INDIAN RAILWAY STANDARD SPECIFICATION

FOR

PVC INSULATED, UNDERGROUND, UNSCREENED CABLE FOR RAILWAY SIGNALLING

(Tentative)

SPECIFICATION NO. IRS : S 63 – 2014

Revision 4.0
Number of pages: 45

SIGNAL DIRECTORATE
RESEARCH DESIGNS & STANDARDS ORGANISATION
LUCKNOW-226011

DOCUMENT DATA SHEET			
Designation IRS: S 63/2014			Revision **4.0**
Title of Document Indian Railway Standard Specification for **PVC INSULATED, UNDERGROUND, UNSCREENED CABLE FOR RAILWAY SIGNALLING**			
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Approved by Sr. Executive Director/ Signal, RDSO			
Abstract This specification covers the requirements and tests for PVC insulated, Underground, Unscreened, Armoured/Unarmoured and PVC sheathed cables for Railway signalling.			

DOCUMENT CONTROL SHEET

NAME	ORGANIZATION	FUNCTION	LEVEL
Director / Signal	RDSO	Member	Prepare
Sr. Executive Director/ Signal	RDSO	-	Approve

REVISIONS AND AMENDMENTS:

Version	Chapter/ Annexure	Amendment	Effective date
IRS: S 63/1983	-	FIRST ISSUE	1983
IRS: S 63/1988	-	Revision 1	1988
IRS: S 63/1989	-	Revision 2	1989
IRS: S 63/1989	-	Amendment 1	Sept 1993
IRS: S 63/1989	-	Amendment 2	Sept. 1996
IRS: S 63/1989	-	Amendment 3	Sept. 1998
IRS: S 63/1989	-	Amendment 4	Oct. 1999
IRS: S 63/1989	-	Amendment 5	Sept. 2002
IRS: S 63/1989	-	Amendment 6	Jan 2006
IRS: S 63/2007	-	Revision 3 (inclusive of all previously issued amendments and policy letters)	June 2007
IRS: S 63/2007	-	Amendment 1	Nov. 2007
IRS: S 63/2007	-	Amendment 2	May 2009
IRS: S 63/2007	-	Amendment 3	April 2012
IRS: S 63/2014	-	Revision 4 (inclusive of all previously issued amendments)	2014

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GOVERNMENT OF INDIA
MINISITRY OF RAILWAYS
(RAILWAY BOARD)

INDIAN RAILWAY
STANDARD SPECIFICATION
FOR
PVC INSULATED UNDERGROUND, UNSCREENED CABLE FOR RAILWAY SIGNALLING
(Tentative)

Serial No. IRS : S 63 – 2014

0. FOREWARD

0. 1 This specification is issued under the fixed Serial No. S 63 followed by the year of original adoption as standard or in the case of revision, the year of last revision.

Adopted - 1983, First Revision - 1988, Second Revision – 1989, Third Revision - 2007

0. 2 This specification requires reference to the following Indian Railway Standard Specifications (IRS) and Indian Standard Specification (IS).

IRS : S - 23	:	Electrical Signalling and Interlocking Equipment (Tentative
IS : 723	:	Steel Countersunk head wire nails
IS : 3975	:	Mild steel wires, strips and tapes for Armoured Cables
IS : 5831	:	PVC Insulation and sheath of electric Cables
IS : 6745	:	Determination of Mass of zinc coating on zinc coated iron and steel articles
IS : 8130	:	Conductors for Insulated Electric Cables and flexible cords
IS : 9938	:	Recommended colours for PVC Insulation for LF wires and cables.
IS : 10810	:	Methods of test for Cables

0.3 Whenever in this Specification, any of the above mentioned specifications are referred to by number only without mentioning the year of issue, the latest issue of that specification is implied; otherwise the particular issue referred to is meant.

0.4 This specification is intended chiefly to cover the technical provisions and does not include all the necessary provisions of a contract.

1. SCOPE

1.1 This specification covers the requirements and tests for armoured and unarmoured single core, twin core, three core and multi-core copper conductors PVC insulated and sheathed cables for railway signalling. This specification covers the complete requirement of underground (U/G), unscreened (U/S), Railway Signalling & Power Cables.

