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(Reference)

TECHNICAL SPECIFICATION

FOR

FLEXIBLE ELASTOMERIC CABLES WITH COPPER CONDUCTORS
FOR POWERED ROLLING STOCK APPLICATIONSPART - IFOR WORKING VOLTAGES UPTO & INCLUDING 750 VOLTSSPECIFICATION No. SPEC/E-14/01 (PART-I) : REV - II

(FEBRUARY 1993)

~~Cancelled~~with Amendment Nos 1, 2, 3, 4
ISSUED BY

RESEARCH DESIGNS & STANDARDS ORGANISATION

LUCKNOW - 226 011

Rs 1000/-

Technical Specification for flexible
Elastomeric Cables with copper conductors
for powered rolling stock applications.

0 FOREWORD

- 0.1 Indian Railway Technical Specification No. E-13/03 for flexible cables with copper conductors for powered rolling stock applications was issued by RDSO in December-1977. The above specification covered both Thermoplastic (PVC) insulated cables as well as Elastomer insulated cables for use on electric locos, Diesel hydraulic and diesel electric locos and Electrical Multiple Units. Three amendments to this Specification have already been issued and various IS and other Specifications on which the specification was based have also been revised since the issue of this specification.
- 0.2 PVC insulated cables are being kept out of the Scope of this specification, as they are no longer considered suitable for rolling stock applications on account of their low life and low current densities.
- 0.3 Specification E-14/01 was prepared in 1988 due to certain additions/modifications in the earlier specification E-13/03. E-14/01 was in 3 parts. Part-I was covering cables of 750V grade and Part-II those above 750V upto and including 3000V. Part-III was covering HRPVC cables. E-14/01 had to be revised once again due to certain additions/alterations which were considered necessary in this specification.
- 0.4 This revised Specification supersedes earlier specification No. E-14/01 (Part-I) : 1988 and E-14/01 (Part-I) : REV - I and deals with Elastomeric Cables of 750V grade.
- 0.5 The following voltage grade is recognised for the purpose of this specification :-
- 750V grade : This shall be used on AC and DC circuits where the normal voltage does not exceed 500V.
- Industrial frequency 50 Hz shall be taken as frequency for all the AC applications mentioned above.
- 0.6 To fall in line with Indian Standards for Elastomeric cables, the specification has been based on Indian Standard Specification for Elastomer insulated cables IS : 9968 (Part-I) of 1988 and 9968 (Part-II) of 1981.

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SECTION - IGENERAL1 SCOPE

- 1.1 The specification covers the requirement of single core, 3, 13, 19 and 27 core copper flexible cables for use on electric locos, diesel electric locos, diesel hydrauling locos, diesel rail cars, battery locomotives and electrical multiple units.
- 1.2 The specification covers requirements of cables for control and auxiliary circuits covering a voltage range from 24V to 500Volts.

2 TERMINOLOGY

- 2.1 For the purpose of this specification, the definition given in IS : 1886 (Part XXXII) - 1971 and the following shall apply.

2.2 Routine tests.

This test shall be carried out by the manufacturer on all finished cable lengths to demonstrate the integrity of the cable. The purchaser may however carry out these tests on samples selected at random as per Appendix 'A' of IS : 9968 (Part-I) : 1988 to verify the results observed by the manufacturer.

2.3 Type tests.

This test is carried out to prove the conformity with the specification and intended to prove the general quality and design. The type test results shall be valid for a maximum period of 3 years.

2.4 Acceptance tests.

Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

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SECTION - IIMATERIALS3 CONDUCTOR

- 3.1 The conductor shall be made up with circular tinned annealed copper wires complying with IS : 8130-1984. For composition, Class 5 (flexible) and Class 6 (Extra-flexible), nominal cross sectional area, nominal diameter of wires in conductor, number of wires and maximum resistance of conductor at 20°C as per Table-1 of this Specification will be followed.
- 3.2 The composition Class 5 or 6 as desired by the user may be separately specified. Unless specifically indicated, it may be presumed that the cables to be supplied are as per composition Class 5.
- 3.3 The separator tape of red or any other distinguishing colour polyester shall be applied over the conductor.

