# TRANSNET FREIGHT RAIL

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|---|---|---|
| | SPECIFICATION FOR HALOGEN FREE, FLEXIBLE, HEAT-RESISTING, OIL-RESISTING, DIESEL RESISTING AND FLAME-RETARDANT, SINGLE-CORE, CONCENTRIC AND MULTICORE CABLES FOR INSTALLATION IN RAILWAY ROLLING STOCK | Document no: RS/EE/SP/015 |
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PRODUCT & SERVICES DEVELOPMENT
CONFIGURATION MANAGEMENT







Bidder's signature_____ Date _____

## 1.0 SCOPE

1.1 This specification covers the following voltage ratings of cables: 500V, 1000V, 3kV, 6kV between conductor and earth.

1.2 This specification must be used in conjunction with the OEM of the rolling stock.

1.3 Pertaining to single core cables with reduced insulation properties and with the following voltage ratings:

0.6/1 kV, 1.8/3 kV, 3.6/6 kV refer to BS EN 50264-3-1.

1.4 Pertaining to multi core cables with reduced insulation properties and with the following voltage ratings:

300/500 V, 0.6/1 kV refer to BS EN 50264-3-2.

1.5 This specification encompasses the requirements for construction, materials, dimensions and electrical properties of flexible single-core, multicore and concentric cables for use on electric rolling stock.

1.6 This standard also specifies insulation and sheathing material requirements for heat resisting, oil resisting, and diesel resisting halogen free and flame retardant cables as applicable.

1.7 This specification covers cables used on rolling stock that specifies diesel resistive cable, which must conform to the standards mentioned in this specification.

## 2.0 NORMATIVE REFERENCES

The following standards contain provisions, which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of that standard indicated below. Information on currently valid national and international standards may be obtained from the South African Bureau of Standards.

| | |
|---|---|
| SANS 1411-1 (SABS 1411-1) | *Materials of insulated electric cables and flexible cords - Part 1: Conductors* |
| SANS 1411-5 (SABS 1411-5) | *Materials of insulated electric cables and flexible cords - Part 5: Halogen-free, flame-retardant materials* |
| SANS 5526 (SABS SM 526) | *Dielectric resistance of electric cables.* |
| SANS 6282-1 (SABS SM 1282-1) | *Test methods for bare conductors and conductors of insulated electric cables – Part 1: Conductor resistance.* |
| SANS 6284-3 (SABS SM 1284-3) | *Test methods for cross-linked polyethylene (XLPE) insulated electric cables - Part 3: Tests on finished cable.* |
| SANS 10005 (SABS 05) | *The preservative treatment of timber.* |
| SANS 60332-1-2 (IEC 60332-1-2) | *Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable — Procedure for 1 kW pre-mixed flame* |
| SANS 60332-1-3 (IEC 60332-1-3) | *Tests on electric and optical fibre cables under fire conditions - Part 1-3: Test for vertical flame propagation for a single insulated wire or cable - Procedure for determination of flaming droplets/particles.* |
| SANS 60811-1-1 (IEC 60811-1-1) | *Common test methods for insulating and sheathing materials of electric cables and optical cables - Part 1-1: Methods for general application - Measurement of thickness and overall dimensions – Tests for determining mechanical properties.* |
| SANS 60811-2-1 (IEC 60811-2-1) | *Common test methods for insulating and sheathing materials of electric and optical cables - Part 2-1: Methods specific to elastomeric compounds — Ozone resistance, hot set and mineral oil immersion tests* |
| SANS 61034-2 (IEC 61034-2) | *Measurement of smoke density of cables burning under defined conditions Part 2: Test procedure and requirements.* |
| SANS 62230 | *Electric cables — Spark-test method.* |
| BS 6724 | *Electric cables — Thermosetting insulated, armoured cables for voltages of 600/1 000 V and 1 900/3 300 V, having low emission of smoke and corrosive gases when affected by fire.* |
| BS EN 50264:2008 | *Railway applications-Railway rolling stock power and control cables having special fire performance – Part 3-1: Cables with cross-linked elastomeric insulation with reduced dimensions — Single core cables; Part 3-2 : Cables with cross-linked elastomeric insulation with reduced dimensions — Multicore cables; Part 1:General requirements.* |

**3.0 COMPLIANCE**

3.1 Tenderers shall submit their offers strictly in accordance with the terms of this specification.

3.2 Tenderers shall indicate, paragraph by paragraph, either that their offers comply in every respect with this specification or, if not, how they differ.

3.3 A broad statement to the effect that the cable is in accordance with the specification is not acceptable.

3.4 New products or existing products not qualified against the latest revision of this specification is subject to submission of test certificates/reports or written endorsement from SABS as indication of product compliance to the latest revision of this specification.

3.5 Failure to comply with the above requirements may preclude a tender from consideration.

**4.0 SERVICE CONDITIONS**

4.1 The cable shall be manufactured for service under the following conditions:

a) Ambient temperature: -10º to 50º C

b) Relative humidity: As high as 86%

c) Altitude: From sea level up to 2095 m above sea level.

4.2 Cables meeting this specification are expected to have a minimum useful lifecycle of 20 years when applied to a locomotive environment at the appropriate duty cycle.

**5.0 DEFINITIONS AND REQUIREMENTS**

5.1 Unless contrary provisions are made in this specification, all relevant definitions, requirements, tests and test methods in specifications listed under normative references, namely, clause 2.0 shall apply.

