Eskom	Standard	Technology

Title: **STANDARD INDOOR AND OUTDOOR TELEPHONE CABLE**

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Content

Figures

Tables

1. Introduction

This standard sets out the technical requirements for indoor and outdoor cables to be used for telephones, telemetering, telecontrol, supervisory and all low voltage, low frequency requirements, in areas subject to high electromagnetic and electrostatic interference, as well as for general purpose applications.

2. Supporting clauses

2.1 Scope

This standard covers the design, manufacture, testing and delivery of indoor and outdoor telephone cables for use in Eskom.

2.1.1 Purpose

The document provides for the manufacture, testing at works, user documentation, supply, delivery and off-loading at Eskom's stores and sites.

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.

2.2.1 Normative

[1] ISO 9001, Quality Management Systems.

[2] SANS 1091, National colour standard.

[3] SANS 1411-1, Materials of insulated electric cables and flexible cords Part 1: Conductors

[4] SANS 1411-2, Materials of insulated electric cables and flexible cords Part 2: Polyvinyl chloride (PVC)

[5] SANS 1411-4 Materials of insulated electric cables and flexible cords Part 4: Cross-linked polyethylene (XLPE).

[6] SANS 1411-6, Materials of insulated electric cables and flexible cords Part 6: Armour.

[7] SANS 1411-7, Materials of insulated electric cables and flexible cords Part 7: Polyethylene (PE).

[8] SANS 1507-6, Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 6: Service cables Electric cables.

[9] SANS 6282-3, Test methods for bare conductors and conductors of insulated electric cables Part 3: Mechanical tests.

[10] SANS 62230 Electric cables - Spark-test method

[11] SANS 6284-3 Tests on finished cable.

[12] BS 2627 Specification for Wrought Aluminium for Electrical Purposes : Wire

[13] BS 6007 Specification for Rubber Insulated Cables for Electric Power and Lighting

[14] BS 6746 Specification for PVC Insulation and Sheath of Electric Cables

[15] BS 6746C Colour Chart for PVC Insulation and Sheath of Electric Cables

[16] BS 6234 Specification for Polythene Insulation and Sheath of Electric Cables

[17] (BSI) PD 2379 Register of Colours of Manufacturer's Identification Threads for Electric Cables and Cords

[18] ASTM D 1693 Test method for Environmental Stress Cracking of Ethylene Plastics

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Technical Terms	For the purpose of this specification, technical terms used shall be as defined in the documents listed in clause 2.2.1 Normative References.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
APL	Aluminium / Polyethylene Laminate
PE	Polyethylene
PVC	Polyvinyl Chloride

2.5 Roles and responsibilities

It is the responsibility of the subject matter expert (SME) to ensure that this standard is applied in engineering design and materials procurement.

2.6 Process for monitoring

This standard shall be updated periodically according to Eskom's policy and the latest version shall be available for use at all times.

2.7 Related/ supporting documents

Not applicable.

3. Requirements

3.1 Conductors

a) Each conductor shall consist of annealed, electrolytic copper wire, smoothly drawn, approximately circular in section, uniform in quality, free from all defects and having a diameter in accordance with Table 1 below.

Table 1: Diameter of conductors and insulation thickness

DIAMETER OF CONDUCTOR (mm)			MINIMUM THICKNESS OF INSULATION (mm)	MAXIMUM OVERALL DIAMETER (mm)
NOM	MIN	MAX		
0,5	0,49	0,51	0,18	1,02
0,63	0,62	0,64	0,22	1,22
0,9	0,89	0,91	0,25	1,61

b) The electrical resistance of conductors shall comply with those quoted in Table 2 below.

Table 2: Resistance of conductors at 20^{0}C

DIAMETER OF CONDUCTOR (mm)			MAXIMUM AVERAGE RESISTANCE OF CONDUCTORS (Ω/km)
NOM	MIN	MAX	
0,5	0,49	0,51	90,31
0,63	0,62	0,64	56,94
0,9	0,89	0,91	27,91

c) Conductors shall withstand the following elongation before fracture:

1) 15% for 0,5mm conductors
2) 20% for 0,63 and 0,9mm conductors

d) Any joint in the conductor shall be made by a method approved by the inspecting officer and shall fulfil the following conditions:

1) The tensile strength of a 250mm length of conductor containing a joint shall not be less than 90% of that of a similar sample of conductor without a joint.
2) The overall diameter of the conductor shall not be increased at a joint.

3.2 Insulation

3.2.1 Material

The conductors shall be uniformly covered with an insulating material consisting of coloured polyethylene which meets the requirements of the BS 6234, Type 3 compound. If an equivalent compound is used, the supplier shall provide all the required specifications to Eskom for approval.

3.2.2 Shrink Back Test

Refer to section 4.8 for the shrink back test procedure. The conductor insulation shall not shrink back more than 6mm overall or more than 4mm from either end of the sample cable, when subjected to 100^{o}C for 24 hours.

3.2.3 Thickness

Insulation shall be applied concentrically around the conductor and shall fit closely thereto.

The minimum thickness of the insulation and the maximum overall diameter of the insulated conductor shall be as specified in Table 1.

3.2.4 Colours of Insulation

a) The colours shall be in accordance with BS 6234. Slight deviations from the colour standards defined in BS 6234 shall not constitute grounds for rejection provided the colours are easily identifiable.

b) The insulation of each conductor shall be colour coded in accordance with Table 3 below.

Table 3: Colour Code for Indoor and Outdoor Cables

PAIR OR SUB-UNIT	PAIR INSULATION COLOUR		SUB-UNIT COLOUR
NUMBER	**A**	**B**	
1	Blue	White	Blue
2	Orange	White	Orange
3	Green	White	Green
4	Brown	White	Brown
5	Grey	White	Grey
6	Blue	Red	
7	Orange	Red	
8	Green	Red	
9	Brown	Red	
10	Grey	Red	

Cables with 2 pairs shall not be in sub-units

Cables with 4 pairs shall not be in sub-units

Cables with 10 pairs shall not be in sub-units

Cables with 25 pairs shall be in sub-units of 5 pairs

Cables with 50 pairs shall be in sub-units of 10 pairs

c) Multicolour wires shall have the colour coding incorporated in the insulation or applied by surface marking. The colours shall be fast and indelible and shall be applied in the form of spiralled lines of width not less than 1,5mm (measured at right angles to the lay, and appearing at least once per 25mm of insulated conductor).

Alternatively, ring marking may be applied. Ring markings shall not be less than 1,5mm in width, completely encircling the insulation and shall appear at least once per 25mm of insulated conductor. To ensure satisfactory surface marking, darker colours shall be used.

