0.42	11.9
BVV04DCM	4	2.5	0.49	12.9
BVV07DCM	7	2.5	0.65	15.3
BVV12DCM	12	2.5	0.92	19.8
BVV19DCM	19	2.5	1.36	23.6
BVV37DCM	37	2.5	2.40	31.6
BVV02ECM	2	4	0.48	12.7
BVV03ECM	3	4	0.56	13.1
BVV04ECM	4	4	0.64	14.6
BVV07ECM	7	4	0.93	17.8
BVV03FCM	3	6	0.39	14.7
BVV04FCM	4	6	0.48	16.0
BVV02HCM	2	16	0.62	17.8
BVV03HCM	3	16	0.79	19.0
BVV04HCM	4	16	0.99	20.7
BVV02LCM	2	35	0.93	19.0
BVV03LCM	3	35	1.34	21.9
BVVZ4LCM	4	3 X 35, 1 X 16	1.77	25.2
BVV03NCM	3	70	2.52	28.6
BVVZ4NCM	4	3 X 70, 1 X 35	5.47	32.2
BVV03QCM	3	120	4.16	35.4
BVVZ4QCM	4	3 X 120, 1 X 70	5.47	40.0
BVV03SCM	3	185	6.26	44.6
BVVZ4SCM	4	3 X 185 1 X 95	8.25	51.3
BVV01XCM	1	630	6.63	43.8
Note: Cables with 1.5mm2 rated area are acceptable only with 7 strand conductors, 3 strand conductors				

Table 13: LV POWER CABLES WITH PVC INSULATION, LHFR PVC SHEATH AND BEDDING - ARMOURED 600/1000 V

Code	Number of conductors	Rated area (mm2) per conductor	Mass (kg/m)	Overall diameter (mm)
BVX02CCM	2	1.5	0.34	13

BVX03CCM	3	1.5	0.38	14
BVX04CCM	4	1.5	0.52	15
BVX02DCM	2	2.5	0.48	15
BVX03DCM	3	2.5	0.54	16
BVX04DCM	4	2.5	0.62	17
BVX07DCM	7	2.5	0.82	19
BVX12DCM	12	2.5	1.35	25
BVX19DCM	19	2.5	1.76	29
BVX37DCM	37	2.5	3.12	38
BVX02ECM	2	4	0.59	16
BVX03ECM	3	4	0.67	17
BVX04ECM	4	4	0.75	18
BVX07ECM	7	4	1.04	21
BVX03FCM	3	6	0.80	19
BVX04FCM	4	6	0.92	20
BVX02HCM	2	16	1.10	22
BVX03HCM	3	16	1.52	25
BVX04HCM	4	16	1.78	26
BVX02LCM	2	35	1.70	26
BVX03LCM	3	35	2.19	28
BVXZ4LCM	4	3 x 35, 1 x 16	2.76	32
BVX03NCM	3	70	3.83	36
BVXZ4NCM	4	3 x 70, 1 x 35	4.60	41
BVX03QCM	3	120	5.86	43
BVXZ4QCM	4	3 x 120, 1 x 70	7.50	50
BVX03SCM	3	185	8.79	52
BVXZ4SCM	4	3 x 185, 1 x 95	10.51	59
BVX01XCM	1	630	8.00	52
Note: Cables with 1.5mm2 rated area are acceptable only with 7 strand conductors, 3 strand conductors				

Table 14: MINERAL INSULATED CABLES (CABLE TYPES: LIGHT DUTY - 600V, HEAVY DUTY - 1000V)

Code	Number of conductors	Rated area (mm2)	Mass (kg/100 m)	Overall diameter (mm)
BMC2DD	2	2.5 - LD	18.0	7
BMC3DD	3	2.5 - LD	22.4	7.5
BMC4DD	4	2.5 - LD	27.8	8.2
BMC7DD	7	2.5 - LD	41.3	9.8
BMC2ED	2	4 - HD	35.5	9.9
BMC3ED	3	4 - HD	41.6	10.5

BMC4ED	4	4 - HD	50.6	11.5

Table 15: TELEPHONE CABLES, ARMOURED AND UNARMOURED (NOT USED)

Code	Number of Pairs	Conductor Diameter (mm)	Mass (kg/100 m)	Overall diameter (mm)
TVH4BX	4	0.6	33	13.1
TVH10BX	10	0.6	54	18.0
TVH20BX	20	0.6	72	21.0
TVH50BX	50	0.6	163	32.0
TVH99BX (*)	100	0.6	345	46.0
TVH2BV	2	0.6	6.53	4.3
TVH4BV	4	0.6	11.95	6.0
TVH10BV	10	0.6	15.95	8.1
TVH20BV	20	0.6	29.92	10.6
TVH50BV	50	0.6	53.33	16.2
(*) - Because of computer restrictions only two digits can be allocated, thus 99 for 100 pair cable				

Table 16: UNARMOURED SCREENED INSTRUMENTATION AND CONTROL CABLE

Code	Number of conductors	Rated area (mm2)	Mass (kg/100 m)	Overall diameter (mm)
UVG02ACMV	2	0.5	7.4	8.2
UVG04ACMV	4	0.5	9.8	8.9
UVG08ACMV	8	0.5	16.0	10.9
UVG12ACMV	12	0.5	26.7	13.4
UVG20ACMV	20	0.5	34.7	15.2
UVG40ACMV	40	0.5	65.9	22.3

Table 17: SLEEVE PIPES FOR DRAWING-IN OF CABLES

Arrangement of sleeving	Type of cabling	Pipe arrangement	Type of pipe	Overall Diameter of cable (mm)	Nominal bore of pipe (mm)	Length of pipe
Pipes under road and railway crossings	Armoured multi-core, in exceptions also	PVC	Straight	Up to 60	100	1.2m beyond road kerbstones but not to exceed 15m 3m Beyond railway sleepers
	Single core in trefoil	PVC in trefoil		Above 60	150	
Pipes in ground, in concrete	Armoured multi-core in exceptions	PVC	Straight	Up to 60	100	15m maximum end to end or

under floors	Single core in trefoil	PVC in trefoil		Above 60	150	between manholes
	Armoured multi-core, in exceptions also unarmoured	PVC	Bends 600mm radius	Up to 45	100	
			Bends 900mm radius	Above 45	150	
	Single core in trefoil	PVC in trefoil	Bends 750mm radius	Up to 40 Above 40	100 150	

Table 18: CABLE LAYING IN GROUND, IN HV YARD AND IN AIR (ALSO SEE TABLES 7 AND 9)

Type of Cable	Depth of Laying in ground below finished surface	Minimum horizontal spacing in ground	Minimum horizontal spacing in HV Yard trenches	Minimum horizontal spacing in air on horizontal rack runs	Minimum horizontal spacing in air
Unarmoured control cables Unarmoured telephone cables	800 mm (1)	Touching or space cable diameter	Touching	Touching	Touching (2)
Armoured control cables Unarmoured telephone cables	800 mm (1)	Touching	Touching	Touching	Touching (2)
Unarmoured Power cables	800 mm (1)	350 mm	Touching	Touching	Touching (2)
Armoured Power Cables	800 mm (1)	350 mm	1 x Diameter	Touching	
Unarmoured single core cable in trefoil group	800 mm (1)	450 mm between groups		Min 180mm (3) between centre lines	
NOTES: 300 mm in HV Yards, if not laid in trenches Also on horizontal trays, vertical distance between trays normally less than 300 mm. This allows for 3 trefoil groups on a 600 mm wide rack (6.6 kV and 11 kV cables). For LV cables three trefoil groups plus neutrals to be laid on 800 mm wide rack.					