**6.0 CONSTRUCTION**

6.1 **Conductors**

6.1.1 Conductors shall be of the flexible type. Composed of bunched or rope-stranded, tinned, annealed copper wires, and shall comply with the appropriate requirements of SANS 1411-1 and as per Annexure 1 to this specification unless otherwise specified.

6.2 **Conductor screen**

6.2.1 A conductor screen shall be applied over the conductor of all 6kV cables. The conductor screen shall comprise at least one layer of tape, augmented if desired by an extruded component of substantially uniform thickness immediately over the tape(s).

6.2.2 Where a metallic screening braid is specified it shall consist of tin coated, annealed copper wires. There shall be no more than one splice in any spindle of the braid over any 10 cm length of the braid. The braid shall be applied evenly, it should neither slip nor leave a permanent imprint in the insulation.

6.2.3 Conductor screen shall consist of major constituents, which are established as having flame-retardant, halogen free characteristics.

6.2.4 Conductor screen components, as applicable, shall be in the form of:

a) Semiconducting coated plastic film tape(s) each having a thickness of approximately 0,03mm; or

b) Semiconducting rubber proofed woven plastics or cotton tapes) each having a thickness of approximately 0.1 mm; or

c) Vulcanised, heat resisting, semiconducting, moderately flexible compound applied by extrusion. If this latter is used, the compound shall be bonded to the inner surface of the insulation.

6.3 **Conductor covering tapes**

6.3.1 For 1000V and 3kV cables, one or more conductor tapes shall be applied over the conductor where this has a rated area of 95mm² and larger. For smaller conductors and for all 500V cables, the use of conductor tapes shall be optional.

6.3.2 When used, conductor taping shall provide complete separation between the conductor and the insulation.

6.3.3 Conductor tapes shall be of a synthetic polymer which is established as having flame-retardant, halogen free characteristics.

6.4 **Insulation**

6.4.1 The insulation system shall be applied by extrusion and may consist of one or more closely adherent layers. The insulation system shall form a compact and homogeneous body and shall be so applied that it fits closely on the conductor or over the separator tape and it shall be possible to remove the insulation without damage to the remaining insulation, separator tape or to the tinned conductor.

6.4.2 For 1000V,1.8kV,3kV,3.3kV and 6kV single-core and concentric cables and for 500V and 600V multi core cables, the insulation shall comprise a heat-resisting, oil-resisting, diesel resisting (if specified as diesel resistant) halogen free and flame-retardant composite consisting of an inner layer (insulation) of black cross-linked ethylene propylene rubber (EPR) or similar (EPM or EPDM) type HFB1, as defined in SANS 1411-5, bonded to an outer layer (sheath) of coloured cross-linked ethylene copolymer (EVA or other) type HFS1, as defined in SANS 1411-5, and shall comply with the requirements of clause 7.

6.4.3 For 500V and 600V single-core cables, the insulation shall consist of flexible, heat-resistant, oil-resisting, diesel resisting (if specified as diesel resistant) halogen-free and flame-retardant compounds of type HFD1 as defined in SANS1411-5 and shall comply with the requirements of clause 7.

6.4.4 The surface finish over the insulation shall be smooth, the insulation uniformly applied and substantially circular. Conformity shall be checked by inspection and manual testing. The insulation shall fit tightly over the stranded conductor, but strip freely.

6.4.5 The insulation shall have the capacity to withstand five years of warehouse storage and still meet the required specifications.

6.4.6 The minimum mean insulation thickness and, in the case of single-core cables, the colour of the sheath or insulation, as applicable, and the maximum overall diameters, shall be as stipulated in Annexure 2 hereof for the relevant cable. The insulation shall fit tightly over the stranded conductor, but strip freely.

6.4.7 The manufacture shall ensure that the insulation is not irritating to the skin of the user of the cable.

6.4.8 Neither conductor tapes nor conductor screens, when present, shall be taken to form part of the insulation.

6.4.9 The outer layer of the sheath when using multi-layer insulation with reference to diesel resistant application shall be diesel resistant.

6.4.10 Thermal ageing determination will be accepted as stipulated in SANS 1411-1.

6.5 **Multicore assembly**

6.5.1 Multicore cables are intended for use as jumper cables between locomotives, motor coaches and trailing coaches but can be used for inside installations if so required.

6.5.2 Core numbers shall be by means of printing the required numerals alternated by the relevant numbers in words, down one side of each core. The repetitive pitch between numerals shall not be more than, 100 mm.

6.5.3 The number shall be printed in a colour which contrasts with the core colour.

6.5.4 The cores shall be numbered and laid up as given in table 1:

**Table 1 - Lay of cores**

| Number of cores | Core ring | Sequence of core numbers |
|---|---|---|
| 21 | 1 (inner) | 1 |
| | 2 | 2 - 18 serially |
| | 3 | 9 - 21 serially |
| 27 | 1 (inner) | 1 - 3 serially |
| | 2 | 4 - 12 serially |
| | 3 | 13 - 27 serially |

6.5.5 In multi-core cables each ring of cores need to have a continuous lay length of less than 20 times the diameter of the bunch of cores in the cable.

6.5.6 A rubber-proofed woven textile tape having a thickness of approximately 0,15mm shall bind the laid-up cores.

6.5.7 The bound, laid-up cores shall be substantially circular in outer shape and any fillers used to achieve this shall be of a non-hygroscopic nature. Fillers shall not materially reduce the flexing properties of the cable and shall have major constituents, which are established as having flame-retardant, halogen free characteristics.