3.3 Twinning

a) Two conductors, insulated as described in section 3.2, shall be uniformly twisted together. The twist length of the pair shall not be greater than 100mm for 0,5mm and 0,63 mm diameter conductor cable, and 150mm for 0,9mm diameter conductor cable.

b) The twisting of cable pairs shall be such that the cross-talk-attenuation between any two unscreened pairs of a cable shall be greater than 50 dB/km at audio frequencies (300-3400 Hz).

3.4 Stranding of Cables

a) The insulated pairs shall be stranded together in a clockwise direction to form a compact circular cable. Where applicable, sub-units of five or ten pairs shall be formed. Refer to Table 3.

b) An identification tape or thread shall be applied either helically or longitudinally around each sub-unit, for the whole length of the cable. The colour of the tape shall be in accordance with Table 3.

c) The sub-units shall be stranded clockwise in numerical sequence to form a compact circular cable.

3.5 Tape Lapping of Cables

The cable core shall be covered with lapping of suitable paper or an approved tape similar to melinex, to provide at least two layers at any point. There shall be no adhesion between the core covering and the conductor insulation and no softening of the insulation on the conductors shall occur during the sheathing process.

3.6 Screen Moisture Barrier

a) The cable core shall be completely covered with aluminium foil coated on one side with polyethylene applied longitudinally and with an overlap of not less than 6mm. Where the specified overall diameter of the cable sheath is 25mm or less, the minimum overlap shall be 3mm. The polyethylene coating shall be outside.

b) The nominal thickness of the Aluminium / Polyethylene Laminate (APL) film shall be 0,15mm and 0,04mm respectively.

c) The peel strength of the polyethylene from the aluminium shall not be less than 0,25 N/mm width of foil when tested in accordance with Annexure F.

d) The APL sheath shall be electrically continuous throughout the cable length. The APL shall maintain 100% coverage when the cable is bent through a radius of fifteen times its overall diameter.

3.7 Identification

The number of pairs, conductor size, manufacturers name and the year of manufacture shall be clearly embossed or indelibly marked on the outer sheath of the cable. Alternatively, a tape bearing the information shall be run under the sheath of the cable. Such information shall be repeated at least once every 350mm.

3.8 Sheath

a) All cables shall be compactly sheathed with polyethylene compound type 03C in accordance with BS6234. Reclaimed polyethylene shall not be used.

b) The sheath shall form a smooth surfaced close fitting tube, approximately circular in shape, free from pin holes and any other defects. Ovality shall not exceed 8%. The ovality shall be the difference between the maximum and minimum diameters at the same cross-section expressed as a percentage of the minimum diameter. The sheath shall be applied in such a manner that no undue residual strain is left in the material. There shall be no adhesion between the sheath and the conductor insulation.

c) The thickness of the sheath and the external diameter of the cables shall be in accordance with Table 4 below.

Table 4: Physical Dimensions of Unarmoured Cables

Cable Pairage	2		4		10		25		50	
Nominal Conductor Diameter (mm)	0,5	0,63	0,5	0,63	0,5	0,63	0,5	0,63	0,5	0,63
Minimal Sheath Thickness (mm)	0,6	0,6	0,6	0,6	0,7	0,7	0,9	0,9	1,0	1,0
Nominal Overall Cable Diameter (mm)	5	5,5	7,8	8,5	10,3	11,8	13,5	15,0	17,0	20,0

d) The Polyethylene shall meet the following additional requirements

3.8.1 Impact Test:

A specimen of sheathed cable, approximately 400mm in length, shall be secured at the bottom of a 1m tube, 30mm in diameter. This assembly shall be placed in a cold chamber at a temperature of –20ºC for four hours after which a mass of 0,45kg shall be released at the top of the tube. The cable sheath shall show no cracks.

3.8.2 Environmental Stress-Cracking Test:

A certificate from the suppliers of polyethylene to the effect that their compound meets the environmental stress-cracking test of ASTM D 1693 is acceptable, but Eskom reserves the right to request Eskom's authorised inspector to carry out sporadic tests with compound provided by the cable manufacturer.

3.8.3 Shrink Back Test:

Sample specimens shall be cut from the cable sheath, 50mm long, 13mm wide. The specimens shall be placed in a convection type circulating air oven operating at a temperature of 100°C ± 1°C for 24 hours. At the end of this period, the shrinkage as measured in the lengthwise direction shall not exceed 5%.

e) The colour of the indoor sheath shall be white and the colour of the outdoor sheath shall be black.

3.9 Armouring

a) Outdoor cables supplied against this specification shall all be armoured with single galvanised steel wires in accordance with the requirements of SANS 1507.

b) The 2 pair cable shall not be armoured.

c) The nominal diameter of the wire is specified in Table 5 below.

Table 5: Physical Dimensions of Armoured Cables

Cable Pairage	4		10		25		50	
Nominal Conductor Diameter (mm)	0,5	0.63	0,5	0,63	0,5	0,63	0,5	0,63
Minimal Sheath Thickness (mm)	1,0	1,0	1,0	1,0	1,2	1,2	1,2	1,2
Nominal Overall Cable Diameter (mm)	11	13,5	15	16,2	19	22	23	25,2
Nominal Diameter of Steel Wire Armouring (mm)	0,9		0,9		0,9		1,25	

d) The armouring shall be covered with Polyethylene as stipulated in section 3.8

4. Tests

The cable supplied in this specification must be tested at the works, as detailed in the SANS 1507-6 as a minimum requirement. Eskom will, however, accept standard European or American test methods on imported cable if evidence provided indicates that these are equal to, or more stringent, than the test specified.

In view of the above requirements, all details of the manufacturer’s intended “Type”, “Sample” and “Routine” tests are to be supplied with the tender documentation.

4.1 Diameter of Wires

The diameter of the wire forming the conductor shall be taken as the average of not fewer than six measurements made at random on a representative piece of wire 300mm long. A method of measurement giving an accuracy of not less than 0,0025mm shall be used.

4.2 Conductor Resistance

The DC resistance shall be measured at room temperature, care being taken that at commencement of test the samples and reference standard have the same temperature as the surrounding air. The measurement shall be carried out to an accuracy of within 0,5%. The length of conductor and method of testing shall be adequate to provide the accuracy required.

To determine multi-paired cable compliance with the resistance requirement, twenty conductors distributed throughout the cable and selected at random, shall be connected in series, measured and an average conductor resistance obtained. The average so obtained shall not exceed the maximum specified in Table 2.