Table 19: MINIMUM PERMISSIBLE BENDING RADII FOR LV AND MV CABLES

Voltage	Type of Cable	Minimum radius during installation	Fixed in position	
			Minimum	Preferred
LV	Unarmoured Single core thermoplastic	15 x D	10 x D	12 x D

LV	Unarmoured Multi core thermoplastic	12 x D	10 x D	12 x D
LV	Armoured Multi core thermoplastic	15 x D	12 x D	15 x D
MV	Armoured Multi core cross linked polythethylene	18 x D	15 x D	15 x D
MV	Unarmoured single core cross linked polyethylene	15 x D	12 x D	12 x D
D = Overall diameter of cable				

Table 20: MAXIMUM CURRENT RATINGS IN AMPERE FOR SINGLE AND TWO CORE UNARMOURED CABLES 600/1000 V - PVC INSULATED AND LHFR SHEATH

Installation conditions			In air				
Temperature (ambient) °C			30				
Min vertical spacing mm			(1)				
Min horizontal spacing mm			150	Touching			
Max No of fully loaded cables in route			1	2	3	4	6
Cable							
Code	Cores	Rated Area mm2					
BVV2CCM	2	1.5	22	17	14	12	10
BVV2DCM	2	2.5	31	24	20	17	13
BVV2ECM	2	4	41	31	26	22	19
BVV2FCM	2	6	53	40	33	29	24
BVV2HCM	2	16	91	69	57	50	41
BVV2LCM	2	35	149	113	94	82	68
BVV2NCM	2	70	229	174	144	126	105
BVV1XCM	1	630	1207	917	760	664	550
NOTE: 300 mm Between horizontal racks. For cables up to 6 mm2 double layers permissible, from 16 mm2 Current rating based on a maximum conductor temperature of 70°C Voltages: 24V DC, 220 V DC							

Table 21: A MAXIMUM CURRENT RATINGS IN AMPERE FOR SINGLE AND TWO CORE ARMOURED CABLES 600/1000 V - PVC INSULATED AND LHFR SHEATH AND BEDDING

Installation conditions			In air				
Temperature (ambient) °C			30				
Min vertical spacing mm			(1)				
Min horizontal spacing mm			150	Touching			
Max No of fully loaded cables in route			1	2	3	4	6
Cable							
Code	Cores	Rated Area					
BVX2CCM	2	1.5	22	18	18	17	16
BVX2DCM	2	2.5	31	26	25	24	23
BVX2ECM	2	4	41	34	33	32	31
BVX2FCM	2	6	52	44	42	40	39

BVX2HCM	2	16	95	80	76	73	71
BVX2LCM	2	35	156	131	125	120	117
BVX2NCM	2	70	238	200	190	183	178
BVX1XCM	1	630	1224	1028	979	942	918
	(Touching)						

NOTE:
300 mm Between horizontal racks. For cables up to 6 mm2 double layers permissible from 16 mm2
Current rating based on a maximum conductor temperature of 70°C
Voltages: 24V DC, 220 V DC

Table 22: MAXIMUM CURRENT RATINGS IN AMPERE FOR 2 CORE UNARMOURED CABLES 600/1000 V – PVC INSULATION AND LHFR SHEATH

Installation conditions			In air					In ground					In PVC sleeve pipe (3)				
Temperature (ambient) °C			30					For cables in ground					30				
Resisivity °C C m/w			-					table 11A for					-				
Max length of cable in sleeve			6										Longer than 15m				
Depth of laying mm			-										800				
Minimum vertical spacing mm			(1)										Touching or 1 cable per				
Min horizontal spacing mm			150	Touching													
Max No of fully loaded cables in			1	2	3	4	6	1	2	3	4	6	1	2	3	4	6
Max No of fully loaded cables in			1	2	3	4	6	1	2	3	4	6	1	2	3	4	6
Cables																	
Code	Cores	Rated area															
BVV2CCM	2	1.5	20	19	18	17	16						22(4)	17(4)	14(4)		
BVV2DCM	2	2.5	27	25	24	23	22						29(4)	22(4)	18(4)		
BVV2ECM	2	4	36	34	32	31	30						38(4)	29(4)	24(4)		
BVV2FCM	2	6	45	42	40	39	37						47(4)	36(4)	30(4)		
BVV2HCM	2	16	86	81	78	75	72						83(4)	63(4)	52(4)		
BVV2LCM	2	35	138	131	125	121	115						129(4)	98(4)	81(4)		
BVV2NCM	2	70	211	200	192	192	177						189(4)	143(4)	119(5)		

NOTES:
300 mm between horizontal racks. For cables up to 6 mm2 double layers permissible. From 16 mm2
Cables shall only be continuously operated at their tabulated rating if the minimum current at which operate does not exceed 1.5 times (cable in air) or 1.3 times (cables in ground or trenches) the
For relation cable diameter to sleeve pipe refer to Table 7.
For cables laid in 100 or 150 mm sleeve pipe.
For cables laid in 150 mm pipe (laying in 100 mm diameter pipe not permissible).
Current rating based on a maximum conductor temperature of 70°C
Voltages: 220 V AC

Table 23: MAXIMUM CURRENT RATINGS IN AMPERE FOR 2 CORE ARMOURED CABLES 600/1000 V – PVC INSULATION AND LHFR PVC SHEATH AND BEDDING

Installation conditions			In air					In ground					In PVC sleeve pipe (3)				
Temperature (ambient) °C			30					20					30				
Resisivity °C C m/w			-					1.5					-				
Max length of cable in sleeve			6					15					Longer than 15m				
Depth of laying mm			-					800					800				
Minimum vertical spacing mm			(1)					Not permissible					Touching or 1 cable per				
Min horizontal spacing mm			150	Touching				300									
Max No of fully loaded cables			1	2	3	4	6	1	2	3	4	6	1	2	3	4	6
Cables																	
Code	Cores	Rated area															
BVX2CCM	2	1.5	22	18	18	17	16	27	25	23	22	21	23(5)	21(5)	19(5)		

BVX2DCM	2	2.5	31	26	25	24	23	35	32	29	28	27	31(5)	28(5)	25(5)
BVX2ECM	2	4	41	34	33	32	31	47	43	39	38	36	40(5)	36(5)	33(5)
BVX2FCM	2	6	58	49	46	45	43	68	62	57	55	52	49(5)	44(5)	40(5)
BVX2HCM	2	16	95	80	76	73	71	101	92	85	82	77	88(5)	79(5)	72(5)
BVX2LCM	2	35	156	131	125	120	117	161	146	135	130	122	137(5)	123(5)	112(5)
BVX2NCM	2	70	232	195	186	179	174	240	218	202	194	182	185(5)	166(5)	152(6)

NOTES:

300 mm Between horizontal racks. For cables up to 6 mm2 double layers permissible, from 16 mm2 single layers only.