6.6 **Outer sheath**

6.6.1 Concentric and multicore cables are intended for installation and use under conditions of direct exposure to sunlight, weather, continuous flexing, movement and vibration, and shall be so manufactured as to be suitable for this service.

6.6.2 The outer sheath on multicore cables shall consist of a heavy duty, heat resisting, oil-resisting, halogen free and flame-retardant, cross-linked ethylene copolymer (EVA or other) type HFS1and shall comply with

the requirements of clause 7. Multicore cables that is specified to be diesel resistant shall comply with 7.7.2.

6.6.3 The surface finish shall be as specified in 6.4.4.

6.6.4 The insulation thickness and overall diameter shall be as stipulated in Annexure 2 and 3.

6.7 **Colour**

6.7.1 The colour of the insulation and sheathing compounds of finished cable shall, unless otherwise required, be as specified in Annexure 2 and 3.

6.7.2 The colour for 500V and 1000V cables as specified in annexure 2 (a) is the preferred colour for use by locomotive business, other departments may require different colors which shall be specified at the time of order or request for quotation.

6.8 **Flexibility**

6.8.1 Although flexibility of assembled cables (conductor with applied insulation) is not implicitly defined in this specification, cables shall have conductors with flexibility as defined in SANS 1411-1 for class 5 and 6 as required in this specification.

6.8.2 Transnet reserves the right to visually inspect any cable for flexibility and to reject any cable based on deemed poor flexibility irrespective if the product offering complies to all other requirements as defined in this specification.

6.8.3 Suppliers shall endeavor to offer compliant products with the best flexibility achievable, within the constraints of the construction requirements as defined in Clause 6.0 of this specification.

## 7.0 TEST REQUIREMENTS OF THE COMPLETED CABLE

7.1 **High voltage test**

7.1.1 The tests must be done in accordance with SANS 6284-3 (SABS SM 1284-3).

7.1.2 Single-core cables shall be tested in water at 20º ± 10º C after having been immersed for at least 1 hour.

7.1.3 The appropriate power frequency r.m.s. test voltage as stipulated in table 2 shall be maintained between the conductor and the water without breakdown of the insulation. A similar test shall be applied to 3kV concentric cables (see Annexure 3), which shall be tested in the dry state between the central conductor and the metal braiding. The test duration shall be 15 minutes.

**Table 2 - Test voltage**

| Voltage grade of cable | Test voltage (r.m.s.) |
|---|---|
| 500 V | 2000 V |
| 600 V | 3500 V |
| 1000 V | 3500 V |
| 1800 V | 6500 V |
| 3000 V | 11000 V |
| 3600 V | 11000 V |
| 6000 V | 18000 V |

7.1.4 Multicore 500V cables shall be tested without breakdown in the dry state at a power frequency voltage of 2000 V (r.m.s.) for 15 minutes, the successive test connections being such as to prove the soundness of the insulation between adjacent cores in each ring of cores and the insulation between adjacent rings. As an alternative, under the conditions covered by 9.2, the duration of each test may be reduced to 10 minutes.

7.2 **Dielectric resistance test**

7.2.1 The tests must be done in accordance with SANS 5526 (SABS SM 526).

7.2.2 In all cases where the high voltage test is applied, the dielectric resistance shall be measured directly after the completion of high voltage testing. The result/s related to a cable length of 1 km and a temperature of 20ºC shall be not less than the minimum value stipulated in Annexure 4 for the relevant cable.

7.2.3 Dielectric resistance shall only be measured when the ambient or water temperature, as appropriate, is within the range of 10 to 30ºC and the temperature co-efficient of dielectric resistance shall be taken to be 6% per degree Celsius. Tenderers may comment on these values.

7.3 **Spark test**

7.3.1 The tests must be done in accordance with SANS 62230 (IEC 62230).

7.3.2 Single-core 500V and 1000V cables with conductors having rated areas of up to 6mm² may, under the conditions covered by 9.2, be spark tested during the final coiling or reeling operation in lieu of the high voltage and dielectric resistance tests (7.1.2 and 7.2).

7.3.3 All cores of all multicore cables shall be spark tested before laying out.

7.3.4 The spark test voltage shall be according to SANS 62230 (IEC 62230) table A1.

7.4 **Conductor resistance test**

7.4.1 The tests must be done in accordance with SANS 6282-1 (SABS SM 1282-1).

7.4.2 The DC resistance of the conductor(s) of any single core cable (one meter minimum), related to a cable length of 1km (one) and a temperature of 20ºC shall be not more than the maximum value specified for class 5, table 3 Column 4 of SANS 1411-1.

7.4.3 The DC resistance of the conductor(s) of any multicore cable (one meter minimum), related to a cable length of 1km (one) and a temperature of 20ºC shall be not more than the maximum value specified for class 6, table 4 Column 4 of SANS 1411-1.

7.4.4 For cables with conductors having a rated area of 10mm² and above, the conductor resistance shall be measured on each cable. For smaller cables under the conditions covered by 9.2, the conductor(s) may instead by checked for continuity, provided that the conductor resistance is measured in that proportion of an inspection lot of single-core cables or cores of multicore cables which may be agreed upon from time to time between the companies representative and the manufacturer.