1.2 The cable covered in this specification shall be suitable for use on AC systems (earthed or unearthed) for rated voltages upto and including 1100 volts. These cables may be used on DC systems for rated voltages upto and including 1500 volts to earth.

1.3 The cables covered in this specification are suitable for use where the combination of ambient temperature and temperature rise due to load results in a conductor temperature not exceeding 70° C.

2. TERMINOLOGY

2.1 For the purpose of this specification terminology given in IRS: S-23, in addition to the following, shall apply.

2.2 ROUTINE TESTS

Tests carried out on each cable length to check the requirements, which are likely to vary during production.

2.3 TYPE TESTS

Tests carried out to prove conformity with the Specification. These are intended to prove the general qualities and design of a given type of Cable.

2.4 ACCAPTANCE TESTS

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

2.5 OPTIONAL TEST

Special tests to be carried out when required by agreement between the purchaser and the supplier.

3. GENERAL REQUIREMENTS

3.1 CONDUCTORS:

3.1.1 The conductor shall be composed of plain, annealed high conductivity copper wire (s) complying with IS: 8130 except for annealing test requirements. The dimensions, nominal weights and resistances of conductors shall be in accordance with the values given in Table 1. Any other sizes may be accepted as agreed between the purchaser and the manufacturer. In such cases, the wire diameter, the insulation thickness and the tolerances thereon shall be specified by the purchaser.

3.1.2 Conductors of nominal area less then 25 sq. mm shall be circular only. Conductors of nominal area 25 sq. mm and above may be circular or shaped.

3.2. INSULATION:

3.2.1 The Insulation shall be of PVC compound conforming to the requirements of Type 'A' compound of IS: 5831-84**.** (General purpose insulation for maximum rated conductor temperature 70° C operation) except for insulation resistance, tensile strength and percentage elongation. Re-cycled or re-claimed material shall not be used. The specific gravity of PVC insulation taken from finished cable shall not exceed 1.42.

3.2.2

Applicable for power cable only	**Applicable for Signalling Cable only**
The insulation resistance of each core shall not be less than 5.0 Mega-Ohm per kilometre at 50° C.	The insulation resistance (Dry) of each core shall not be less than 10.0 Mega-Ohm per kilometre at 50° C and insulation resistance (Wet) shall not be less than 7.5 Mega-Ohm per kilometre at 50° C for cable conductor sizes upto 2.5 sq. mm. For cable conductor sizes more than 2.5 sq. mm, the insulation resistance (Dry and Wet) shall be 5 Mega-ohms / Km at 50^{o} C.

3.2.3 The insulation shall be applied by extrusion in one continuous process and shall be homogeneous and free from any joints or repairs it shall fit closely on the conductor but shall not adhere to it so that it is possible to remove it easily, without damage to the conductor.

3.2.4 The average thickness of the insulation shall not be less than the nominal value t_1 as specified in Table 2. The smallest of the measured values of the thickness of insulation shall not fall below the nominal value t_1 in mm. by more than 0.1mm+0.1 t_1.

3.2.5 The cores of cables shall be identified by different colouring of PVC insulation. The colours shall conform reasonably with the standard colours shown in IS: 9938**.** The following colour scheme shall be adapted:-

1. Core - Red, black, yellow, blue or grey.
2. Cores - Red and black.
3. Cores - Red, yellow and blue.
4. Cores - Red, yellow, blue and black.
5. Cores - Red, yellow, blue, black and grey.
6. Cores and above - Two adjacent cores (counting and direction core) in each layer, blue and yellow, remaining cores grey.

Note : For a single core in the centre of a multi-core cable, red or black colour shall be used. For 2, 3, 4, or 5 centre cores, the colours shall correspond to these specified for 2, 3, 4, or 5 core cable respectively.

3.2.6 Alternatively the cores of cables with 6 cores and above may be identified by numbers 1, 2, 3, 4, 5 ……. Printed indelibly at intervals of not more than 50mm.

In that case, the insulation of cores shall be of grey colour and printing of number shall be black. The core shall be numbered sequentially in clock wise direction, starting with number 1 for the inner layer. The numbers shall be printed in Hindu-Arabic numerals on the outer surface of the cores. The numbers shall be legible. The consecutive number shall be inverted in relation to each other.