Cables shall only be continuously operated at their tabulated rating if the minimum current at which exceed 1.5 times (cable in air) or 1.3 times (cables in ground or trenches) the tabulated rating.
For relation cable diameter to sleeve pipe refer to Table 7.
For cables laid in 100 or 150 mm sleeve pipe.
For cables laid in 150 mm pipe (laying in 100 mm diameter pipe not permissible).
Current rating based on a maximum conductor temperature of 70°C
Voltages: 220 V AC

Table 24: MAXIMUM CURRENT RATINGS IN AMPERE FOR MULTICORE UNARMOURED CABLES 600/1000 V – PVC INSULATION AND LHFR SHEATH

Installation conditions			In Air					In Ground					In PVC Sleeve Pipe				
Temperature (ambient) °C			30					For cables in ground					30				
Resisivity °C C m/w			-					12A for armoured					-				
Max length of cable in sleeve			6										Longer than 15m				
Depth of laying mm													800				
Minimum vertical spacing mm			(1)										Touching or 1 cable				
Min horizontal spacing mm			150	Touching													
Max No of fully loaded cables			1	2	3	4	6	1	2	3	4	6	1	2	3	4	6
Cables Code	Cores	Rated area															
BVV7DCM	7	2.5	16	15	14	14	13						18(2)	14(2)			8(3)
BVV12DCM	12	2.5	13	12	12	11	11						14(2)	11(2)			6(3)
BVV19DCM	19	2.5	9	8	8	8	7						11(2)	8(2)	7(2)		5(3)
BVV37DCM	37	2.5	5	4	4	-	-						6(2)	4(2)	-	-	-
BVV7ECM	7	4	22	21	20	19	18						24(2)	18(2)	15		11(3

NOTES (GENERAL)

Neither international recommendations or national standards nor cable manufacturer's information contain derating factors or derated currents for multi-core cables assuming simultaneous continuous currents in all cores, as multi-core cables are mainly current ratings have been generated from the Employer's own experience.

300 mm between horizontal racks. For cables up to 6 mm2 double layers permissible, from 16 mm2 single layers only.

For one or more cables laid in 100 or 150 mm sleeve pipe.
For one or more cables laid in 100 or 150 mm sleeve pipe (laying in 100 mm diameter pipe not
For relation cable diameter to sleeve pipe refer to Table 7.
Current rating based on a maximum conductor temperature of 70°C
Voltages: 220V DC, 220 V AC and 400 V AC

Table 25: MAXIMUM CURRENT RATINGS IN AMPERE FOR MULTICORE ARMOURED CABLES 600/1000 V – PVC INSULATION AND LHFR SHEATH AND BEDDING

Installation conditions	In air	In ground	In PVC sleeve pipe (3)
Temperature (ambient) °C	30	20	30
Resistivity °C C m/w	-	1.5	
Max length of cable in sleeve	6	15	Longer than 15m
Depth of laying mm	-	800	800
Min vertical spacing mm	(1)	Not permissible	Touching or 1 cable per sleeve
Min horizontal spacing mm	15 Touching	300	
Max No of fully loaded cables	1 2 3 4	1 2 3 4 6	1 2 3 4 6
Cables Code Cores Rated area			
BVX7DCM 7 2.5	20 17 16 15	25 23 21 20 19	18(3) 16(3) 15(3) 14(3)
BVX12DCM 12 2.5	16 13 13 12	20 18 17 16 15	14(3) 13(3) 11(3 11(3)
BVX19DCM 19 2,5	13 11 10 10	15 14 13 13 11	11(3 10(3) 9(3)9(4)8(4)
BVX37DCM 37 2,5	9 8 7 -	11 10 9 9 8	8(3)7(3) - - -
BVX7ECM 7 4	23 19 18 18	26 24 22 21 20	21(3) 19(3) 17(4) 16(4)

NOTES (GENERAL)

Neither international recommendations or national standards nor cable manufacturer's information contain derating factors or derated currents for
multi-core cables assuming simultaneous continuous currents in all cores, as multi-core cables are purposes. The above current ratings have been generated from the Employer's own experience.

300mm between horizontal racks. For cables up to 6 mm2 double layers permissible, from 16 mm2 single layers only.

For one or more cables laid in 100 or 150 mm sleeve pipe.
For one or more cables laid in 100 or 150 mm sleeve pipe (laying in 100 mm diameter pipe not
For relation cable diameter to sleeve pipe refer to Table 7.
Current rating based on a maximum conductor temperature of 70°C
Voltages: 220V DC, 220 V AC and 400 V AC

Table 26: MAXIMUM CURRENT RATINGS IN AMPERE FOR 3 AND 4 CORE UNARMOURED CABLES 600/1000 V – PVC INSULATION AND LHFR SHEATH

Installation conditions	In air	In ground	In PVC sleeve pipe (3)
Temperature (ambient) °C	30	For cables in ground for armoured cables	30
Resisivity °C C m/w	-		-
Max length of cable in	6		Longer than 15m
Depth of laying mm	-		800
Min vertical spacing mm	(1)		Touching or 1 cable per
Min horizontal spacing	150 Touching		
Max No of fully loaded	1 2 3 4 6	1 2 3 4 6	1 2 3 4 6
Cables Code Cores Rated area			
BVVnCCM 3+4 1.5	20 19 18 17 16		22(4) 16(4) 13(4)
BVVnDCM 3+4 2.5	27 25 24 23 22		29(4) 22(4) 18 (4)
BVVnECM 3+4 4	36 34 32 31 30		38(4) 29(4) 24(4)
BVVnFCM 3+4 6	45 42 40 39 37		47(4) 36(4) 29(4)
BVVnHCM 3+4 16	86 81 78 75 72		83(4) 63(4) 52(4)
BVVnLCM 3+3% 35	138 131 125 121 115		129(4) 98(4) 81(5)
BVVnNCM 3+3% 70	211 200 192 185 177		189(4) 143(4) 119(5)
BVVnQCM 3+3% 120	302 286 274 265 253		260(4) 197(5) - -
BVVnSCM 3+3% 185	398 378 362 350 334		334(4) - - - -
BVVnXCM 3x1 (Trefoil)	900 873 855 846 -		548(4) - - - -

NOTES:
300 mm Between horizontal racks. For cables up to 6 mm2 double layers permissible, from 16 mm2