4.3 Conductor Elongation before fracture

Samples of the conductor, 250mm long, taken from a completed cable, shall when slowly and steadily stretched at a rate of 50mm/min give an elongation, before fracture, of 15% for 0,5mm cables and 20% for 0,63mm and 0,9mm cables.

4.4 Thickness of Insulation

The thickness of the insulation shall be measured at three or more sections along the length of a representative sample of the PE insulated conductor, 300mm long, and taken not less than 300mm from the end of a factory length.

This measurement shall be made by taking two measurements on each of the two diameter at right angles to one another through the centre of the conductor, i.e. at least 12 individual measurements shall be taken on the sample. A method of measurement capable of reading accurately to 0,025mm shall be used. No reading shall fall below the specified minimum in Table 1. The thickness of the sheathing shall be measured by the same method, except that the measurement shall be taken at those points of a section where the sheath thickness is at its geometrical minimum. No reading shall fall below the specified minimum in Table 5.

4.5 Conductor insulation stripping force

The force required to strip the PVC insulation of which 40% to 50% has been severed circumferentially off the conductors shall not exceed the respective values indicated in Table 6 when tested with an approved stripping gauge, (e.g. the GEC tension gauge is an approved gauge). The test procedure is indicated in Annexure E.

Table 6: Conductor Stripping Force

WIRE DIAMETER (mm)	MAXIMUM STRIPPING FORCE PER 50mm OF WIRE (N)
0,60	17,7 (1 800g Force)
0,9	24,6 (2 5009 Force)

4.6 High Voltage Test

2000V RMS at a frequency of 50Hz, or 3000V DC shall be applied between each conductor in the cable and the remaining conductors bunched and earthed. The voltage shall be applied gradually and maintained at the full value for one minute without breakdown.

4.7 Insulation Resistance

Sample lengths (10m or longer) of insulated conductor shall be immersed in tap water for at least one hour. Thereafter 500V DC shall be applied between the conductor and water. After steady electrification for one minute, the insulation resistance shall not be less than 37,5 MΩ per 1 000m at 20°C.

4.8 Shrink Back Test

Sample lengths of insulated wires shall be selected, at random, from a multi-conductor cable or from rolls of single wire and cut to lengths of 150mm. These lengths shall be placed in a convection type circulating air-oven at 100°C for 24 hours.

The total shrink back of insulation after cooling, as represented by the sum of the lengths of bare conductor protruding from the insulation at each end, shall not exceed 6mm and the length of bare conductor at either end shall not exceed 4mm. In addition the insulation shall have no visible signs of cracking.

4.9 Spark Test

Conductors shall be spark tested after insulation, in accordance with SANS 62230 or an approved alternative method.

4.10 Capacitive Unbalance

Unless otherwise specified the capacitive unbalance between pairs in the cable, measured at audio frequency and corrected in accordance with this sub-clause, shall not exceed 400pF per 500m.

The measured values shall be corrected as follows: Lengths less than 100m being considered as 100m.

The measured value shall be divided by X if shorter than 500m and multiplied by X if longer than 500m:

$$X = 1/2 \left(\frac{L}{500} + \sqrt{\frac{L}{500}} \right)$$

where L is the length in metres of the cable under test

4.11 Continuity of Moisture Barrier

The moisture barrier shall be electrically tested for continuity and its resistance recorded in Ω/km.

4.12 Sheath Spark Test

The sheath shall be spark tested in accordance with SANS 62230.

4.13 Pressure Test (Armoured Cables Only)

The sheath shall be capable of withstanding, without leakage, an internal air pressure of 100kPa for three hours after equalisation of pressure throughout the length. When lengths of 2000m and longer are subjected to this test, the pressure may be reduced to 600kPa.

4.14 Bond Test

A test piece taken from the sheath of the finished cable shall be cut parallel to the axis of the sheath and opened out.

When tested in accordance with Annexure F, separation shall occur at the interface between the aluminium and its primary polyethylene coating leaving the latter bonded to the sheath. The peel strength shall not be less than 0,5 N/mm.

4.15 Bend Test (Armoured Cables Only)

The cable shall be coiled to a diameter of 15D for at least one complete turn, D being the diameter of the cable under test. The sheath shall not ripple. There shall be no damage to the sheath or moisture barrier. This test shall be carried out at the discretion of the inspecting officer.

4.16 Water Vapour Permeation Rate (Outdoor Cables Only)

When measured by the method described in Annexure G, the permeability of the cable sheath at 60°C ±1°C and 100% gradient shall not exceed 0,13Dg/100m/week, where D is the internal diameter of the cable sheath in mm. Alternate test methods may be used if approved by the inspecting officer.

Records of all tests shall be available to Eskom for inspection.

4.17 Test to be performed

All certificates must be provided for the tests listed in Table 7.

Table 7: Tests to be performed

No.	Component	Test Property	Reference
1	Conductor	Elongation at Break	According to SANS 6282-3, Section 2. Elongation at break of wire.
2	Conductor	Spark test	According to SANS 62230.
3	Conductor	Resistance	According to section 4.2
4	Insulation	Physical properties	According to SANS 1411-7 Polyethylene (PE) or an equivalent standard. Report shall be provided.
5	Sheath	Spark test	According to SANS 62230
6	Sheath	Physical properties	According to SANS 1411-7 Polyethylene (PE) or an equivalent standard. Report shall be provided.
7	Sheath	Pressure Test	According to section 4.13
8	Moisture Barrier	Continuity	According to section 4.11
9	Finished Cable	Voltage withstand	According to SANS 6284-3

5. Cable Samples

A sample length of a minimum of 1 metre of the cable covered in this specification shall be submitted to Eskom within 30 days of the notification of the request.

6. Cable Identification, Marking and Packing

a) Cable types will be identified by means of a six character code, details of which are set out in Annexure C. The code is made up and has the meaning assigned in table 8 below.

Table 8: The example is written as TV H20 BR

ODE CHARACTER	MEANING	EXAMPLE
1st	Type of Cable (Alpha Character)	T = Telephone Cable
2nd	Conductor Insulation (Alpha Character)	V = PVC Insulation
3rd	Construction of Pairs (Alpha Character)	H = Twisted Pairs, Overall Screened
4th	Number of Pairs (Group of Numerals)	20 = 20 Pair Cable
5th	Conductor Diameter (Alpha Character)	B = 0,6mm Diameter
6th	Type of Cable Finish (Alpha Character)	R = Aluminium/Polythene Laminate Inner Sheath and Aluminium Wire Armouring, PVC Sheath

6.1 Witnessing of Tests

Eskom reserves the right to appoint a representative to inspect the cable at any stage of manufacture or to be present at any time that tests are performed. If witnessed type tests apply, the samples must be selected according to the procedure detailed in SANS 1507-6. Such inspection shall not relieve the manufacturer of his responsibility for meeting the requirements of the specification, and it shall not prevent the subsequent rejection if the goods are later found to be defective.