4 INSULATION

- 4.1 Single Elastomeric covering of oil resisting and flame retardant CSP based insulating material complying with requirements of Type IE-4, Serial No. (ii) (e) of Table 1 of IS : 6380-1984 shall be provided.
- 4.2 For multicore cables individual cores shall have single elastomeric covering of IE-4 type material as mentioned in Clause 4.1 above.
- 4.3 Binder tape
- 4.3.1 Jumper cables as indicated in Table-3 shall be provided with a covering of rubberised proofed cotton tape (RPCT) of nominal thickness of 0.15mm over individual core to avoid vulcanisation or sticking of different cores and also for strengthening of individual cores to prevent snapping of conductors.
- 4.3.2 In case of multi-core cables, a binder tape either of polyester (Melinex) of nominal thickness of 0.025mm to 0.050mm or rubber proofed cotton tape (RPCT) of nominal thickness of 0.15mm shall be applied over the laid up cores below the overall outer sheath.

5 SHEATH

- 5.1 As explained above for single core cables, only single covering of elastomeric material shall be provided. Separate insulation and sheath shall not be provided.
- 5.1.1 However, multicore cables shall be provided with overall outer sheath of SE-4 type CSP based material.

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SECTION - IIICONSTRUCTION.6 CONDUCTOR

- 6.1 The conductor formation shall be according to Table-1 of this Specification for flexible and extra-flexible cables.

7 INSULATION

- 7.1 The conductor with separator shall be provided with elastomeric covering in accordance with Table-2 and 3.

7.2 Thickness of insulation

The average thickness of elastomeric covering shall not be less than the Value 'tc' specified in Table 2 and 3.

7.3 Tolerance on thickness of insulation (tc) :

The smallest of the measured value of thickness of elastomeric covering shall not fall below the value 'tc' specified in Table 2 and 3 by more than $0.1\text{mm} + 0.1'tc'$.

7.4 Application of insulation

The insulation shall be so applied by extrusion that it fits closely on the conductor with separator but shall not adhere to it.

7.5 Colour

The colour of the elastomeric covering shall be black or any other colour as agreed to between the Purchaser and the Supplier. Unless specifically indicated, it may be presumed that the covering shall be of black colour.

8 OUTER SHEATH

- 8.1 The outer sheath for multicore cables shall be applied by extrusion in accordance with Table-3.

8.2 Thickness of sheath

The average thickness of the sheath shall not be less than the value 'ts' specified in Table-3.

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8.3 Tolerance on thickness of sheath 'ts'

The smallest of the measured values of thickness of sheath shall not fall below the value 'ts' specified in Table-3 by more than $0.2\text{mm} + 0.2'ts'$.

8.4 Colour

The colour of outer sheath shall be black or any other colour as agreed to between the Purchaser and the Supplier. When the cable is intended for exposure to sunlight, the colour of sheath shall be black only. Unless specifically indicated, it may be presumed that the outer sheath shall be of black colour.

8.5 The material of finished covering shall be uniform and free from voids. It shall be possible to remove the covering/sheath without any difficulty.

9 CORE IDENTIFICATION

9.1 The cores shall be identified either by numbers or colours in accordance with 9.2 using one of the following methods :-

- (a) Numbers printed on cores; and
- (b) Coloured insulation.

9.2 The colour or number scheme shall be as per Clause 13.2 of IS : 9968 (Pt.I)-1988. For multicore cables, printed legend comprising a numeral and word shall be followed. The legend shall be well defined, legible and permanent. Any 150mm of core shall contain at least one complete legend and each legend shall be inverted from the adjacent legends as illustrated

ENIN 8	9 NINE	ENIN 6	OR	8
				N
				I
				N
				6
				9
				N
				I
				N
				8
				8
				N
				I
				N
				6

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- 9.3 For multicore cables numbering of core shall start from outermost layer and hence central core will have last number.

10 LAYING UP OF CORES

- 10.1 In case of multicore cables, the cores shall be laid together with a suitable right hand lay and alternate layers shall be laid in opposite direction. Fillers in interstices may be used to provide reasonable circularity of laid up cables. The approximate value of lay shall be 16 times and 12 times the pitch circle dia. for sizes above 25 mm² and upto & including 25 mm² respectively.
- 10.2 The fillers for interstices shall be natural or synthetic fibre or elastomer. The filler material shall be suitable for the operating temperature of 90°C and compatible with the material used for elastomeric covering.
- 10.3 In case of multicore cable, a binder tape either of polyester (Melinex) of nominal thickness 0.025mm to 0.050mm or rubber proofed cotton tape (RPCT) of thickness 0.15mm shall be applied over the laid up cores below the overall outer sheath.