Cables shall only be continuously operated at their tabulated rating if the minimum current at which exceed 1.5 times (cable in air) of 1.3 times (cables in ground or trenches) the tabulated range.
For relation cable diameter to sleeve pipe refer to Table 7.
For cables laid in 100 or 150 mm sleeve pipe.
For cables laid in 150 mm pipe (laying in 100 mm diameter pipe not permissible).
Current rating based on a maximum conductor temperature of 70°C
Voltages: 400 V AC and 660 V AC

Table 27: MAXIMUM CURRENT RATINGS IN AMPERE FOR 3- AND 4-CORE ARMOURED CABLES 600/1000 V – PVC INSULATION AND LHFR SHEATH AND BEDDING

Installation conditions	In air					In ground					In PVC sleeve pipe (4)				
Temperature (ambient) °C	30					20					30				
Resisivity C C m/w	-					1.5					-				
Max length of cable in sleeve	6					15					Longer than 15m				
Depth of laying mm	-					800					800				
Min vertical spacing mm	(1)					Not permissible					Touching or 1 cable per				
Min horizontal spacing mm	150	Touching				300									
Max No of fully loaded cables	1	2	3	4	6	1	2	3	4	6	1	2	3	4	6
Cables Code Cores Rated area															
BVXnCCM 3+4 1.5	19	16	15	15		23	21	19	19	17	20(5)	18(5)	16(5)		
BVXnDCM 3+4 2.5	26	22	21	20		30	27	25	24	23	26(5)	23(5)	21(5)		
BVXnECM 3+4 4	35	29	28	27		40	36	34	32	30	34(5)	31(5)	28(5)		
BVXnFCM 3+4 6	45	38	36	35		50	45	42	40	38	43(5)	39(5)	35(5)		
BVXnHCM 3+4 16	81	68	65	62		86	78	72	70	65	74(5)	67(5)	61(5)		
BVXnLCM 3+3% 35	133	112	106	102		134	122	113	109	102	115(5)	103(5)	94(6)		
BVXnNCM 3+3% 70	204	171	163	157		195	177	164	158	148	169(5)	152(5)	139(6)		
BVXnQCM 3+3% 120	291	244	233	224		265	241	223	215	201	229(5)	206(6)	-	-	
BVXnSCM 3+3% 185	382	321	306	294		336	306	282	272	255	292(5)	-	-	-	-
BVXnXCM 3x1 (Trefoil) 630	816	685	653	612	-	585	532	491	474	445	472(5)	-	-	-	-

NOTES:
300 mm Between horizontal racks. For cables up to 6 mm2 double layers permissible, from 16 mm2
Cables shall only be continuously operated at their tabulated rating if the minimum current at which exceed 1.5 times (cable in air) of 1.3 times (cables in ground or trenches) the tabulated range.
For relation cable diameter to sleeve pipe refer to Table 7.
For cables laid in 100 or 150 mm sleeve pipe.
For cables laid in 150 mm pipe (Laying in 100 mm diameter pipe not permissible).
Current rating based on a maximum conductor temperature of 70°C
Voltages: 400 V AC and 660 V AC

Table 28: MAXIMUM CURRENT RATINGS IN AMPERE FOR SINGLE AND 3-CORE UNARMOURED CABLES – XLPE INSULATION AND LHFR SHEATH

Installation conditions	In air					In ground					In PVC sleeve
Temperature (ambient) °C	30					For cables in ground See Table 14A for armoured cables					30
Resistivity °C C m/w											
Max length of cable in sleeve pipe	6										Longer than
Depth of laying mm	-										800
Min vertical spacing mm	(1)										
Min horizontal spacing mm	150	Touching									
Max No of fully loaded cables in	1	2	3	4	6	1	2	3	4	6	1

Cables Code Cores Rated area mm2							
6.6 kV							
DXG3MCM	3	50	185	176	168	163	155	150(2)
DXG3PCM	3	95	263	250	239	231	221	210(2)
DXG1UCM	3 x 1 (Trefoil)	300	589	560	530	518	-	400(3)
11 kV								
EXG3RCM	3	150	347	330	316	305	219	290(2)
EXG1WCM	3 x 1 (Trefoil)	500	779	740	701	686	-	550(4)

NOTES:
300 mm Between horizontal racks. Only single layers permissible (all cables).
For one cable laid in 100 mm sleeve pipe (flat touching).
For one cable laid in 100 mm sleeve pipe (in Trefoil arrangement).
For relation cable diameter to sleeve pipe refer to Table 7.
Current rating based on a maximum conductor temperature of 90°C
Voltages: 3.8/6.6 kV CABLE FOR 6.6 kV SYSTEM AND 6.35/11 kV CABLE FOR 11 kV SYSTEM

Table 29: MAXIMUM CURRENT RATINGS IN AMPERE FOR SINGLE AND 3 CORE ARMOURED CABLES – XLPE INSULATION AND LHFR SHEATH AND LHFR SHEATH AND BEDDING.

Installation conditions	In air					In ground (2)					In PVC sleeve pipe
Temperature (ambient) ° C	30					20					30
Resisivity °C C m/w						1.5					
Max length of cable in sleeve pipe	6					15					Longer than 15m
Depth of laying mm	-					800					800
Min vertical spacing mm	(1)					Not permissible					
Min horizontal spacing mm	150	Touching				300					
Max No of fully loaded cables in	1	2	3	4	6	1	2	3	4	6	1
Cables Code Cores Rated area											
6,6 kV											
DXE3MCM	3	50	191	181	174	168		165	147	132	127	117	146 (3)
DXE3PCM	3	95	286	272	260	252		237	211	190	182	168	211 (3)
DXE1UCM	3 x 1 (Trefoil)	300	576	559	547	541	-	433	368	329	316	307	354 (4)
11 kV													
EXE3RCM	3	150	371	352	338	326		300	267	240	231	213	217 (3)
EXE1WCM	3 x 1 (Trefoil)	500	762	739	724	761	-	517	439	393	377	367	430 (4)

NOTES:
300 mm Between horizontal racks. Only single layers permissible (all cables).
Ratings in shallow sand-filled chases or troughs at ground level are 0.95 times ratings in ground at
For one cable laid in 100 mm sleeve pipe (flat touching).
For one cable laid in 100 mm sleeve pipe (in Trefoil arrangement).
For relation cable diameter to sleeve pipe refer to Table 7.
Current rating based on a maximum conductor temperature of 90°C
Voltages: 3.8/6.6 kV CABLE FOR 6.6 kV SYSTEM AND 6.35/11 kV CABLE FOR 11 kV SYSTEM