Eskom must be informed of inspection or witnessed tests, and Eskom requires not less than 7 days notice of such tests.

6.2 Sealing

All cable ends are to be sealed on completion of all tests, prior to delivery.

6.3 Cable Drums

The cable shall be supplied on wooden drums in accordance to SANS 1507-1. The wood shall have been impregnated (by pressure or in a hot/cold open tank) in accordance with SANS 10005. The inside faces of the flanges and the barrel of each drum shall be smooth and free of splinters in order to prevent sharp edges or wood splinters or any other irregularity from causing damage to the cable.

After being rolled onto the drum, the cable shall be covered by a suitable material so as to provide additional protection. After the cable has been covered, the drum shall be lagged by battens of adequate thickness to prevent damage to cable during storage and transit. The battens shall be butted and shall enclose the cable space completely.

7. Packaging and Delivery

7.1 Packaging

Cables shall be supplied in drum lengths of 500m unless otherwise indicated. All cables shall be marked with the following:

a) Eskom order number.

b) Eskom cable code and specification to which the cable is manufactured.

c) Gross mass of drum and cable in kilograms.

d) The words “Not to be laid flat” shall be written visibly on the drum.

e) The name of the Manufacturer and Trade mark

f) Arrow indicating the correct direction of rolling

g) The length of the cable

The telephone cable supplied in each drum shall be in one continuous length and shall have no joints.

7.2 Delivery

a) The equipment shall be delivered to the destination stated in the enquiry document

b) The ex-work delivery dates, and delivery dates to site shall be indicated in the relevant schedule of the enquiry document.

c) The equipment shall be protectively packed in such a way that it can be safely transported, handled and stored at site, as it will not necessarily be possible for installation to commence immediately upon delivery.

d) Attention is drawn to the fact that Eskom will accept delivery at the specified destination only, and that the supplier shall make all necessary arrangements for acceptance, off-loading and trans-shipping at all intermediate points, as well as the ultimate off-loading at the specified destination.

7.3 Documentation

The supplier shall furnish Eskom with the following product documentation:

a) Cable specification

b) Cable construction details

7.4 Statement of Compliance or Deviation

The Tenderer must complete Schedule B of Annex A - Schedules A and B by stating compliance with or deviation from the requirements of this specification and Schedule A. Any deviations from this specification or Schedule A shall be listed in Annex B - Statement of Non-Compliance, on a section by section and clause by clause basis.

8. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Aletta Mashao	Senior Manager – PTM&C Dx
Alison Maseko	Senior Manager – Eskom Telecommunications
Johan Pieterse	Chief Engineer – Tx Works Planning and Centralized Services
Lenah Mothata	Senior Manager – Grids
Prudence Madiba	Senior Manager – Gx Engineering
Richard McCurrach	Senior Manager (Acting) - Tx Information Management
Sikelela Mkhabela	Senior Manager – Dx Network Operations
Sithembile Songo	Senior Manager – Information Security

9. Revisions

Date	Rev	Compiler	Remarks
Jun 2022	3	R. Gangat	Periodic review
Feb 2019	2	R. Gangat	Included SANS 1507-6 Type Test requirements, SANS 6282-3 Mechanical tests, SANS 1411-4 Cross-linked polyethylene (XLPE), SANS 1411-7 Polyethylene (PE), SANS 62230 Electric cables - Spark-test method and SANS 6284-3 Tests on finished cable.
Aug 2013	1	T. Gosai	First issue.

10. Development team

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

- R. Gangat
- T. Gosai

11. Acknowledgements

Not applicable.

Annex A – Schedules A and B

ITEM	DESCRIPTION	SCHEDULE A ESKOM'S REQUIREMENTS	SCHEDULE B TENDER OFFER	REMARKS
1.	Conductors - Wire	Circular, Annealed, Electrolytic Copper		
	- Diameter Tolerance	0,5mm - 0,49 / 0,51 0,63mm - 0,62 / 0,64 0,91mm - 0,89 / 10,91		
	- Maximum Electrical Resistance	0,5mm - 90,31 Ω/km 0,63mm - 56,94 Ω/km 0,9mm - 27,91 Ω/km		
	- Maximum Elongation before Fracture	0,5mm - 15% 0,63mm - 20% 0,9mm - 20%		
2.	Conductor Insulation - Material	Coloured Polyethylene		
	- Minimum Thickness of Insulation	0,5mm - 0,18mm 0,63mm - 0,22mm 0,9mm - 0,25mm		
	- Maximum tolerated shrink back when subjected to 100°C for 24 hours	6mm overall, less than 4mm per end		
	- Maximum force required to strip insulation from conductor	0,5mm - 17,7 N 0,63mm-17,7 N 0,91mm-24,6 N		

ITEM	DESCRIPTION	SCHEDULE A ESKOM'S REQUIREMENTS	SCHEDULE B TENDER OFFER	REMARKS
	- High voltage withstand capability for 1 minute	2000 V RMS (50Hz) or 3000 V DC		
	- Insulation resistance (Refer to Page 10 of Specification)	> 37,5 MΩ per km at 20°C		
2.	Conductor Insulation (Cont)			
	- HV spark withstand capability	According to SANS 62230		
	- Colours of insulation	According to BS6234 incorporated in Insulation		
	- Application of colour coding	1,5mm spiral or ring with dark colours over light, visible every 25mm		
	- Colour code of conductors	Pair 1 - Blue/White Pair 2 - Orange/White Pair 3 - Green/White Pair 4 - Brown/White Pair 5 - Grey/White Pair 6 - Blue/Red Pair 7 - Orange/Red Pair 8 - Green/Red Pair 9 - Brown/Red Pair l0 - Grey/Red		

ITEM	DESCRIPTION	SCHEDULE A ESKOM'S REQUIREMENTS	SCHEDULE B TENDER OFFER	REMARKS
3.	Conductor Twinning - Twist	 0,5mm - ≤ 100mm 0,63mm-≤100mm 0,9mm - ≤ 150mm		
	- Crosstalk Attenuation	> 50 dB/km at audio		
	- Maximum capacitive unbalance	400 pF per 500m		
4.	Stranding of Cables - Ten pairs and below	 Single Unit		
	- Above ten pairs * 25 pairs * 50 pairs	 Sub-units of 5 pairs Sub-units of 10 pairs		
	- Colour code of sub-units	Unit 1 – Blue Unit 2 – Orange Unit 3 – Green Unit 4 – Brown Unit 5 – Grey		
5.	Tape Lapping of Cables Material	 Paper or Melinex		
6.	Aluminium/Polyethylene Laminate - Nominal thickness	 0,15mm – Aluminium 0,04mm – PE		
	- Construction	Aluminium on inside		
	- Overlap			