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SECTION - IVTESTS11 CLASSIFICATION OF TESTS11.1 Type tests

The following shall constitute type tests :-

<u>Test</u>	<u>Reference Specification for requirements</u>	<u>Reference Specification for Test Method</u>
(a) Tests on conductor		
i) Composition of conductor	Table-1 of this Specification	As per Appendix Clause 7 of this Specification.
ii) Persulphate test (for copper)	6.1.1 of IS:8130-1984	Part-4 of IS : 10810-1984
iii) Annealing Test (for copper)	6.1.2 of IS:8130-1984	Part-1 of IS : 10810-1984
iv) Resistance Test	Table-I	Part-5 of IS : 10810-1984
(b) Test for thickness of insulation and sheath	Table 2 & 3	Part-6 of IS : 10810-1984
(c) Physical tests for elastomeric insulation and sheath	Table 2 & 3 of IS : 6380-1984	Respective Parts of IS:10810-1984 as mentioned in IS:6380-1984 Table 2 & 3
(d) 0 Zone resistance test	UIC 895-OR-1976	Appendix-3 of UIC 895-OR
(e) High voltage test (Water immersion test)	Clause 22.2.1 of IS : 9968-I-88	Part 45 of IS : 10810-1984
(f) Insulation resistance test (Insulation resistance constant)	Table 2 of IS : 6380-1984	Part 43 of IS : 10810-1984
(g) Destructive puncture test	Appendix Clause 6	Appendix Clause 6
(h) Resistance to cracking test	Appendix Clause 1	Appendix Clause 1

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Test	Reference Specification for requirements	Reference Specification for Test Method
(i) Flexibility (Bending) test	Appendix Clause 2	Appendix Clause 2
(j) Fire resistance Test	Appendix Clause 3	Appendix Clause 3
(k) DC stability test	Appendix Clause 4	Appendix Clause 4
(l) Resistance to surface tracking	Appendix Clause 5	Appendix Clause 5
(m) Slippage test	Appendix Clause 8	Appendix Clause 8
(n) Tests for identification of rubber polymers	ASTM D-3677-83	ASTM D-3677-83
(o) Life cycle test	Clause 22 of British Railway Board Specification TDE/76/P/16.	

11.1.1 Should a sample fail in Life Cycle Test, the test shall be repeated on three samples selected from the same batch. Should any of these samples fail, the batch shall be deemed not to comply with British Railway Board Specification No. TDE/76/P/16 and will not be accepted.

11.2 Acceptance tests

The following shall constitute Acceptance Tests :-

(a) Test on conductor

(i) Composition of conductor	Table 1 of this Specification.	As per Appendix Clause 7 of this Specn.
(ii) Persulphate test (for copper)	Cl. 6.1.1 of IS: 8130-1984	Part-4 of IS : 10810-1984
(iii) Annealing test	Cl. 6.1.2 of IS: 8130-1984	Part-1 of IS : 10810-1984
(iv) Resistance test	Table-I	Part-5 of IS : 10810-1984

(b) Test for thickness of insulation & sheath

Table 2 & 3

Part-6 of IS : 10810-1984

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(c) Physical tests
as indicated
below for Elasto-
meric Insulation
and Sheath

Table 2 & 3
of IS :
6380-1984

Respective
Parts of
IS : 10810-
1984 as
mentioned
in IS :
6380-1984
Table 2 and
3