Table 30: MAXIMUM CURRENT RATINGS IN AMPERE FOR MULTICORE MINERAL INSULATED CABLE

LAID IN AIR ON HORIZONTAL OR VERTICAL TRAYS OR ON WALLS AND CEILINGS

CABLE TYPES: LD - LIGHT DUTY 600 V CURRENT RATING AT AMBIENT
HD - HEAVY DUTY 1 000 V TEMPERATURE OF

CODE	NUMBER OF CONDUCTORS	RATED AREA (mm2)	ASSUMING SINGLE CABLE AND SHEATH TEMPERATURE OF 70°C
BMC2DD	2	2,5 - LD	Single Phase AC or DC
BMC3DD	3	2,5 - LD	Three Phase AC
BMC4DD	4	2,5 - LD	Three Phase AC
BMC7DD	7	2,5 - LD	All Cores fully loaded
BMC2ED	2	4 - HD	Single Phase AC or DC
BMC3ED	3	4 - HD	Three Phase AC
BMC4ED	4	4 - HD	Three Phase AC

REDUCTION FACTORS FOR MULTICORE CABLES FOR BUNCHING I.E. CABLES IN A TRAY TOUCHING

NUMBER OF LOADED CABLES

FACTORS TO BE APPLED TO CURRENT RATING OF 1 CABLE

Table 31: FAULT CURRENT RATING (RMS CURRENT)

FAULT CURRENT I (kA) = AK
√t

where A = Rated Core Area (mm2), K = As Tabulated Below
and t = Fault Time (in seconds)

							FAULT RATING [kA rms]					
CODE (3)	INSULATION	VOLTAGE	CORES	RATED AREA	CONDUCTOR TEMP (°C)		K	t	t	t	t	t
					INITIAL	FINAL		0.2s	0.6s	1.0s	1.5s	2.0s
BVn	LHFR	1 000 V	2,3,4	1.5	70	150	0.11	0.36	0.21	0.165	0.134	0.11
BVn	LHFR	1 000 V	2,3,4	2.5	70	150	0.11	0.61	0.35	0.275	0.224	0.19
BVn	LHFR	1 000 V	2,3,4	4	70	150	0.11	0.98	0.56	0.44	0.359	0.31
BVn	LHFR	1 000 V	2,3,4	6	70	150	0.11	1.47	0.85	0.66	0.538	0.46
BVn(2,3,4)	LHFR	1 000 V	2,3,4	16	70	150	0.11	3.90	2.27	1.76	1.43	1.24
BVn(2,3,4)	LHFR	1 000 V	2,3,4	35	70	150	0.11	9.60	4.97	3.85	3.14	2.72
BVn(2,3,4)	LHFR	1 000 V	2,3,4	70	70	150	0.11	17.2	9.94	7.70	6.28	5.44
BVn	LHFR	1 000 V	3,4	120	70	150	0.11	29.51	17.40	13.20	10.77	9.33
BVn	LHFR	1 000 V	3,4	185	70	150	0.11	45.50	26.27	20.35	16.60	14.3
BVn	LHFR	1 000 V	1	630	70	150	0.11	154.9	89.46	69.30	56.58	49.0
Dxn 3	XLPE	6,6 kV	3	50	90	250	0.14	15.87	9.16	7.10	5.79	5.02
Dxn 3	XLPE	6,6 kV	3	95	90	250	0.14	30.00	17.40	13.49	11.00	9.50
Dxn 3	XLPE	6,6 kV	3	150	90	250	0.14	47.60	27.40	21.30	17.39	15.0
Dxn 1	XLPE	6,6 kV	1	300	90	250	0.14	95.00	54.90	42.60	34.78	30.1
Exn 3	XLPE	11kV	3	95	90	250	0.14	30.16	17.41	13.49	11.01	9.53
Exn 3	XLPE	11kV	3	150	90	250	0.14	47.00	27.40	21.30	17.39	15.0
Exn 1	XLPE	11kV	1	300	90	250	0.14	95.25	54.99	42.60	34.78	30.1
Exn 1	XLPE	11kV	1	500	90	250	0.14	158.7	91.66	71.00	57.97	50.2

NOTES:
For single-core cables in trefoil the cable clamps shall be designed for 400 V - 50 kA rms, 660 V - 50 kA rms, for 6,6 kV - 25 kA rms and for 11 kV - 31,5 kA rms.

As first approximation the above values may also be used for fault rating of DC cables.
n = For unarmoured BVV, DXG and EXG cables. For armoured BVX, DXE and EXE cables

Table 32: MAXIMUM FUSE RATING (CLASS Q1) FOR THE PROTECTION OF UNARMOURED CABLES 600/1000 V AGAINST OVERLOADING

CODE	NUMBER OF CONDUCTORS	RATED AREA (mm2) PER CONDUCTOR	AIR		GROUND (see table 17A)	
			MAX CABLE RATING	MAX FUSE RATING	MAX CABLE	MAX FUSE
BVV02CCM	2	1.5	20	25		
BVV03CCM	3	1.5	20	25		
BVV04CCM	4	1.5	20	25		
BVV02DCM	2	2.5	27	40		
BVV03DCM	3	2.5	27	40		
BVV04DCM	4	2.5	27	40		
BVV07DCM	7	2.5	16	20		
BVV012DCM	12	2.5	13	16		
BVV019DCM	19	2.5	9	10		
BVV037DCM	37	2.5	5	6		
BVV02ECM	2	4	36	50		
BVV03ECM	3	4	36	50		
BVV04ECM	4	4	36	50		
BVV07ECM	7	4	22	25		
BVV03FCM	3	6	45	63		
BVV03FCM	4	6	45	63		
BVV02HCM	2	16	86	125		
BVV03HCM	3	16	86	125		
BVV03HCM	4	16	86	125		
BVV02LCM	2	35	138	200		
BVV03LCM	3	35	138	200		
BVV024LCM	3%	3 x35, 1x16	138	200		
BVV03NCM	3	70	211	315		
BVVZ4NCM	3%	3x70, 1x35	211	315		
BVV03QCM	3	120	302	400		
BVVZ4QCM	3%	3x120, 1x95	302	400		
BVV03SCM	3	185	398	500		
BVVZ4SCM	3%	3 x 185, 1 x 95	398	500		
BVV01XCM	1	630	900	1 250		

Table 33: MAXIMUM FUSE RATING (CLASS Q1) FOR THE PROTECTION OF ARMOURED CABLES 600/1000 V AGAINST OVERLOADING

CODE	NUMBER OF CONDUCTORS	RATED AREA (mm2) PER CONDUCTOR	AIR		GROUND	
			MAX CABLE RATING	MAX FUSE RATING	MAX CABLE	MAX FUSE RATING
BVX02CCM	2	1.5	20	25	27	32
BVX03CCM	3	1.5	20	25	21	25
BVX04CCM	4	1.5	20	25	21	25