When the number is a single numeral, a dash shall be placed underneath it. If the number consist of two numerals, these shall be disposed one below the other and a dash shall be placed below the lower numerals.

3.3 LAYING UP

3.3.1

Applicable for power cable only	**Applicable for Signalling Cable only**
The cores of twin three and multi-core cables shall be laid up together with suitable lay. The outermost layer shall have right hand lay and the successive layers shall be laid with opposite lay. Where necessary, the interstices shall be filled with non-hygroscopic material.	The cores of twin three and multi-core cables shall be laid up together with suitable lay. The outermost layer shall have right hand lay and the successive layers shall be laid with opposite lay. Way of counting from inner to outer layer continuously shall be unidirectional. Where necessary, the interstices shall be filled with non-hygroscopic material.

3.3.1.1 **For Signalling Cable only :** A Malinex/Polyester tape of thickness 0.025 mm shall be applied helically with left hand lay with minimum overlap of 30% over the laid up cores where DST armouring is provided.

3.3.2 The cores of a layer shall not cross each other. The sequence of the cores shall be maintained throughout the length of the cable.

3.3.3 The recommended plan for lay up of cores upto 100 shall be according to Table 3.

Note: - 2, 6, 9, 12, 19, 24 and 30 core cables are recommended for adoption on Railways.

3.4 INNER SHEATH (Common Covering)

3.4.1 The laid up cores shall be provided with an inner sheath applied by extrusion. It shall be ensured that it is as circular as possible.

3.4.2 The inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation.

3.4.3

Applicable for power cable only	Applicable for Signalling Cable only
PVC used shall meet the requirements of type ST1 (General purpose sheath for use at maximum rated conductor temp. 70°C) compound of IS: 5831-84. Re-cycled or Re-claimed material shall not be used. The colour of the PVC for inner sheath shall be either grey or black. For finished cable the specific gravity of the inner sheath shall not exceed 1.50.	PVC used shall meet the requirements of type ST1 (General purpose sheath for use at maximum rated conductor temp. 70°C) compound of IS: 5831-84. Re-cycled or Re-claimed material shall not be used. The colour of the PVC for inner sheath shall be grey. For finished cable the specific gravity of the inner sheath shall not exceed 1.50.

3.4.4

Applicable for power cable only	Applicable for Signalling Cable only
The minimum thickness of inner sheath shall be as given in Table 4. Single core cable shall have no inner sheath.	The minimum thickness of inner sheath shall be 0.6 mm for cable sizes below 12 cores. For cable sizes of 12 cores and above, the minimum thickness of inner sheath shall be 1.0 mm. Single core cable shall have no inner sheath.

Note:- When one are more layers of proofed tape or plastic tape is applied over the laid up cores as a binder, the thickness of such tapes shall not be construed as part of inner sheath.

3.5. ARMOURING

3.5.1 Armouring shall be applied over the insulation in case of single core cables and over the inner sheath in case of twin, three and multi-core cables.

3.5.2

Applicable for power cable only	**Applicable for Signalling Cable only**
Armouring shall consist of the following : a) Galvanised round steel wire to IS: 3975 except tensile strength and percentage elongation, or b) Galvanised Steel strip to IS: 3975 except tensile strength and percentage elongation, or c) Any other material (as agreed between the purchaser and the manufacturer).	Armouring shall consist of the following: a) Galvanised round steel wire to IS: 3975 with exception to tensile strength and percentage elongation, or b) Galvanised Double Steel Tape to IS: 3975 with exception to tensile strength and percentage elongation, or c) Any other material (as agreed between the purchaser and the manufacturer).