ITEM	DESCRIPTION	SCHEDULE A ESKOM'S REQUIREMENTS	SCHEDULE B TENDER OFFER	REMARKS
	• Cables < 25mm diam • Cables > 25mm diam	3mm 6mm		
	- Peel Strength (Aluminium from PE)	0,25 N/nm		
	- 100% coverage when cable bent	15 x diam		
	- Resistance	Indicate Ω/km		
7.	Identification of Cables - Information required on outer Sheath	 - Number of pairs - Conductor size - Manufacturer - Year of manufacture		
	- Identification marks repeated	Every 350mm or less		
8.	Sheath - Material	 Polyethylene		
	- HV spark withstand capability	According to SANS 62230		
	- Internal pressure test	100 kPa for 3 hours		
	- No ripple or damage to sheath and moisture barrier when cable bent	For at least one turn at 15 x diam		
	- Water vapour permeation rate	< 0,13Dg / 100mm/week		
	- Colour	Black Armoured White Unarmoured		

ITEM	DESCRIPTION	SCHEDULE A ESKOM'S REQUIREMENTS	SCHEDULE B TENDER OFFER	REMARKS
	- Minimum thickness (Armoured cable thickness in brackets)	4pair - 0,6mm (1,0) 10pair - 0,7mm (1,0) 25pair - 0,9mm (1,2) 50pair - 1,0mm (1,2)		
	- Comply with the following additional requirements (Refer to the following sections of this standard): 3.8.1 Impact test 3.8.2 Environmental stress – Cracking 3.8.3 Shrink back test	 YES/NO YES/NO YES/NO		
9.	Armouring of Cables - Material	 Galvanised Steel Wire		
	- Nominal diameter of wire	4pair 0,9mm 10pair 0,9mm 25pair 0,9mm 50pair 1,25mm		
10.	Test Certificates. State the location within the tender documentation where the Test Certificates for the following tests can be found:			

ITEM	DESCRIPTION	SCHEDULE A ESKOM'S REQUIREMENTS	SCHEDULE B TENDER OFFER	REMARKS
	10.1 Conductor elongation at break according to SANS 6282-3, Section 2, elongation at break of wire.	Specify		
	10.2 Conductor spark test according to SANS 62230.	Specify		
	10.3 Conductor resistance according to section 4.2	Specify		
	10.4 Insulation physical properties according to SANS 1411-7 Polyethylene (PE) or an equivalent standard. Report shall be provided.	Specify		
	10.5 Sheath spark test according to SANS 62230	Specify		
	10.6 Sheath physical properties according to SANS 1411-7 Polyethylene (PE) or an equivalent standard. Report shall be provided.	Specify		
	10.7 Sheath pressure test according to section 4.13	Specify		
	10.8 Moisture barrier continuity according to section 4.11	Specify		
	10.9 Finished cable voltage withstand according to SANS 6284-3	Specify		
11.	**Drumming and Sealing of Cables:** State whether the product tendered complies with the following specification:			

ITEM	DESCRIPTION	SCHEDULE A ESKOM'S REQUIREMENTS	SCHEDULE B TENDER OFFER	REMARKS
	Cable Drum - according to Telkom Spec 00378	YES/NO		
	Markings on drum:			
	Eskom Order No.	YES/NO		
	Cable Code & Spec	YES/NO		
	Gross Mass	YES/NO		
	"Not to be laid flat"	YES/NO		
	"Sling with bar through centre of drum"	YES/NO		
	Manufacturer	YES/NO		
	Indication of rolling direction	YES/NO		
	Cable Length	YES/NO		

Annex B – Statement of Non-Compliance

The equipment supplied on this contract complies in all respects with the requirements of the specification and Schedule A/B, with the exemption of the following points:

Specification		Details of Deviation or Non – Compliance
Page	Paragraph	

Annex C – Telephone Cable Identification Code

REF	TYPE	CONDUCTOR INSULATION	CONSTRUCTION	CONDUCTOR DIAMETER	FINISH/ PROTECTION
A				0,5	
C				0,63	
E				0,9	
G			Twisted Pairs Unscreened		
H			Twisted Pairs Overall Screen (Water Barrier)		
J			Twisted Pairs Individually Screened		
K			Twisted Pairs Overall and Individually Screened		
N		PVC			
P		PE			
Q		Polythene			
R					APL Inner Sheath, Aluminium Wire Armour with Black PE Outer Sheath
T	Telephone				
U					APL Inner Sheath, Double Steel Tape Armour with Black PE Outer Sheath
V					APL Inner Sheath, No Armouring with White PE Outer Sheath
X					APL Inner Sheath, Single Steel Wire Armour with Black PE Outer Sheath
Z	Special	Special			

Abbreviations used :

- PVC - Polyvinyl Chloride
- PE - Polyethylene
- APL - Aluminium/Polyethylene Laminate

Annex D – Conductor Insulation Stripping Force Test

The purpose of this test is to determine the suitability of Polyethylene insulated wire for solder-less wrapped connection made by the simultaneous "cut, strip and wrap" method.

1) Stripping Gauge

A suitable gauge recommended for this test is shown in the attached Figure 1. It consists of a spring balance which is variable over the range 500g to 2500g, with scale divisions at 150g intervals. The stripping attachment can facilitate wires with the following diameters (mm)

0,32mm 0,4mm 0,5mm 0,6mm 0,7mm 0,9mm

The stripping slots are identical in form and dimensions to those used on wire wrapping bits. They only partly sever the insulation (40% to 50%). The wire diameters and the respective maximum stripping forces are engraved on the hexagonal index rod in line with the respective slots.

2) Test Procedure

Tests may be carried out under the prevailing atmospheric conditions.

a) Select the stripping slot according to the diameter of the wire to be tested and set the gauge to the respective specified maximum force.

b) Select a sample of 200mm to 250mm from the cable to be tested.

c) Cut the selected wire at both ends using sharp cutters. The cut should leave no burrs of distortion of any kind on the wire.

d) Place the wire against the stop on the stripping attachment and over the stripping slot.

e) Gently push the wire into the stripping slot using the wire insertion tool shown in Figure 2. It is important that the wire be kept straight at this point (see Figures 3 (a) and 3 (b) respectively).

f) Apply axial pull on the wire as shown by arrow (a) in Figure 4. In order to facilitate this operation the wire may be bent, but must not be rotated as shown by arrow (b) in Figure 4.