BVX02DCM	2	2.5	27	40	34	40
BVX03DCM	3	2.5	27	40	29	32
BVX04DCM	4	2.5	27	40	29	32
BVX07DCM	7	2.5	16	20	25	32
BVX012DCM	12	2.5	13	16	20	25
BVX019DCM	19	2.5	9	10	15	16
BVX037DCM	37	2.5	5	6	11	10
BVX02ECM	2	4	36	50	47	50
BVX03ECM	3	4	36	50	37	40
BVX04ECM	4	4	36	50	37	40
BVX07ECM	7	4	22	25	26	32
BVX03FCM	3	6	45	63	57	63
BVX03FCM	4	6	45	63	57	63
BVX02HCM	2	16	86	125	100	125
BVX03HCM	3	16	86	125	81	100
BVX03HCM	4	16	86	125	81	100
BVX02LCM	2	35	138	200	159	200
BVX03LCM	3	35	138	200	128	160
BVX24LCM	3%	3 x 35, 1 x 16	138	200	128	160
BVX03NCM	3	70	211	315	184	200
BVXZ4NCM	3%	3 x 70, 1 x 35	211	315	184	200
BVX03QCM	3	120	302	400	257	315
BVXZ4QCM	3%	3 x 120, 1 x 95	302	400	257	315
BVX03SCM	3	185	398	500	322	400
BVXZ4SCM	3%	3 x 185, 1 x 95	398	500	322	400
BVX01XCM	1	630	900	1 250	655	800

4. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
	Document Approved by TDAC ROD 27 February 2013

5. REVISIONS

Date	Rev.	Compiler	Remarks
November 2012	0	MJ Magano Senior Electrical Engineer	Draft Document for review created from GGS 0386
May 2013	1	MJ Magano	Final Document for Publication

6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- None

7. ACKNOWLEDGEMENTS

None

APPENDIX A

8. SCHEDULES A AND B

a. SCHEDULE A: PARTICULARS OF EMPLOYER'S REQUIREMENTS

b. SCHEDULE B: GUARANTEES AND TECHNICAL PARTICULARS OF PLANT AND MATERIAL OFFERED

c. Notes with regards to the completion of the schedule:

d. Where there is insufficient space provided in Schedule B, particulars must be furnished on a separate sheet marked with the number of the Schedule A item referred to.

e. If a blank space is left in Schedule B next to the Employer's requirements listed in Schedule A it is assumed that the Tenderer does comply with this requirement.

f. Where the Tenderer does not comply with the Employer's requirements these deviations must be clearly stated on Schedule B.

Item	Description	Schedule A	Schedule B
1	SYSTEM CONDITIONS		
1.1	Normal system conditions (extremes of these parameters can occur simultaneously)		
1.1.1	- Voltage range % - Frequency range %	95 to 105 97,5 to 102,5	
1.1.2	- Voltage imbalance: Negative sequence voltage as a percentage of normal positive sequence voltage %	2	
1.1.3	- Wave form: Maximum amplitude deviation from sine wave	5	
1.2	Sustained abnormal system conditions (up to six hours unless otherwise indicated)		
1.2.1	- Voltage range %	90 to 110	
1.2.2	- Voltage depressions (for up to ten seconds) down to %	75	
1.2.3	- Voltage depressions (for up to one hour) down to %	85	
1.2.4	- Frequency range %	95 to 105	
1.2.5	- Voltage imbalance - Negative sequence voltage as a percentage of normal positive sequence voltage %	3	
1.3	11 kV system		
1.3.1	- Rated short-duration power-frequency withstand voltage	95 kV	
1.3.2	- Rated lightning impulse withstand voltage (common value)	28 kV	
1.4	6.6 kV system		
1.4.1	- Rated short-duration power-frequency withstand voltage	75 kV	
1.4.2	- Rated lightning impulse withstand voltage (common value)	20 kV	
1.5	400 V and 220 V DC system		
1.5.1	- Rated short-duration power-frequency withstand voltage	2.5 kV	
1.5.2	- Rated lightning impulse withstand voltage (common value)	5 kV	

1.6	220 V DC system (Normal power supply conditions)		
1.6.1	- Voltage range %	85 to 110	
1.6.2	- Maximum r.m.s. ripple voltage %	2,5	
1.6.3	- DC earthing	high resistance	
1.7	24 V DC system (Normal power supply conditions)		
1.7.1	- Voltage range %	87,5 to 125	
1.7.2	- Maximum rms. ripple voltage %	2,5	
1.7.3	- DC earthing	high resistance	
2	ERECTION		
2.1	General		
2.1.1	- Type of cable openings provided by Others	Slots	
2.1.2	- Core drilling cable openings provided by Contractor	Yes	
2.1.3	- Scaffolding and working platforms provided by the Contractor	Yes	

Item	Description	Schedule A	Schedule B
2.2	Sub-Contractors		
2.2.1	- Subcontractor to be engaged in erection and	***	
2.2.2	- Sub-Contractor to be engaged in delivery	***	
2.2.3	- Other subcontractors	***	
3	TERMINALS		
3.1	Control and protection terminals		
	- Manufacturer	***	
	- Type designation	RSF spring loaded	
3.2	Power terminals		
3.2.1	- Manufacturer	***	
3.2.2	- Type designation	as for above but not spring loaded	
4	LUGS		
4.1	Power wiring cable lugs		
4.1.1	- Type	Crimped	
4.1.2	- Manufacturer	***	
4.1.3	- Type designation	***	
4.2	Control and protection wiring lugs		
4.2.1	- Type	Crimped	
4.2.2	- Manufacturer	***	
4.2.3	- Type designation	***	
5	LABELS		
	- Language	English	
6	FERRULE NUMBERS		
4.1.1	- Type	***	
4.1.2	- Manufacturer	***	
4.1.3	- Type designation	***	
7	INSPECTION AND TESTING		
7.1	- Short Circuit Tests Forms A1 & A2 required	Yes	
7.2	- Type Tests to attached schedule required	Yes	
8	QUALITY		
8.1	The co-ordination and formally documented management system for the assurance of quality as specified by ISO 9001 is required	Yes	
9	INSTRUCTION MANUALS		
9.1	- Number of copies of instruction manuals required	5	
10	SPECIAL TOOLS		
10.1	- Number of tool boxes for operating	1	
10.2	- Number of tool boxes for maintenance	5	

11	TRAINING		
	Number of Eskom personnel to be trained over a three year period	None	

ITEM	DESCRIPTION	SCHEDULE B
	MANUFACTURERS OF CABLES	
12.1	MV power cables	
12.2	LV power cables	
12.3	Process control and instrumentation cables	
	MANUFACTURERS OF CABLE ACCESSORIES	
13.1	Termination and jointing kits for XLPE cables	
13.2	Heat shrink sleeving jointing kits for LV power and control cables	
13.3	Cable glands - Armour gripping type	
13.4	Cable glands - Cable gripping type	
13.5	Normal and heat shrink sleeving	
13.6	Tinned copper cable lugs up to 630 mm2	
13.7	Pre-insulated cable lugs up to 6 mm2	
13.8	Crimping tools for 13.6	
13.9	Crimping tools for 13.7	
13.10	Cable junction boxes for cables 50 - 185 mm2	
13.11	Cable junction boxes for cables up to 35 mm2	
13.12	Stainless steel strapping	
13.13	Nylon strapping	
14	CABLE RACKING	
14.1	Standard ladder racks, open and closed trays with all accessories	
	- Manufacturer	
	- Galvanising method	
	- Minimum thickness	
14.2	Support structure details	
14.3	Fixing material details	
14.4	Trefoil cable clamps manufacturer	
14.5	Weldmesh trays and accessories manufacturer	
14.6	Galvanised conduit manufacturer	
14.7	Flexible conduit manufacturer	
15	INSTALLATION	
15.1	Name of engineer who will supervise installation	
15.2	Name of site engineer who will be resident at site	
14.3	Qualifications of site engineer	
15.4	Previous experience of site engineer	
15.5	Site Facilities Proposed (m2 area)	
	General offices	
	Drawing Office	
	Site Store	
	Material and machinery yard	
	Workshop	