3.5.3

Applicable for power cable only	**Applicable for Signalling Cable only**
Where the calculated diameter below armouring does not exceed 13mm, the armour shall consist of galvanised round steel wires only. Wire armouring shall be applied upto 9 cores of 1.5 mm^2 conductor nominal cross sectional areas. Above 9 core of 1.5 mm^2 or any other sizes of conductor where the calculated diameter below armouring is greater than 13 mm, the armouring shall consist of either Galvanised round steel wires or Galvanised steel strips.	Where the calculated diameter below armouring does not exceed 13mm, the armour shall consist of galvanised round steel wires only. Wire armouring shall be applied below 12 core of 1.5 mm^2 conductor nominal cross sectional areas. 12 core and above of 1.5 mm^2 or any other sizes of conductor where the calculated diameter below armouring is greater than 13 mm, the armouring shall consist of Double Steel Tape.

3.5.4

Applicable for power cable only	**Applicable for Signalling Cable only**
The armour wires/strips shall be applied as close as practicable. The maximum gap between any two adjacent wires or strips shall not exceed 10% of the nominal	The armour wires shall be applied as close as practicable and shall not override each other. The cumulative gap shall not exceed the nominal diameter of a wire.

diameter of the wire or the nominal width of the strip used. The cumulative gap shall not exceed the nominal diameter of the wire or the nominal width of the strip used, as the case may be.	

3.5.4.1 **For Signalling Cable only :** The double steel tape shall be applied helically over the inner sheath with a gap of not more than 50% and minimum overlap of 15%.

3.5.5 The direction of lay of the armour shall be left hand.

3.5.6

Applicable for power cable only	**Applicable for Signalling Cable only**
The dimensions of galvanised steel wire and strip shall be as specified in Table 5 (i).	The dimensions of galvanised steel wire and **tape** shall be as specified in Table 5 (ii).

3.5.7

Applicable for power cable only	**Applicable for Signalling Cable only**
When joints in armour wire / strip are necessary, they shall be made by brazing or welding and any surface irregularity shall be removed. A joint in any wire / strip shall not be less than 300mm from a joint in any other armour wire / strip in the completed cable. The wire / strip shall be continuous throughout the length of cable.	When joints in armour wire / tape are necessary, they shall be made by brazing or welding and any surface irregularity shall be removed. A joint in any wire / tape shall not be less than 300mm from a joint in any other armour wire / tape in the completed cable. The wire / tape shall be continuous throughout the length of cable.

3.6 OUTER SHEATH

3.6.1 The outer sheath shall be applied by extrusion in one continuous process and shall be homogeneous and free from joints and repairs.
It shall be applied :

a) Over the insulation in case of unarmoured single core cables.

&

b) Over the inner sheath in case of unarmoured twin, three and multi-core cables.

&

c) Over the armouring in case of armoured cables.

3.6.2 PVC compound conforming to the requirements of type ST1 compound to IS : 5831-84 except for tensile strength, percentage elongation and shrinkage shall be used for outer sheath. The colour of the outer sheath shall be black. Recycled or

reclaimed material shall not be used. For finished cable, the specific gravity for outer sheath shall not exceed 1.50.

3.6.3 The Thickness of PVC outer sheath shall be determined in accordance with procedure laid down in IS: 10810 (Part-6)-1984. The average thickness shall not be less than the nominal value (t_s) specified in Table 6 and the smallest of the measured values shall not fall below the nominal value by more than (0.2mm+0.2 t_s).

Note 1 **:-** In case of single core unarmoured cables. It is permissible to supply insulation and outer sheath in a single extrusion out of the material intended for insulation. However the thickness or such extruded sheath shall be equal to the sum of thickness of insulation and outer sheath specified separately. The smallest of the measured values of the total thickness shall not fall below the sum of the nominal values of insulation and outer sheath thickness specified by more than 0.2mm + 0.2 ($t_1 + t_s$) .

Note 2 **:-** In case of multi-core unarmoured cables, it is permissible to apply the inner and outer sheath in a single extrusion out of the materials intended for outer sheath. However, the thickness of such extrude sheath shall be equal to the sum of the thickness of inner and outer sheath specified separately.

The smallest of the measured values of the total thickness shall not fall below the sum of the minimum value of inner sheath thickness and nominal value of outer sheath thickness specified by more than 0.2mm + 0.2 t_s .

3.6.4 **For Signalling Cable only :** It shall be ensured that outer sheath is circular and ovality (ratio of minor to major dia.) does not exceed 15% of outer sheath.