For Insulation

(i) Without
ageing
Elongation
& Tensile
strength

- do -

- do -

(ii) Hot set
test

For Sheath

(i) Without
ageing -
Elongation
& Tensile
strength

- do -

- do -

(ii) Tear
resistance
test

(iii) Hot set
test

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	Test	Reference Specification for requirements	Reference Specification for Test Methods	
(d)	High voltage test (Water immersion test)	Clause 22.2.1 IS:9968-I-1988 (6 kV AC RMS for 5 Minutes)	Part 45 of IS : 10810-1984	
(e)	Insulation resistance test (Insulation resistance constant)	Table 2 of IS : 6380-1984	Part 43 of IS : 10810-84	
(f)	Destructive puncture test	Appendix Clause 6	Appendix Clause 6	
(g)	Resistance to cracking test	Appendix Clause 1	Appendix Clause 1	
(h)	Flexibility (Bending Test)	Appendix Clause 2	Appendix Clause 2	
(i)	Fire resistance test	Appendix Clause 3	Appendix Clause 3	1
(j)	DC stability test	Appendix Clause 4	Appendix Clause 4	
(k)	Resistance to surface tracking	Appendix Clause 5	Appendix Clause 5	
(l)	Slippage test	Appendix Clause 8	Appendix Clause 8	
(m)	0 zone resistance test	UIC 895-OR-1976	Appendix 3 of UIC-895-OR	
(n)	Tests for identification of rubber polymers	ASTM D-3677-83	ASTM D-3677	

11.2.1 A recommended sampling plan for acceptance tests is given in Appendix-A of IS : 9968 (Pt.I) - 1988

11.3 Routine tests

The following shall constitute routine test :-

(a)	Conductor resistance test	Table 1	Part 5 of IS : 10810-1984	
(b)	High voltage test (3kV AC RMS for 5 minutes)	Clause 22.2.2 of IS : 9968-I-1988	Part 45 of IS : 10810-1984.	

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TABLE - 1

S. No.	Normal area (mm ²)	Composition Class-5 & Ohmic resistance			Composition Class-6 & Ohmic resistance		
		Min.No.of Wires and composition.	Nominal dia. of wire (mm)	Max.Resis- tance at 20° C (Ohm/Km)	Min.No.of Wires and composition.	Nominal dia. of wire (mm)	Max. Resis- tance at 20° C. (Ohm/Km)
1	0.5	16	0.20	40.1	28	0.15	40.1
2	0.75	24	0.20	26.7	42	0.15	26.7
3	1.0	32	0.20	20.0	56	0.15	20.0
4	1.5	30	0.25	13.7	85	0.15	13.7
5	2.5	50	0.25	8.21	140 (7 x 20)	0.15	8.21
6	3.0	45	0.30	6.031	-	-	-
7	4.0	56	0.30	5.09	228 (12 x 19)	0.15	5.09
8	6.0	64	0.30	3.39	189 (7 x 27)	0.20	3.39
9	10.0	80	0.40	1.95	324 (12 x 27)	0.20	1.95
10	16.0	126	0.40	1.24	513 (19 x 27)	0.20	1.24
11	25.0	196	0.40	0.795	783 (27 x 29)	0.20	0.795
12	35.0	276	0.40	0.565	1107 (27 x 41)	0.20	0.565
13	50.0	396	0.40	0.393	702 (27 x 26)	0.30	0.393
14	70.0	360	0.50	0.277	999 (37 x 27)	0.30	0.277
15	95.0	475	0.50	0.210	1332 (37 x 36)	0.30	0.210
16	120.0	602 (19 x 32)	0.50	0.164	1702 (37 x 46)	0.30	0.164
17	150.0	756 (27 x 28)	0.50	0.132	2109 (37 x 57)	0.30	0.132
18	195.0	925 (37 x 25)	0.50	0.108	2590 (37 x 70)	0.30	0.108
19	240.0	1221 (37 x 33)	0.50	0.0817	3360 (48 x 70)	0.30	0.0817
20	300.0	1525 (61 x 25)	0.50	0.0654	4270 (61 x 70)	0.30	0.0654
21	400.0	2013 (61 x 33)	0.50	0.0495	-	-	-
22	500.0	1769 (61 x 29)	0.60	0.0391	-	-	-

A tolerance of $\pm 0.01\text{mm}$ shall be permitted on nominal wire dia.

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SECTION - VIDENTIFICATION, PACKING AND MARKING12 IDENTIFICATION

12.1 The following details shall be printed over the sheath of the cable within 1000mm :-

- i) Manufacturer's Name/Trade Mark
- ii) Rated voltage.
- iii) Year of manufacture
- iv) Indication of insulating material and its operating temperature as per Clause 23.2 of IS : 9968 (Pt. I) - 1988, viz., HR 90.
- v) Customer's Specification No. viz., IRS/E-14/01 (Part-I) : Rev - II - 1993.