7.5 **Reaction to fire**

7.5.1 **Flame propagation test**

7.5.1.1 The tests must be done in accordance with SANS 60332-1-2, (IEC 60332-1-2).

7.5.2 **Flaming droplets/particles test**

7.5.2.1 The tests must be done in accordance with SANS 60332-1-3 (IEC 60332-1-3).

7.5.2.2 No flaming particles shall fall off during or after tests.

7.5.3 **Smoke emission test**

7.5.3.1 The completed cable shall be tested in accordance with SANS 61034-2 (IEC 61034-2)

7.5.3.2 The percentage light transmission shall not be less than 60%

7.6 **Physical tests on insulation and sheathing**

7.6.1 Test specimens of insulation and/or sheathing, taken from the finished cable shall comply with all the tests as specified in table 2 of SANS 1411-5 for the relevant type of insulation:

7.7 **Oil, Mineral oil and Diesel resistivity**

**For all Rolling stock, the following will be applicable:**

7.7.1 The test shall be carried out in accordance with clause 10 of SANS 60811-2-1 (IEC 60811-2-1), using the following conditions:

Compound type HFB1

Treatment:

| | |
|---|---|
| - Type of oil | IRM 902 |
| - Temperature | (100 ± 2) °C |
| - Duration | 24 h |

Compound type HFD1, HFS1

Treatment:

| | |
|---|---|
| - Type of oil | IRM 902 |
| - Temperature | (100 ± 2) °C |
| - Duration | 72 h |

**For Rolling stock with specified diesel resistivity, the following will be an additional requirement:**

7.7.2 The test shall be carried out in accordance with clause 7 of BS EN 50264-3-1:2008 and the outer sheath/insulation shall be EI 109/EM 104 compliant as described in clause 6.6, using the following conditions:

Compound type HFD1, HFS1

Treatment:

| | |
|---|---|
| - Type of oil | IRM 903 |
| - Temperature | (70 ± 2) °C |
| - Duration | 168 h |

7.7.3 The outer sheath/insulation shall be diesel resistant pertaining to all Rolling stock application.
The test shall be carried out as following:

Treatment:
Compound type HFS1

| | |
|---|---|
| - Type of diesel | 50 ppm |
| - Temperature | (70 ± 2) °C |
| - Duration | 48 h |

7.7.4 The maximum variation for each sheathing compound shall be

| | |
|---|---|
| - For the tensile strength | ± 30 % |
| - For the elongation at break | ± 40 % |
| - Outer sheath expansion | ± 10 % |

7.8 **Abrasion tests on finished cables**

7.8.1 Abrasion tests shall be performed according to BS 6724: Test method Annex E.

7.8.2 The vertical force shall be as specified in Table 3 – Vertical force on cable during abrasion test.

**Table 3 – Vertical force on cable during abrasion test**

| **Overall measured diameter of cable** | | Force N |
|---|---|---|
| 500V cables | | |
| Greater than or equal to mm | Less than mm | |
| 1 | 5 | 2.5 |
| 5 | 12 | 5 |
| 1000V cables | | Force N |
| Greater than or equal to mm | Less than mm | |
| 5 | 10 | 5 |
| 10 | 18 | 7.5 |
| 18 | 30 | 10 |
| 3000V cables | | Force N |
| Greater than or equal to mm | Less than mm | |
| 10 | 35 | 15 |
| 6000V cables | | **Force** N |
| Greater than or equal to mm | Less than mm | |
| 30 | 40 | 30 |

7.8.3 After a sample of the complete cable is tested the insulation shall be deemed to be satisfactory provided that, examination of the sample without magnification reveals no cracks or splits in the internal and external surfaces.

7.9 **Physical tests on conductor wires**

7.9.1 Samples of conductor wires shall comply with the requirements of SANS 1411-1 (SABS 1411-1), in respect of:

a) tinning; and

b) Ductility.

**8.0 MANUFACTURER'S IDENTIFICATION**

8.1 **Marking of cables**

8.1.1 The outer surface of each finished cable shall bear the information asked for in (a) to (f) below, in legible and indelible marking.

a) The manufacturer's name, trade name or trademark.

**b) The operating voltage (*U*) for which the cable has been designed, given in volts or kilovolts (e.g. 500 V, 1000 V, 3 kV or 6 kV), in two lines on opposite sides of the cable should the cable overall diameter exceed 15 mm.**

c) A marking that indicates the cross-sectional area and in the case of multicore cables the number of cores.

d) The manufacturer's product code/number.

e) The rated continuous operating temperature of the cable.

f) When applicable, identification of special properties in accordance with column 3 of table 4. (Optional additional marking can be done in accordance with column 2).

8.1.2 The letters and numerals shall be upright characters of maximum height of 13 mm and minimum height of 3 mm. In the case of cables that have an overall diameter of less than 6 mm, the height of the characters may be less than 3 mm provided that the legend is acceptably legible.

8.1.3 The gap between the end of one legend and the beginning of the next shall not exceed 550 mm.

8.1.4 When manufacturer's identification, either in coloured thread or printed tape is provided it shall be along the entire length of the cable. When a thread is used, its colours shall have been registered with the South African Bureau of Standards. Any tape or thread used for identification purposes shall be of durable nature and any printing or embossing present shall be legible, indelible and restricted to the manufacturer's name or trade name, or both, repeated at intervals not exceeding 275 mm.

8.1.5 When the stripe is applied it shall form an integral part of the insulation and shall not protrude or affect the concentricity of the insulation in any manner.

**Table 4 — Marking of cables**

| Property | Marking | Colour of stripe |
|---|---|---|
| No halogen, reduced smoke emission and reduced flame propagation | NHLSFR | White |

## 9.0 SAMPLING AND RETEST

9.1 Companies that do not conform to ISO 9001 must have a sampling and retest system in place.

9.2 Transnet reserves the right to audit manufacturer's facilities to ascertain that above system is in place

9.3 Routine tests shall be applied to, and passed by, all cables produced, provided that any cable subjected to alternative routine testing shall be capable of passing the full relevant tests.