4. MARKING

4.1

Applicable for power cable only	**Applicable for Signalling Cable only**
The following information shall be legibly and indelibly indicated throughout the length of the cable by indenting or embossing on the cable. The indentation or embossing shall only be done on the outer sheath: a) Name or trade mark of the manufacturer. b) IRS Specification number. c) Month and year of manufacture.	The following information shall be legibly and indelibly indicated throughout the length of the cable by embossing them on the outer sheath at every one metre having letter height not less than 3 mm in case of cables upto 6 core and 5 mm in case of cables more than 6 core: a) Name or trade mark of the manufacturer. b) IRS Specification number. c) Month and year of manufacture. d) Drum Number. e) Size of the cable (e.g. 12 C x 1.5 sq. mm)

4.2

Applicable for power cable only	Applicable for Signalling Cable only
The length of the cable shall be marked in a sequential manner, over the outer sheath at an interval of every one meter with an accuracy of ±0.2%. The marking shall be distinctively in printing cum indented/ embossed form.	The length of the cable shall be marked in a sequential manner, over the outer sheath at an interval of every one meter with an accuracy of ±0.2%. The marking shall be distinctively in printing cum indented/ embossed form. Printing shall not be easily erasable.

4.3 The following information shall be stencilled on the drum in black paint over yellow painted background. In case of coils, it shall be contained in a label attached to them.

a) Manufacturer's name, brand name or trade mark.
b) IRS Specification number.
c) Type of cable and voltage grade.
d) Number of cores.
e) Nominal cross sectional area of the conductor.
f) Colour of cores (in case of single core cable).
g) Number of lengths on drums/ in coil (if more than one).
h) Length of the cable on the drum/coil (length of each piece to be indicated in case there is more than one length).
i) Initial and final sequential marking for the length.
j) Direction of rotation of drum (by means of an arrow).
k) Approximate gross weight.
l) Country of manufacture.
m) Month and year of manufacture.

4.4 The cable drum number shall be legibly embossed at every one metre or less on the PVC outer sheath throughout the length of cable.

5 TEST AND PERFOMANCE REQUIREMENTS

5.1 Unless other wise specified, all tests shall be carried out under ambient atmospheric conditions.

5.1.1 For inspection of material, relevant clauses of IRS : S-23 shall also apply.

5.2 TYPE TESTS :

Applicable for power cable only	Applicable for Signalling Cable only
The following shall constitute type tests and shall be carried out once in three years or earlier at the discretion of the	The following shall constitute type tests and shall be carried out once in three years or earlier at the discretion of the Inspecting

Inspecting Authority a) Physical tests for conductor (Cl. 5.6) b) Conductor resistance test (Cl. 5.7) c) Test for armour wires/ strips (Cl. 5.8) d) Test for thickness of insulation and sheath (s) - (Cl. 5.9) e) Physical tests for insulation and inner and outer sheaths (Cl. 5.10) f) Flammability test (Cl. 5.11) g) High Voltage test (Cl. 5.12.1) h) Insulation resistance test (Cl. 5.13) i) Water immersion test (Cl. 5.14) j) Visual inspection (Cl. 5.15) and Sequential marking (Cl. 4.2)	Authority a) Physical tests for conductor (Cl. 5.6) b) Conductor resistance test (Cl. 5.7) c) Test for armour wires/ tapes (Cl. 5.8) d) Test for thickness of insulation and sheath (s) - (Cl. 5.9) e) Physical tests for insulation and inner and outer sheaths (Cl. 5.10) f) Flammability test (Cl. 5.11) g) High Voltage test (Cl. 5.12.1) h) Insulation resistance test (Cl. 5.13) i) Water immersion test (Cl. 5.14) j) Visual inspection (Cl. 5.15) and Sequential marking (Cl. 4.2)