13 PACKING AND MARKING

13.1 End sealing - All cables shall have their ends sealed with non-hygroscopic sealing materials.

13.2 The cables shall be either wound on reels or drums or supplied in coils packed and labelled.

13.3 The label or the stencilling on the drum shall contain the following information :-

- (a) Reference to this Specification, i.e., RDSO Specification No. E-14/01 (Pt.-I): Rev-II 199
- (b) Manufacturer's name, brand name or trade mark.
- (c) Types of cables and voltage grade.
- (d) Number of cores.
- (e) Nominal cross-sectional area of the conductor.
- (f) Cable Code : as defined in Clause 23.3 of IS : 9968 (Part-I) - 1988.
- (g) Length of the cable on the drum/reel/coil.
- (h) Number of length on the reel, drum or coil (if more than one)
- (i) Direction of rotation of drum (by means of a
- (j) Approximate gross weight
- (k) Year of manufacture.

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TABLE - 2

750V grade single core cables with Elastomeric coverings of IE-4 type CSP based material in accordance with IS : 6380.

CONSTRUCTION: (a) Tinned annealed copper conductor
(b) Separator tape of polyester as per Clause 3.3
(c) Elastomeric covering of IE-4 type insulation.

S.No.	Nominal cross-sectional area of conductor	Thickness of covering (tc)	External nominal dia.	Tolerance on external dia.
	(mm ²)	(mm)	(mm)	(mm)
1	0.5	1.4	4.2	± 0.5
2	0.75	1.4	4.4	± 0.5
3	1.0	1.4	4.6	± 0.5
4	1.5	1.4	4.9	± 0.5
5	2.5	1.4	5.3	± 0.5
6	3.0	1.4	5.5	± 0.5
7	4.0	1.4	6.1	± 0.5
8	6.0	1.5	7.0	± 0.7
9	10.0	1.6	8.1	± 0.7
10	16.0	1.8	10.0	± 0.7
11	25.0	2.1	12.1	± 0.8
12	35.0	2.1	13.7	± 1.0
13	50.0	2.2	15.7	± 1.0
14	70.0	2.3	18.0	± 1.0
15	95.0	2.4	20.3	± 1.0
16	120.0	2.5	22.0	± 1.0
17	150.0	2.6	24.2	± 1.0
18	185.0	2.8	26.6	± 1.0
19	240.0	2.9	30.1	± 1.3
20	300.0	3.1	33.7	± 1.5
21	400.0	3.2	37.9	± 1.5
22	500.0	3.5	42.1	± 1.6

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Multicore cables with Class-5 conductor having Elastomeric covering of IE-4 type CSP based insulation and overall outer sheath of SE-4 type CSP based material in accordance with IS : 6380-1984.

- CONSTRUCTION
- (a) Tinned annealed copper conductor
 - (b) Separator tape of polyester as per Clause 3.3
 - (c) Elastomeric covering of IE-4 type insulation
 - (d) Binder tape of polyester (Melinex) or RPC
 - (e) Elastomeric sheath of SE-4 type material.

S. No.	No. of cores	Nominal Sectional area per core (mm ²)	Thickness of Elastomeric covering (tc) mm	Overall nominal sheath thickness mm	Overall nominal external dia. mm	Tolerance on external dia. mm
1	13	2.5	1.4	1.4	25.5	± 1.5
2	19	2.5	1.4	1.4	29.0	± 1.5
3	27	2.5	1.4	1.4	34.5	± 1.5
4	19	3.0	1.4	1.4	30.0	± 1.5
5	19	4.0	1.4	1.6	32.0	± 1.5
6	3	10.0	1.5	1.5	20.0	± 1.5
7*	19	4.0	1.2	3.6	36.5	± 1.5
8*	27	4.0	1.2	3.6	43.0	± 1.5

- * Jumper cables for inter coach coupler connections on EMUs. These multicore cables shall have overall outer sheath in two layers with an open braid of cotton twine reinforced in between.

Flexing test similar to that specified, vide Clause 9.1 of IS : 6500-1975 is being included as an optional test for these jumper cables. Test procedure and other details for the same may be decided by the manufacturer and the user Railway mutually.