Routine tests are:

a) High voltage test with alternative duration when applicable (7.1),

b) Dielectric resistance test (7.2),

c) Alternative spark test (7.3.2),

d) Spark test on all cores before laying up (7.3.3),

e) Conductor resistance test (7.4), and

f) Alternative continuity check (7.4.4).

9.4 Sample tests shall be carried out on samples of cables taken from production batches or inspection lots of cables at sampling rates and under acceptance conditions laid down at the time of the order, in consultation with the manufacturer. Sample tests are:

a) High voltage test followed by dielectric resistance test where alternative spark testing is permitted on the bulk of the batch or lot (7.1, 7.2 and 7.3.2).

b) Conductor resistance test where alternative continuity checking is permitted on the bulk of the batch or lot (7.4.2 and 7.4.3); and

c) Constructional and dimensional examination of cables in the batch or lot and/or samples taken there from (6).

9.5 Materials tests shall be carried out as for sample tests, but the sampling rates shall be based on the broader spectrum of the materials common to the range of cables manufactured. Materials tests are;

a) Electrical tests on insulation (7.2).

b) Flame propagation test on cable (7.5.1).

c) Flaming droplets/particles test (7.5.2).

d) Smoke emission test (7.5.3).

e) Physical tests on insulation and sheathing (7.6).

f) Oil, Mineral oil and Diesel resistivity (7.7).

g) Abrasion tests (7.8).

h) Physical tests on conductor wires (7.9).

**10.0 INSPECTION**

10.1 The cables shall be inspected for compliance with the requirements of this specification.

10.2 Transnet reserves the right to inspect cables made to this specification at any stage of manufacture.

**11.0 PACKING AND MARKING**

11.1 **Cable lengths/packing**

11.1.1 Cables shall be packed on drums or reels or in coils.

11.1.2 The requirements of 11.1.3 and 11.1.4 shall apply unless other arrangements have been agreed between the purchaser and the manufacturer e.g. in the case of cables to be supplied to Assembly Works.

11.1.3 The unit lengths in which cables shall be ordered are:

a) Reels and drums: 500m

b) Coils: 100m

11.1.4 Cables shall be supplied in the manner ordered, except that for reeled or drummed cables 1 in every 7, or part of 7, reels or drums ordered may contain the required total length of cable in 2 or 3 separate lengths, provided that:

a) The minimum individual length shall be 50 and 100m respectively for reeled and drummed cables;

b) All cables ends are available for testing; and

c) Adequate information is clearly indicated on all relevant labels and documents

11.2 **Drums and reels**

11.2.1 The moisture content of the wood of a wooden drum or reel shall not exceed 20 %. When wooden drums or reels are required to be resistant to biological attack, the wood shall have been impregnated (by pressure or in a hot/cold open tank) in accordance with SANS 10005 with a class C preservative or with chromated copper arsenate.

11.3 **Cable ends**

11.3.1 Each end of the cable shall, before being secured to the drum or reel, be sealed by an acceptable method. The outer end shall be secured to the drum or reel, and the inner end shall be protected in an acceptable manner against mechanical damage.

11.4 **Marking of coils**

Each coil package shall bear the following information in legible and indelible marking:

a) the manufacturer's trade name or trademark or both;

b) a brief cable description

c) the cross-sectional area of conductor(s)

d) the rated voltage

e) the number of cores, when applicable; and

f) the length of cable.

11.5 **Marking of drums or reels**

Each drum or reel shall bear the following information in legible and indelible marking:

a) the information required in 11.3.1 above;

b) the gross mass;

c) an identifying serial number;

d) unless the manufacturer guarantees that the drum or reel may be laid flat without damage to the cable, the words "NOT TO BE LAID FLAT" (in capital letters), or a suitable pictogram;

e) unless the manufacturer guarantees that the drum or reel may be rolled in either direction without damage to the cable, an arrow or the words "ROLL THIS WAY" (in capital letters, to indicate the direction in which the drum or reel is to be rolled in order to prevent the cable from unwinding); and if the wood of the drum or reel has been treated, a capital letter "T" of approximate height 50 mm surrounded by a circle of approximate outside diameter 65 mm.



Bidder's signature_____ Date _____

**ANNEXURE 1**

**TABLE 5-1 - CONDUCTOR DETAILS - SINGLE CORE CABLES**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | (CLASS) TYPE REFERENCE (SANS 1411-1) | *MAXIMUM DIAMETER OF WIRES IN CONDUCTOR | *MAXIMUM DIAMETER OF CONDUCTOR |
|---|---|---|---|
| mm² | | mm | mm |
| 0.5 | 5 | 0.21 | 1.1 |
| 1 | 5 | 0,21 | 1,4 |
| 1,5 | 5 | 0,26 | 1,65 |
| 2,5 | 5 | 0,26 | 2,1 |
| 4 | 5 | 0,31 | 2,7 |
| 6 | 5 | 0,31 | 3,25 |
| 10 | 5 | 0,41 | 4,25 |
| 16 | 5 | 0,41 | 5,3 |
| 25 | 5 | 0,41 | 7 |
| 35 | 5 | 0,41 | 8,45 |
| 50 | 5 | 0,41 | 10,3 |
| 70 | 5 | 0,51 | 11,6 |
| 95 | 5 | 0,51 | 14 |
| 120 | 5 | 0,51 | 15,5 |
| 150 | 5 | 0,51 | 17,3 |
| 185 | 5 | 0,51 | 20 |
| 240 | 5 | 0,51 | 23,3 |
| 300 | 5 | 0,51 | 25,1 |
| * Indicative only, refer to SANS 1411-1 | | | |