5.2.1 At least two samples will be taken from the lot. There shall be no failures.

5.3 ACCEPTANCE TESTS

Applicable for power cable only	**Applicable for Signalling Cable only**
The following shall constitute acceptance tests a) Physical tests for conductor (Cl. 5.6) b) Conductor resistance test (Cl. 5.7) c) Test for armour wires/ strips (Cl. 5.8) d) Test for thickness of insulation and sheath (s) - (Cl. 5.9) e) Physical tests for insulation and inner and outer sheaths (Cl. 5.10.1 (i), 5.10.2, and 5.10.12) f) Flammability test (Cl. 5.11) g) High Voltage test (Cl. 5.12.1) h) Insulation resistance test (Cl. 5.13) i) Water immersion test (Cl. 5.14.1) j) Visual inspection (Cl. 5.15) and Sequential marking (Cl. 4.2)	The following shall constitute acceptance tests a) Physical tests for conductor (Cl. 5.6) b) Conductor resistance test (Cl. 5.7) c) Test for armour wires/ tapes (Cl. 5.8) d) Test for thickness of insulation and sheath (s) - (Cl. 5.9) e) Physical tests for insulation and inner and outer sheaths (**Cl. 5.10.1 (ii)**, 5.10.2, 5.10.4, 5.10.11 and 5.10.12) f) Flammability test (Cl. 5.11) g) High Voltage test (Cl. 5.12.1) h) Insulation resistance test (Cl. 5.13) i) Water immersion test (Cl. 5.14.1) j) Visual inspection (Cl. 5.15) and Sequential marking (Cl. 4.2)

5.3.1 Sampling plan as per Clause 7 shall be followed.-

5.3.2

Applicable for power cable only	**Applicable for Signalling Cable only**
For conductor diameter and resistance, thickness of insulation, thickness of inner and outer sheath, zinc coating of armour	For conductor diameter and resistance, thickness of insulation, thickness of inner and outer sheath, zinc coating of armour

wire/ strip, specific gravity of PVC insulation/sheath, flammability test, insulation resistance test, high voltage test, shrinkage test, visual inspection and sequential marking, there shall be no failures.	wire/ strip, flammability test, insulation resistance test, high voltage test, shrinkage test, percentage variation before and after ageing test, thermal stability test, loss of mass test, specific gravity test, visual inspection and sequential marking, there shall be no failures.

5.3.3 For annealing test, elongation and tensile strength test of insulation, inner sheath, outer sheath and armour torsion and winding test, water immersion test not more than one specimen may fail. If more than one sample fails, the lot will be rejected. If only one sample has failed, two further samples of the same drum will be tested and there shall be no failure.

5.4 ROUTINE TESTS

The followings shall constitute routine tests:

a) Conductor Dia. Test

Conductor diameter. shall be measured at three different points (at intervals of not less than 100 mm) with two reading at 90^0 along the length. This measurement shall be done at the following stages.

I. Before annealing of conductor.
II. After annealing of conductor.
III. After extrusion of insulation over conductor.
IV. At finished cable.

b) Conductor resistance test (Cl. 5.7) all cores
c) High Voltage test (Cl. 5.12) all drums
d) Insulation resistance test (Cl. 5.13.2) all cores
e) Insulation resistance test (Cl. 5.13.3) 4% subject to min. all cores
f) Annealing test (Cl. 5.6.2) all cores 2 drums,
g) Tensile Strength and percentage elongation of sheaths (Cl. 5.10.1) Minimum two samples of each sheath from each drum
h) T.S. and percentage elongation of insulation (Cl. 5.10.1) 100% upto 10 cores. Above 10 cores, 10+50% of the core in excess of 10 (Specimen shall cover all colours).
i) Spark test (Cl. 5.12.2)

The routine test shall be conducted on total drums offered for inspection.

Note : - The results of routine tests shall be made available to the Inspecting Authority.

5.5 OPTIONAL TESTS

The following shall constitute optional tests:

a) Hot deformation test (Cl. 5.10.3)
b) Loss of mass test (Cl. 5.10.4)
c) Colour fastness to day light exposure (Cl. 5.10.5)
d) Colour fastness to water (Cl. 5.10.6)
e) Bleeding and blooming test (Cl. 5.10.7)
f) Cold bend test (Cl. 5.10.8)
g) Cold impact test (Cl. 5.10.9)
h) Heat shock test (Cl. 5.10.10)
i) Thermal stability test (Cl. 5.10.11)

There shall be no failure in optional tests.