Increase the pulling force gradually until the insulation is broken and the wire pulled out from the insulation. The speed with which the wire is pulled out from the insulation is not critical, it should, however, not be done with a jerk.

If the wire is pulled out from its insulation completely without tripping the pivot of the gauge, set at the relevant force, it complies with the specified requirements. The gauge with the pivot tripped is shown in Figure 5.

Annex E – Peel Strength Between Polyethylene And Aluminium On Aluminium / Polyethylene Laminated (APL) Sheath

The test determines the force required to separate the aluminium and polyethylene at a specified speed using a suitable testing machine.

On polyethylene coated aluminium foil peel strength up to 0,35 N/mm width can be measured by the following procedure:

As the peel strength in some cases exceeds the strength of the polyethylene coating, the polyethylene ruptures during the test. Only test pieces which give a peel strength below the specified figure shall be deemed to be unsatisfactory. Those that give a value above the specified figure before rupture, shall be considered satisfactory.

1) Size of Test Pieces

Parallel sides test pieces 150mm long and of width not less than 13mm and not more than 16mm shall be cut longitudinally in one operation using a sharp punch. Test pieces taken from the sheath shall exclude the overlap.

2) Testing Machine

An electrically driven tensile machine shall be used. The rate of separation of the grips shall be between 100mm/min and 125mm/min. If a pendulum type machine is used, the ratchet mechanism shall be rendered inoperative.

3) Procedure

Peel 50mm to 100mm of aluminium from one end of the test piece. Insert the aluminium in the upper grip of the machine and the polyethylene in the lower grip and determine the steady force to separate the materials.

To facilitate the initial separation of the materials 25mm at the end of the test piece may be immersed in boiling industrial alcohol for approximately 30 seconds. An alternative procedure is to insert a length of 75mm of the test piece in the grips of the machine and stretch it until the aluminium fractures. If this procedure is adopted, a longer test piece may be necessary.

4) Results

The average of five tests shall be regarded as the peel strength.

Annex F – Water Permeation Rate - Method of Test, Piece Preparation And Measurement

The core is carefully removed from a piece of cable of minimum length 1m. Metal end caps carrying capillary gas connections are fitted to the test piece (Note 1). Nitrogen dried to a constant value r_1 below 1 parts/million of water vapour is then passed through the test piece restrained under water at 60°C and into a coulometric hygrometer at a rate between 20ml/min and 50ml/min for 24 hours until a steady reading r_2 is obtained, whichever is the shorter.

The difference in moisture content between the ingoing and outgoing nitrogen is then translated into a water vapour permeation rate P, expressed as 91100 m/week. P may be calculated by the formula given below:

Calculation of P - (Note 2)

$$P \quad \frac{(r_2 - r_1) \times 7{,}45 \times 10^{-2}}{1}$$

where r_1 and r_2 are expressed in parts/million

Note 1: Brass plugs with a 1/10 taper are heated to 160°C in an oven. A 25mm wide band of thermoplastic adhesive (thermogrip 9436 supplied by Bostik Limited) is applied to the interface area of the plug and the sheath. The hot-coated plug is then inserted into the cable and held in position until the adhesive sets. The junction of the plug and the cable is then covered with a thick layer of butyl putty which extends 25mm down the cable sheath. The putty is then over wrapped with any suitable tape to hold it in place. The length of the test piece 1, between the ends of the putty over seals is the effective length for test purpose.

Note 2: The formula assumed that he dial is calibrated in parts/million for a flow rate of 10ml/min.

WIRE STRIPPING GAUGE

WIRE DIAMETER (mm)	MAXIMUM STRIPPING FORCE GRAM FORCE PER 50mm AT 20°C (68°F)	DIMENSION X (mm)	DIMENSION Y (mm)
	% BREAKING LOAD AND ADHESION		
COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
0,4	1150	0,46	0,94
0,5	1500	0,56	1,07
0,6	1800	0,66	1,10
0,7	2000	0,77	1,35
09	250	0,97	1,60