**TABLE 5-2 - CONDUCTOR DETAILS - MULTICORE CABLES**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | (CLASS) TYPE REFERENCE (SANS 1411-1) | MAXIMUM DIAMETER OF WIRES IN CONDUCTOR | MAXIMUM DIAMETER OF CONDUCTOR |
|---|---|---|---|
| mm² | | mm | mm |
| *3 | 6 | 0,16 | 2,4 |
| *25 | 5 | 0,41 | 7 |
| * For multicore cables refer to Annexure 3. | | | |



Bidder's signature_____ Date _____

**ANNEXURE 2 (a)**

**TABLE 6.1 - INSULATION DIMENSIONS AND COLOURS - 500V SINGLE CORE CABLES**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | THICKNESS OF INSULATION | | MAXIMUM OVERALL DIAMETER | COLOUR |
|---|---|---|---|---|
| | min. mean | min | | |
| mm² | mm | mm | mm | |
| 1 | 0,8 | 0,62 | 3.2 | Light Green (See clause 6.7.2) |
| 1,5 | 0,8 | 0,62 | 3.5 | |
| 2,5 | 0,9 | 0,71 | 3.9 | |
| 3* | 0,8 | 0,62 | 4.2 | |
| 4 | 1 | 0,8 | 4.6 | |
| 6 | 1 | 0,8 | 5.4 | |
| 10 | 1,2 | 0.98 | 6.8 | |
| 16 | 1,2 | 0.98 | 8.5 | |
| 25* | 1,4 | 1,16 | 10 | |
| 35 | 1,4 | 1,16 | 11.5 | |
| * For multicore cables refer to Annexure 3. | | | | |

**TABLE 6.2 - INSULATION DIMENSIONS AND COLOURS – 0,6 / 1 kV SINGLE CORE CABLES (UNSHEATHED)**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | THICKNESS OF INSULATION | MAXIMUM OVERALL DIAMETER | | COLOUR |
|---|---|---|---|---|
| | min. mean | min | max | |
| mm² | mm | mm | mm | |
| 1 | 0.6 | 2.4 | 2.8 | Light Green (See clause 6.7.2) |
| 1,5 | 0.7 | 2.8 | 3.3 | |
| 2,5 | 0.7 | 3.2 | 3.8 | |
| 4 | 0.7 | 3.8 | 4.4 | |
| 6 | 0.7 | 4.2 | 5 | |
| 10 | 0.7 | 5.1 | 5.9 | |
| 16 | 0.7 | 6.1 | 7.2 | |
| 25* | 0.9 | 7.8 | 9.1 | |
| 35 | 0.9 | 9 | 10.6 | |
| 50 | 1 | 10.6 | 12.4 | |
| 70 | 1.1 | 12.5 | 14.6 | |
| 95 | 1.1 | 13.9 | 16.3 | |
| 120 | 1.2 | 15.7 | 18.4 | |
| 150 | 1.4 | 17.6 | 20.6 | |
| 185 | 1.6 | 19.6 | 22.9 | |
| 240 | 1.7 | 22.2 | 26 | |
| 300 | 1.8 | 24.6 | 28.8 | |



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| | | | | |
|---|---|---|---|---|
| 400 | 2 | 28.1 | 32.9 | |
| *For multicore cables refer to Annexure 3. | | | | |
| * Indicative only, refer to BS EN 50264-3-1 | | | | |

**TABLE 7 - INSULATION DIMENSIONS AND COLOURS - 1000V SINGLE CORE CABLES (SHEATHED)**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | THICKNESS OF INSULATION | | MAXIMUM OVERALL DIAMETER | COLOUR OF OUTER SHEATH |
|---|---|---|---|---|
| | min. mean | min | | |
| mm² | mm | mm | mm | |
| 2,5 | 1,4 | 1,16 | 5,6 | Light Green (See clause 6.7.2) |
| 4 | 1,4 | 1,16 | 6,4 | |
| 6 | 1,5 | 1,25 | 7,2 | |
| 10 | 1,5 | 1,25 | 8,6 | |
| 16 | 1,5 | 1,25 | 9,9 | |
| 25 | 1,6 | 1,34 | 11,8 | |
| 35 | 1,6 | 1,34 | 13,3 | |
| 50 | 1,7 | 1,43 | 15 | |
| 70 | 1,8 | 1,52 | 17,4 | |
| 95 | 2 | 1,7 | 19,8 | |
| 120 | 2,2 | 1,88 | 22,4 | |
| 150 | 2,3 | 1.97 | 24,6 | |

**TABLE 8.1 - INSULATION DIMENSIONS AND COLOURS – 1.8 / 3 kV SINGLE CORE CABLES (UNSHEATHED)**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | THICKNESS OF INSULATION | MAXIMUM OVERALL DIAMETER | | COLOUR |
|---|---|---|---|---|
| | min. mean | min | max | |
| mm² | mm | mm | mm | |
| 1,5 | 2 | 5.3 | 6.2 | Red (See clause 6.7.2) |
| 2,5 | 2 | 5.7 | 6.7 | |
| 4 | 2 | 6.2 | 7.3 | |
| 6 | 2 | 6.7 | 7.8 | |
| 10 | 2 | 7.5 | 8.8 | |
| 16 | 2 | 8.6 | 10 | |
| 25* | 2 | 9.9 | 11.6 | |
| 35 | 2 | 11.1 | 13 | |
| 50 | 2 | 12.5 | 14.6 | |
| 70 | 2 | 14.2 | 16.6 | |
| 95 | 2.2 | 16 | 18.7 | |
| 120 | 2.2 | 17.6 | 20.6 | |
| 150 | 2.2 | 19.1 | 22.3 | |