9. INFORMATION REGARDING CABLE INSULATING MATERIALS

a. CABLE INSULATING MATERIALS FOR 3.8/6.6 kV MV CABLES WITH XLPE INSULATION, LHFR SHEATH - UNARMOURED AND INDIVIDUALLY SCREENED

	DESCRIPTION	REQUIREMENTS	CORE INSULATIO ..	BEDDING	SHEATH
	PHYSICAL PROPERTIES				
1.2	Basic Compound Component				
1.3	Tensile Strength	MPa			
1.4	Elongation at Break	%			
1.5	Resistance to tear (ASTM D470)	N/mm			
1.6	Resistance to abrasion (BS6724)				
1.7	Resistance to oil				
1.8	Weatherometer	SANS, Method 182			
1.9	Volume resistivity	Ohm.m			
	FIRE RELATED PROPERTIES				
	(for finished cable)				
2.1	Flame propagation IEC 332/3				
2.2	Smoke density BS 6724				
	(10% toluene)				
2.3	Toxicity index IEC 754-I				
2.4	Acid Gas Emission Volume	%			
2.5	Dripping of compound under fire				
2.6	Limiting Oxygen Index	%			
	COMPATABILITY WITH JOINTING/TERMINATION KITS				
3.1	Standard Materials or special requirements				

b. CABLE INSULATING MATERIALS FOR 6.35/11 kV MV CABLES WITH XLPE INSULATION, LHFR SHEATH AND BEDDING - ARMOURED AND INDIVIDUALLY SCREENED

	DESCRIPTION	REQUIREMENTS	CORE INSULATIO ..	BEDDING	SHEATH
	PHYSICAL PROPERTIES				
1.2	Basic Compound Component				
1.3	Tensile Strength	MPa			
1.4	Elongation at Break	%			
1.5	Resistance to tear (ASTM D470)	N/mm			
1.6	Resistance to abrasion (BS6724)				
1.7	Resistance to oil				
1.8	Weatherometer	SANS, Method 182			
1.9	Volume resistivity	Ohm.m			
	FIRE RELATED PROPERTIES				
	(for finished cable)				
2.1	Flame propagation IEC 332/3				
2.2	Smoke density BS 6724				
	(10% toluene)				
2.3	Toxicity index IEC 754-I				
2.4	Acid Gas Emission Volume	%			
2.5	Dripping of compound under fire				
2.6	Limiting Oxygen Index	%			
	COMPATABILITY WITH JOINTING/TERMINATION KITS				
3.1	Standard Materials or special requirements				

c. CABLE INSULATING MATERIALS FOR 600/1000 V POWER CABLES WITH PVC INSULATION, LHFR PVC SHEATH – UNARMOURED

	DESCRIPTION	REQUIREMENTS	CORE INSULATIO ..	BEDDING	SHEATH
	PHYSICAL PROPERTIES				
1.2	Basic Compound Component				
1.3	Tensile Strength	MPa			
1.4	Elongation at Break	%			
1.5	Resistance to tear (ASTM D470)	N/mm			
1.6	Resistance to abrasion (BS6724)				
1.7	Resistance to oil				
1.8	Weatherometer	SANS, Method 182			
1.9	Volume resistivity	Ohm.m			
	FIRE RELATED PROPERTIES				
	(for finished cable)				
2.1	Flame propagation IEC 332/3				
2.2	Smoke density BS 6724				
	(10% toluene)				
2.3	Toxicity index IEC 754-I				
2.4	Acid Gas Emission Volume	%			
2.5	Dripping of compound under fire				
2.6	Limiting Oxygen Index	%			
	COMPATABILITY WITH JOINTING/TERMINATION KITS				
3.1	Standard Materials or special requirements				

d. CABLE INSULATING MATERIALS FOR 600/1000 V POWER CABLES WITH PVC INSULATION, LHFR PVC SHEATH AND BEDDING – ARMOURED

	DESCRIPTION	REQUIREMENTS	CORE INSULATIO ..	BEDDING	SHEATH
	PHYSICAL PROPERTIES				
1.2	Basic Compound Component				
1.3	Tensile Strength	MPa			
1.4	Elongation at Break	%			
1.5	Resistance to tear (ASTM D470)	N/mm			
1.6	Resistance to abrasion (BS6724)				
1.7	Resistance to oil				
1.8	Weatherometer	SANS, Method 182			
1.9	Volume resistivity	Ohm.m			
	FIRE RELATED PROPERTIES				
	(for finished cable)				
2.1	Flame propagation IEC 332/3				
2.2	Smoke density BS 6724				
	(10% toluene)				
2.3	Toxicity index IEC 754-I				
2.4	Acid Gas Emission Volume	%			
2.5	Dripping of compound under fire				
2.6	Limiting Oxygen Index	%			
	COMPATABILITY WITH JOINTING/TERMINATION KITS				
3.1	Standard Materials or special requirements				

10. CABLE DATA SHEETS

a. Data sheet for process control and instrumentation cables

CABLE TYPE WITH REFERENCE	DIMENSION						
1. Manufacturer	Analogue						
2. Voltage rating							
3. Core details							
3.1 Number							
3.2 Area	mm2						
3.3 Conductor material							
3.4 DC Resistance at 200C	Ohm/km						
3.5 50 Hz Resistance at 700C	Ohm/km						
3.6 Inductive reactance at 50 Hz	Ohm/km						
3.7 Capacitance							
All cores to sheath	uF/km						
Between cores							
3.8 Maximum continuous conductor	OC						
4. Insulation details							
Core Insulation							
Screen Insulation							
Cable Sheath							
Fire retardancy of sheath	SANS1507						
5. Screen and sheath							
Screen construction material							
Screen coverage	100%						
Screen thickness	0.15mm min.						
Water barrier							
Individual screen thickness							
Individual screen resistanc							
Individual screen coverage							
Overall screen resistance	Ohms/km						
(I) Method of colour coding: trace or							
6. Core identification							
Colour coded	To spec						
Numbered							
Colour standards	to IEC 304						
Colour stability	To BS 6746 app L						

b. DATA SHEET FOR TELEPHONE CABLES (not required

CABLE TYPE WITH REFERENCE	DIMENSION						
Manufacturer Insulating Material Test Voltage							
Length of lay of twisted pairs (maximum) Mutual capacitance	mm µF/km µF/km						
Conductor resistance at 200C External diameter of completed cable Mass of completed cable	Ohm/km mm kg/m m m						