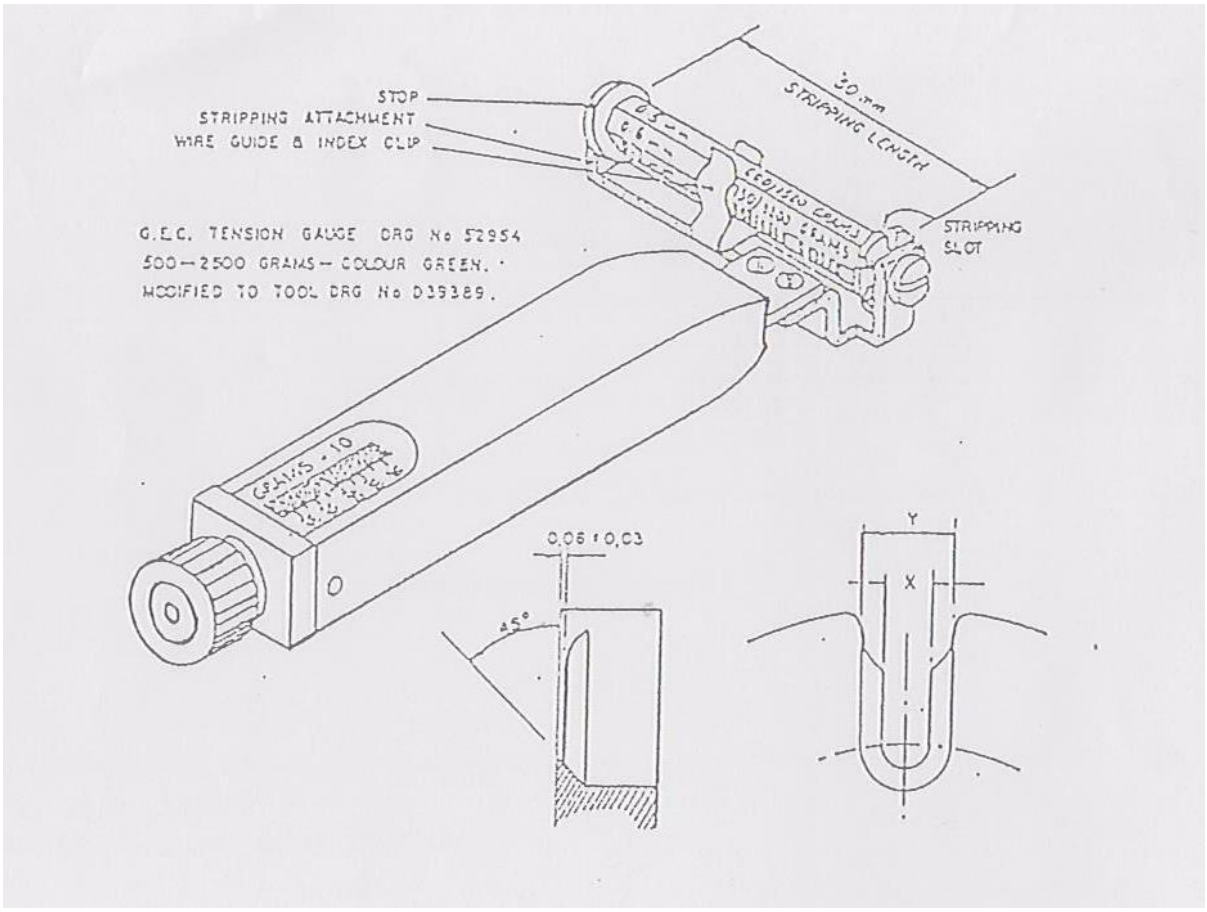

Figure F.1: WIRE INSERTION TOOL

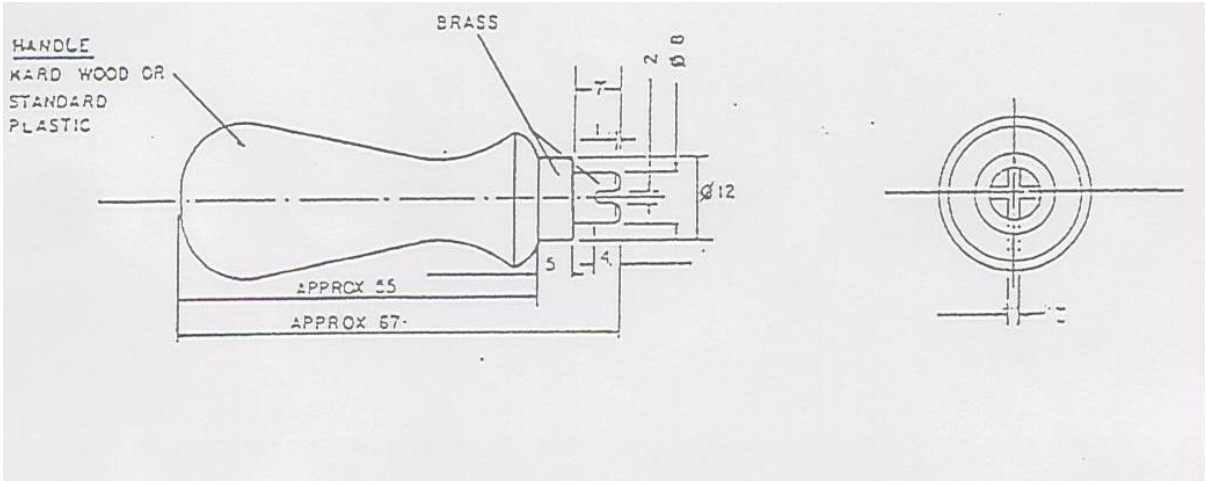

Figure F.2: INSERTING WIRE INTO THE STRIPPING TOOL

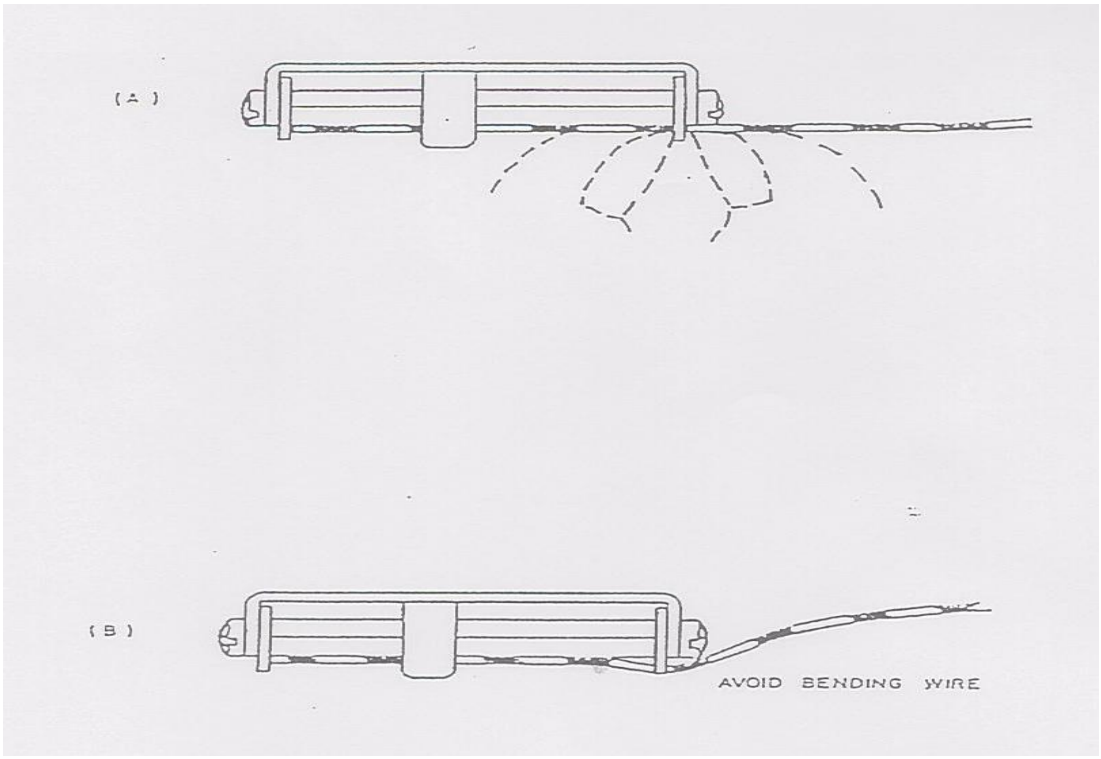

Figure F.3: WIRE STRIPPING OPERATION

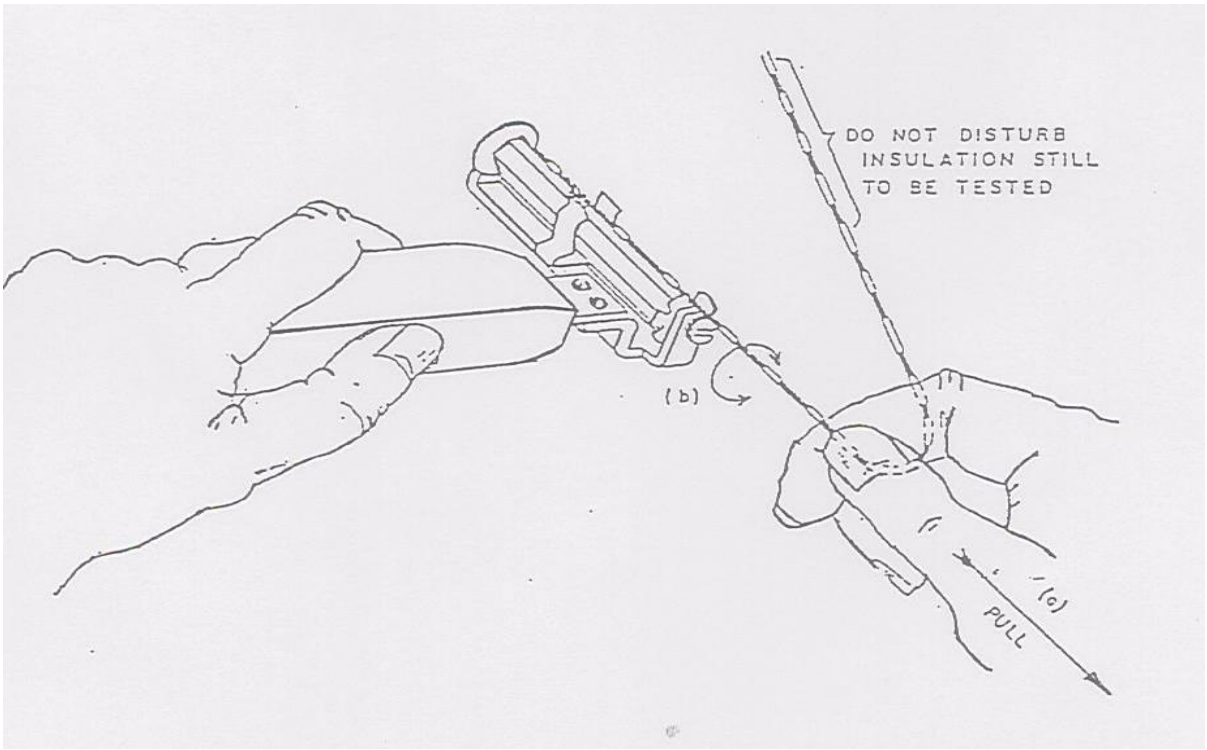

Figure F.4: WIRE STRIPPING OPERATION