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| | | | | |
|---|---|---|---|---|
| 185 | 2.4 | 20.9 | 24.4 | |
| 240 | 2.4 | 23.7 | 27.5 | |
| 300 | 2.4 | 25.6 | 30.1 | |
| 400 | 2.6 | 29.2 | 34.2 | |
| * Indicative only, refer to BS EN 50264-3-1 | | | | |

**TABLE 8.2 - INSULATION DIMENSIONS AND COLOURS – 1.8 / 3 kV SINGLE CORE CABLES (SHEATHED)**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | THICKNESS OF INSULATION | THICKNESS OF SHEATH | MAXIMUM OVERALL DIAMETER | | COLOUR |
|---|---|---|---|---|---|
| | min. mean | min. mean | min | max | |
| mm² | mm | mm | mm | mm | |
| 1,5 | 1.3 | 0.8 | 5.7 | 6.7 | Red (See clause 6.7.2) |
| 2,5 | 1.3 | 0.8 | 6 | 7 | |
| 4 | 1.3 | 0.8 | 6.5 | 7.6 | |
| 6 | 1.3 | 0.8 | 7 | 8.1 | |
| 10 | 1.5 | 0.8 | 8.2 | 9.6 | |
| 16 | 1.5 | 0.8 | 9.2 | 10.8 | |
| 25* | 1.8 | 1 | 11.5 | 13.4 | |
| 35 | 1.8 | 1 | 12.7 | 14.9 | |
| 50 | 1.8 | 1 | 14.1 | 16.5 | |
| 70 | 1.8 | 1 | 15.8 | 18.5 | |
| 95 | 2.2 | 1 | 18 | 21 | |
| 120 | 2.2 | 1 | 19.6 | 22.9 | |
| 150 | 2.2 | 1.2 | 21.4 | 25.1 | |
| 185 | 2.4 | 1.2 | 23.4 | 27.4 | |
| 240 | 2.4 | 1.2 | 25.9 | 30.3 | |
| 300 | 2.4 | 1.2 | 28.1 | 32.9 | |
| 400 | 2.6 | 1.4 | 32 | 37.4 | |
| * Indicative only, refer to BS EN 50264-3-1 | | | | | |



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**ANNEXURE 2 (b)**

**TABLE 9 - INSULATION DIMENSIONS AND COLOURS - 3kV SINGLE CORE CABLES FOR PROTECTED INSTALLATION (SHEATHED)**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | THICKNESS OF INSULATION | | MAXIMUM OVERALL DIAMETER | COLOUR OF OUTER SHEATH |
|---|---|---|---|---|
| | min. mean | min | | |
| mm² | mm | mm | mm | |
| 6 | 3,5 | 3,05 | 11,6 | Red |
| 10 | 3,5 | 3,05 | 12,8 | |
| 16 | 3,5 | 3,05 | 14,1 | |
| 25 | 3,5 | 3,05 | 15,6 | |
| 35 | 3,5 | 3,05 | 17,3 | |
| 50 | 3,5 | 3,05 | 18,8 | |
| 70 | 3,5 | 3,05 | 20,8 | |
| 95 | 3,5 | 3,05 | 23 | |
| 120 | 3,5 | 3,05 | 25 | |
| 150 | 3,5 | 3,05 | 27 | |
| 185 | 3,5 | 3,05 | 29 | |
| 240 | 3,5, | 3,05 | 32,3 | |
| 300 | 3,5 | 3,05 | 34,1 | |





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**ANNEXURE 2 (c)**

**TABLE 10 - INSULATION DIMENSIONS AND COLOURS - 3kV SINGLE CORE CABLES FOR EXPOSED INSTALLATION (SHEATHED)**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | THICKNESS OF INSULATION | | MAXIMUM OVERALL DIAMETER | COLOUR OF OUTER SHEATH |
|---|---|---|---|---|
| | min. mean | min | | |
| mm² | mm | mm | mm | |
| 70 | 5 | 4,4 | 24,3 | Red |
| 95 | 5 | 4,4 | 26,3 | |
| 120 | 5 | 4,4 | 28,3 | |
| 150 | 5 | 4,4 | 30,3 | |
| 185 | 5 | 4,4 | 23,6 | |
| 240 | 5 | 4,4 | 35,6 | |
| 300 | 5 | 4,4 | 37,4 | |