APPENDIX1 RESISTANCE TO CRACKING

The insulation and/or the sheath should not crack during normal use. Checking shall be carried out by means of the following tests. Two samples of the appropriate length shall be taken from two separate points at least 1 metre apart. The complete cable sample shall be wound on to a mandrel in such a way that a spiral of adjoining turns shall be formed. The dia. of Dia-mandrel and the number of turns are specified in the table below :-

S. No.	Ex. Dia. of the sample (mm)	Dia. of Mandrel (mm)	No. of turns
1	Upto and inclusive of 2.5	5	6
2	From 2.5 to 4.5	9	6
3	From 4.5 to 6.5	13	6
4	From 6.5 to 9.5	19	4
5	From 9.5 to 12.5	40	2
6	From 12.5 to 15.0	60	2
7	From 15.0 to 20.0	120	2
8	From 20.0 to 25.0	180	2
9	From 25.0 to 30.0	200	2
10	From 30.0 to 35.0	250	2
11	From 35.0 to 45.0	300	2

Each sample, wound to the correct mandrel shall be kept for 7 hours in an oven at a temperature of 150 ± 200 . Afterwards the samples shall be allowed to cool at an ambient air temperature at which point they shall be examined without being unwound from the mandrel. No evidence of cracking should be visible to the naked eye on insulation and/or the sheath.

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Appendix

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FLEXIBILITY (BENDING) TESTS

The test-pieces shall be wound round a mandrel with a dia. of :-

- for cables with a dia. of \leq 20mm - 3 times
- for cables with a dia. of $>$ 20mm - 5 times, being

the external dia. of the cable, and in such a way as to form 10 continuous turns in a right-hand direction. This procedure shall be followed 3 times.

The test-pieces shall be unwound carefully straightened and rewound 3 times on the same mandrel, in such a way as to form 10 continuous turns in a left-hand direction so that the external surface of the cable is now on the inside. No cracks visible to the naked eye shall occur.

The cable shall withstand the high voltage test after the cable has been subjected to the above bending test.

3

FIRE RESISTANCE

The test shall be carried out in still air on a section of cable 300mm long using a Bunsen burner with an opening of 9mm, fed by the local gas supply.

The burner shall be regulated to provide a flame 100mm and an inner blue cone 50mm long.

The centre line of the burner shall be inclined at an angle of 45° from the vertical (See Fig. 1).

The sample for testing shall be placed vertically and at right angles to the centre line of the burner. The sample shall be positioned so that the whole of its periphery is enveloped in flame upto a distance of 100mm from the lower end and the sample is 35mm from the opening of the burner.

The flame shall be applied for one minute.

Any ignition of the insulating sheathing or the external sheathing must be of a subdued nature and must not spread noticeably, any flame produced on the cable must be extinguished of its own accord within 30 seconds after being withdrawn from the flame.

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Appendix4 DC STABILITY TEST

This test is carried out on cables with a single covering using direct current to ensure that the mechanical characteristics of the single covering, which permit the commission of the protection sheath, retains adequate insulating properties.

The test shall be carried out on samples 5 metres long. The samples shall be continuously immersed, except for its end which shall project about 250mm, for 240 hours in a water bath in which sodium chloride has been dissolved to a proportion of 10 gms per litre. The temperature of water shall be $60^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The conductor of the sample shall be connected to the negative pole of a DC supply of a voltage not less than the maximum working voltage of the cable. The positive pole of the DC supply shall be connected to a copper electrode immersed in the water (without galvanic connection in the container).

There shall be no breakdown of the insulation during the 240 hours test. There shall be no damage to the outer surface of the insulation; discolouration shall be ignored.

5 RESISTANCE TO SURFACE TRACKING

The annular electrodes shall consist of at least 3 continuous turns of copper wire of about 1.8mm dia. Care must be taken when applying the electrodes to ensure that the cable is not damaged. The samples with two annular electrodes 50mm apart shall be bent into a single loop and placed in water for four hours at a temperature from 15 to 20°C . The ends of the cable shall project at least 50mm above the surface of the water. After this immersion, the samples shall be removed and dried with non-fluffy filter paper. Immediately afterwards the leakage current shall be measured by a milli-ammeter when a voltage of 2000V 50 Hz is applied for 10 seconds between the electrodes. The voltage shall then be raised at the rate of 100V per second until tracking occurs followed by a flash-over.