Apply force in the direction of arrow (a). To facilitate this, the wire may be bent but must not be rotated as shown by the arrow (b)

The wire is suitable for solderless insertion displacement use if it can be pulled out of from its insulation without stripping the pivot of the gauge, set at the respective load.

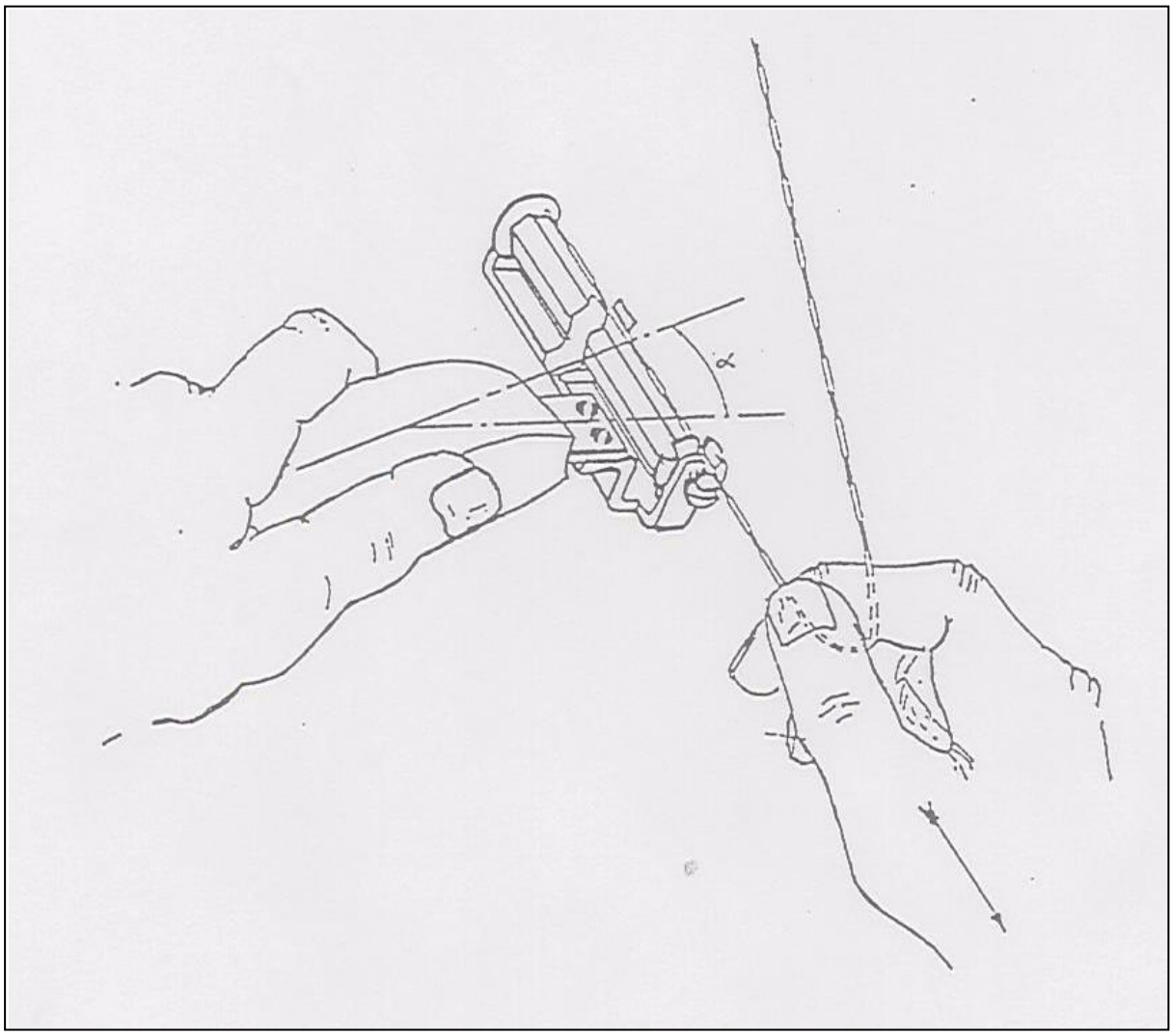

Figure F.5: WIRE STRIPPING OPERATION