**TABLE 11 - INSULATION DIMENSIONS AND COLOURS – 3,6 / 6 kV SINGLE CORE CABLES (SHEATHED)**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | THICKNESS OF INSULATION | THICKNESS OF SHEATH | MAXIMUM OVERALL DIAMETER | | COLOUR |
|---|---|---|---|---|---|
| | min. mean | min. mean | min | max | |
| mm² | mm | mm | mm | mm | |
| 2,5 | 2.6 | 0.8 | 8.6 | 10.1 | Red (See clause 6.7.2) |
| 4 | 2.6 | 0.8 | 9.1 | 10.7 | |
| 6 | 2.6 | 0.8 | 9.6 | 11.2 | |
| 10 | 2.6 | 0.8 | 10.4 | 12.2 | |
| 16 | 2.6 | 0.8 | 11.5 | 13.4 | |
| 25* | 2.9 | 1 | 13.7 | 16.1 | |
| 35 | 2.9 | 1 | 14.9 | 17.5 | |
| 50 | 2.9 | 1 | 16.4 | 19.1 | |
| 70 | 2.9 | 1 | 18 | 21.1 | |
| 95 | 2.9 | 1 | 19.5 | 22.8 | |
| 120 | 2.9 | 1.2 | 21.4 | 25.1 | |
| 150 | 2.9 | 1.2 | 22.9 | 26.8 | |
| 185 | 3.2 | 1.2 | 25.1 | 29.4 | |
| 240 | 3.4 | 1.4 | 28.3 | 33.1 | |
| 300 | 3.4 | 1.4 | 30.6 | 35.8 | |
| 400 | 3.4 | 1.4 | 33.7 | 39.4 | |

* Indicative only, refer to BS EN 50264-3-1





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**TABLE 12 - INSULATION DIMENSIONS AND COLOURS - 6kV SINGLE CORE CABLES (SHEATHED)**

| NOMINAL CROSS-SECTIONAL AREA OF CONDUCTOR | THICKNESS OF INSULATION | | MAXIMUM OVERALL DIAMETER | COLOUR OF OUTER SHEATH |
|---|---|---|---|---|
| | min. mean | min | | |
| mm² | mm | mm | mm | |
| 6 | - | | - | Black (See clause 6.7.2) |
| 10 | - | | - | |
| 16 | - | | - | |
| 25 | - | | - | |
| 35 | - | | - | |
| 50 | - | | - | |
| 70 | - | | - | |
| 95 | - | | - | |
| 120 | 6,2 | 5,48 | 31,1 | |
| 150 | 6,2 | 5,48 | 33,4 | |
| 185 | 6,2 | 5,48 | 35,4 | |
| 240 | 6,2 | 5,48 | 38,4 | |




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**ANNEXURE 3**

**TABLE 13- CONCENTRIC AND MULTICORE CABLE CONSTRUCTIONS**

| RATED AREA OF CONDUCTOR | NUMBER OF CORES | VOLTAGE GRADE OF CABLE | INSULATION THICKNESS OF SINGLE CORE | SHEATH THICKNESS | OVERALL DIAMETER | COLOUR OF CORE | COLOUR OF SHEATH |
|---|---|---|---|---|---|---|---|
| | | | nom./min | min. mean /min | max | | |
| mm² | | | mm | mm | mm² | | |
| 25* | 1 | 3kV | 3,5/3,05 | 3/2,45 | 25,4 | Red | Orange |
| 25 | 2 | 500V | 1,4 / 1,16 | 3 / 2,45 | 29 | Yellow | Orange |
| 3 | 10 | 500V | 0,8 / 0,62 | 3 / 2,45 | 28,2 | Yellow | Orange |
| 3 | 21 | 500V | 0,8/0,62 | 2,6/2,11 | 31,8 | Yellow | Orange |
| 3 | 27 | 500V | 0,8/0,62 | 3,2/2,62 | 37 | Yellow | Orange |

*This concentric cable shall have the following applied successively over the central core:

a) A rubber proofed woven textile tape approximately 0,15mm thick;

b) A tinned copper braid having a rated area of 16mm², a maximum resistance of 1,12 ohms per km at 20ºC and having been forced from 0,5mm nominal diameter wires braided with a maximum lay of 80mm;

c) A rubber proofed woven textile tape approximately 0,15mm thick; and

d) An overall cross-linked ethylene copolymer (EVA or other) type HFS1 sheath, as defined in SANS 1411-5, and shall comply with the requirements of clause 7.

e) With reference to cross-linked elastomeric insulation with reduced dimensions for multicore cables; 300/500 V and 0,6/ 1000 V make use of BS EN 50264-3-2.



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**ANNEXURE 4**

**TABLE 14 - DIELECTRIC RESISTANCE REQUIREMENTS**

| RATED AREA OF CONDUCTOR | DIELECTRIC RESISTANCE PER km AT 20ºC, MEGOHMS, MINIMUM FOR CABLES OF VOLTAGE GRADE | | | | |
|---|---|---|---|---|---|
| mm² | 500V | 500V MULTICORE | 1000V sheathed | 3kV sheathed | 6kV sheathed |
| 1 | 12 | 490 | - | - | - |
| 1,5 | 11 | 420 | - | - | - |
| 2,5 | 9.5 | 380 | 520 | - | - |
| 3 | - | 330 | - | - | - |
| 4 | 8.3 | 330 | 430 | - | - |
| 6 | 7.2 | 290 | 700 | - | - |
| 10 | 6.6 | 260 | 310 | 580 | - |
| 16 | 5.3 | 210 | 260 | 490 | - |
| 25 | 5 | 200 | 230 | 420 | - |
| 35 | 4.6 | | 195 | 370 | - |
| 50 | - | | 180 | 330 | - |
| 70 | - | | 160 | 280 | - |
| 95 | - | | 155 | 250 | - |
| 120 | - | | 150 | 300 | 350 |
| 150 | - | | 140 | 280 | 320 |
| 185 | - | | - | 250 | 300 |
| 240 | - | | - | 230 | 270 |
| 300 | - | | - | 180 | 240 |





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