c. DATA SHEET FOR 3.8/6.6 kV MV CABLES WITH XLPE INSULATION, LHFR SHEATH - UNARMOURED AND INDIVIDUALLY SCREENED

CABLE TYPE WITH REFERENCE	Unit	CABLE SIZE MM2				
1. Manufacturer						
2. Voltage rating (phase kV/line kV)	3.8/6.6kV					
3. Core Details						
3.1 Number						
3.2 Area	mm2					
3.3 Conductor material						
3.4 DC Resistance at 200C	Ohm/km					
3.5 50 Hz Resistance at 50 Hz	Ohm/km					
3.6 Inductive reactance at 50 Hz	Ohm/km					
3.7 Capacitance						
All cores to sheath	µF/km					
Between cores	µF/km					
3.8 Maximum continuous conductor	0C					
4. Construction material						
4.1 Conductor screen						
4.2 Core insulation						
4.3 Core screen						
4.4 Copper tape screen						
4.5 Fillers	mm					
4.6 Cable sheath						
4.7 Method of colour coding trace or printing						
5. Complete Cable						
5.1 Diameter	mm					
5.2 Mass	kg/m					
5.3 Drum length	m					
5.4 Maximum symmetrical (bursting)	kA rms					

d. DATA SHEET FOR 6.35/11 kV MV CABLES WITH XLPE INSULATION, LHFR SHEATH AND BEDDING - ARMOURED AND INDIVIDUALLY SCREENED

CABLE TYPE WITH REFERENCE		CABLE SIZE MM2					
1. Manufacturer							
2. Voltage rating	6.35/11 kV						
3. Core details							
3.1 Number							
3.2 Area	mm2						
3.3 Conductor material							
3.4 DC Resistance at 200C	Ohm/km						
3.5 50 Hz Resistance at 700C	Ohm/km						
3.6 Inductive reactance at 50 Hz	Ohm/km						
3.7 Capacitance							
All cores to sheath	µF/km						
Between cores	µF/km						
3.8 Maximum continuous conductor	0C						
4. Construction material							
4.1 Core insulation							
4.2 Bedding where applicable							
4.3 Cable sheath							
4.4 Method of colour coding: trace or printing							
5. Complete cable							
5.1 Diameter	mm						
5.2 Mass	kg/m						
5.3 Drum length	m						
5.4 Maximum symmetrical (bursting)	kA rms						

e. DATA SHEET FOR 600/1000 V LV POWER CABLES WITH PVC INSULATION, LHFR PVC SHEATH - UNARMOURED

CABLE TYPE WITH REFERENCE		CABLE SIZE MM2					
1. Manufacturer							
2. Voltage rating	600/1000V						
3. Core details							
3.1 Number							
3.2 Area	mm2						
3.3 Conductor material							
3.4 DC Resistance at 200C	Ohm/km						
3.5 50 Hz Resistance at 700C	Ohm/km						
3.6 Inductive reactance at 50 Hz	Ohm/km						
3.7 Capacitance							
All cores to sheath	µF/km						
Between cores	µF/km						
3.8 Maximum continuous conductor	0C						
4. Construction material							
4.1 Core insulation							
4.2 Bedding where applicable							
4.3 Cable sheath							
4.4 Method of colour coding: trace or printing							
5. Complete cable							
5.1 Diameter	mm						
5.2 Mass	kg/m						
5.3 Drum length	m						
5.4 Maximum symmetrical (bursting)	kA rms						

f. DATA SHEET FOR 600/1000 V LV POWER CABLES WITH PVC INSULATION, LHFR PVC SHEATH AND BEDDING - ARMOURED

CABLE TYPE WITH REFERENCE		MM2					
1. Manufacturer							
2. Voltage rating	600/1000V						
3. Core details							
3.1 Number							
3.2 Area	mm2						
3.3 Conductor material							
3.4 DC Resistance at 200C	Ohm/km						
3.5 50 Hz Resistance at 700C	Ohm/km						
3.6 Inductive reactance at 50 Hz	Ohm/km						
3.7 Capacitance							
All cores to sheath	µF/km						
Between cores	µF/km						
3.8 Maximum continuous conductor	0C						
4. Construction material							
4.1 Core insulation							
4.2 Bedding where applicable							
4.3 Cable sheath							
4.4 Method of colour coding: trace or printing							
5. Complete cable							
5.1 Diameter	mm						
5.2 Mass	kg/m						
5.3 Drum length	m						
5.4 Maximum symmetrical (bursting)	kA rms						

11. LUGS AND FERRULES

11.1 INSULATED LUGS

Manufacturer											
	Size										
Lug Type											
Barrel length											
Barrel outer diameter											
Barrel inner diameter											
Barrel cross sectional area											
Material											
Material purity	mm2										
Crimping tool type	kV/mm										

11.2 UNINSULATED LUGS AND FERRULES

Manufacturer											
Lugs											
	Size										
Lug Type	mm2										
Barrel length											
Barrel outer diameter											
Barrel inner diameter											
Barrel cross sectional area											
Material											
Ferrules											
	Size										
Ferrule Type	mm2										
Ferrule Type	mm2										
Barrel length											
Barrel outer diameter											
Barrel inner diameter											
Barrel cross sectional area											
Material											

a. MV CABLE ACCESSORIES – HEATSHRINK TERMINATIONS AND JOINTS

1. Manufacturer											
2 Terminations											
Size											
Type											
3 Joints											
Size											
Type Material Material purity Operational temperature range Shrink ratio Flame retardant Shrinking by application off Electrical strength kV/mm Semi-conductor stress control tubing characteristics Joint											

12. TYPE TEST CERTIFICATES

12.1 XLPE INSULATED CABLES

Type test certificates shall be clearly referenced and labelled and then indexed in the following schedule.

Applicable standard	TYPE TEST	Equipment to which Applicable	Test Certificate	Testing Authority	Comments

12.1.1 PVC cables

Type test certificates shall be clearly referenced and labelled and then indexed in the following schedule.

Applicable standard	TYPE TEST	Equipment to which Applicable	Test Certificate Reference	Testing Authority	Comments

a. CABLE ACCESSORIES

Type test certificates shall be clearly referenced and labelled and then indexed in the following schedule.

Applicable standard	TYPE TEST	Equipment to which Applicable	Test Certificate	Testing Authority	Comments
AC Withstand		Cable, joint and termination systems, ferrules and lugs.			
Partial Discharge		Cable, joint and termination systems, ferrules and lugs.			
Impuls Voltage Withstand		Cable, joint and termination systems, ferrules and lugs.			
Load cycle		Cable, joint and termination systems, ferrules and lugs.			
Heat run		Cable, joint and termination systems, ferrules and lugs.			
Thermal Short Circuit		Cable, joint and termination systems, ferrules and lugs.			