The requirements are as follows :-

(a) Maximum leakage current

Cross sectional area of copper	Max. leakage current 10 seconds at 2 kV
0.5 - 1.5 mm ²	5 mA
2.5 - 4.0 mm ²	5 mA
6.0 - 16.0 mm ²	7.5 mA
25.0 - 95.0 mm ²	10 mA

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Appendix

- (b) (i) Surface tracking shall not occur below 7 kV
 (ii) Flash-over shall not occur below 10 kV

6 DESTRUCTIVE PUNCTURE TEST

A sample of cable of 1 metre length shall be immersed in water for 24 hours and thereafter an alternating voltage of 50 Hz shall be applied between the conductor and water, commencing from the voltage given below and increasing in steps of 750V every 30 seconds until puncture occurs. The voltage at which puncture occurs shall not be less than the value given below :-

<u>Grade</u>	<u>Voltage at first step</u>	<u>Minimum puncture voltage</u>
(V)	(V)	(V)
3000	12000	30000
1500	6000	15000
1000	4000	10000
750	2500	8000
750 multicore	2500	16000

7 COMPOSITION OF CONDUCTOR

All wires must be of the same nominal dia. The dia. of wires must not differ from the nominal dia. beyond the tolerance $\pm 0.01\text{mm}$.

The dia. of wire shall be measured by means of a ratchet micrometer or a dial micrometer, between smooth faces circular in shape and with a dia. of at least 5mm. The average of the readings of the two measurements taken at right angles to each other shall be accepted as the value of the dia.

8 SLIPPAGE TEST

A sample of length approximately 350mm is taken and bent to a radius of 150mm. The relative displacement of the conductor with insulation shall not be more than 10mm for cables upto 25mm. dia. and 15mm for cables over 25mm dia.

FIRE RESISTANCE TEST

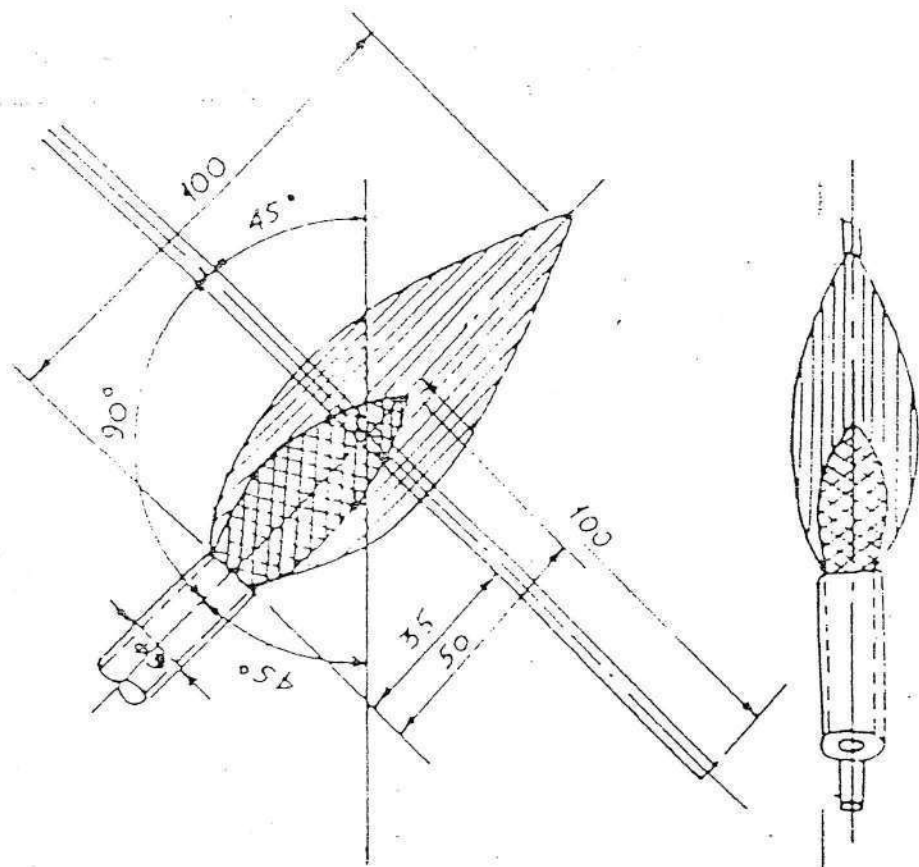


FIG - 1