5.6 PHYSICAL TESTS FOR CONDUCTOR

5.6.1 DIMENSIONS

The diameter of the conductor shall be measured on a sample from the finished cable. The measurement shall be made at three different point (at interval **of** not less than 100mm) with two readings at 90 degree along the length of sample. The values shall meet the requirement given in Clause 3.1.1

5.6.2 ANNEALING TEST

A sample of wire taken from finished cable, when tested as described in IS: 10810 (Part - 1) shall have elongation at fracture of not less than 27.5% minimum.

For nominal wire diameter from 0.85mm to 1.06mm the elongation at fracture shall not be less than 23% minimum. For stranded conductors, the values obtained shall not be less than 95% of the values, mentioned above.

5.6.3 TEST FOR CORRESPONDENCE OF CORES

Applicable for power cable only	**Applicable for Signalling Cable only**
The sequence of cores shall be checked on the complete drum length and there shall be no discrepancy in the correspondence of the cores.	The sequence of cores shall be checked as per Clause 3.2.5/Clause 3.2.6 (as applicable) and Cl. 3.3.1 on the complete drum length/sample length and there shall be no discrepancy in the correspondence of the cores.

5.7 CONDUCTOR RESISTANCE TEST

5.7.1 Conductor Resistance shall be measured first on complete drum lengths. The cable drum under test shall be at reasonably constant temperature for sufficient time to ensure that the cable temperature is equal to the ambient temperature. The measurement shall be carried out to an accuracy of at least one part in hundred.

5.7.2 The DC resistance of the conductor shall be measured at room temperature and corrected to 20° C by means of the appropriate factors given in Table 7.

5.7.3 The corrected resistance in case of full drum lengths shall not exceed the values given in Table 1 nor shall it be less than 87% of the nominal (standard) value.

5.7.4 The specific resistance of conductor shall meet the requirements of APPENDIX B-2 of IS/ 8130**.**

5.8 TEST FOR ARMOUR WIRES / STRIPS/ TAPES

5.8.1 DIMENSIONS : -

The dimensions of armour wires / strips / tape shall be measured in accordance with procedure laid down in IS : 10810 (Part 36).
The measured values shall meet the requirements of Clause 3 of IS : 3975.

5.8.2 TENSILE STRENGTH AND PERCENTAGE ELONGATION TEST

5.8.2 (i) For power cable only : A sample of wire / strip taken from the raw material as well as from the finished cable shall be tested in accordance with IS: 10810 (part 37). The ultimate tensile strength and percentage elongation of wires/ strips shall be as given below:

	Sample taken from the raw material	Sample taken from finished cable
TensileStrength (Kg/mm^2)	30 to 50	25 to 58
Percentage Elongation (%)	10	6

For Signalling Cable only: A sample of wire / tape taken from the raw material as well as finished cable shall be tested in accordance with IS: 10810 (part 37) . The ultimate tensile strength and percentage elongation of wires/ tapes shall be as given below:

	Sample from raw material		Sample from finished cable	
	wire	tape	wire	tape

Tensile Strength (kg / mm2)	30-50	30-45	30-50	30-45
Percentage Elongation (%)	10	10	8	8

5.8.3 TORSION TEST (FOR ROUND WIRES ONLY)

The test shall be conducted in accordance with IS : 10810 (Part 38). A test sample having a gauge length of 150mm between vices shall be twisted by rotating one of the vices at a reasonably constant rate not exceeding 70 turns / minute. The wire shall withstand without breaking or showing splits or other defects.

NOMINAL WIRE DIA	MINIMUM NUMBER OF TURNS
1.40	43
1.60	37
2.00	30
2.50	24
3.15	19
4.00	13

5.8.4

WINDING TEST (FOR GALVANISED STRIPS ONLY) Applicable for power cable only	**WINDING TEST (FOR GALVANISED TAPES) Applicable for Signalling Cable only**
Zinc coating of the strip shall be sufficiently adherent to the base material. Compliance is checked on sample about 200 mm long. The sample shall be tested in accordance with the procedure laid down in IS:10810 (Part – 39). The zinc coating shall show no cracks and no particles of the coating shall be detached by rubbing with the bare finger.	The sample shall be tested in accordance with the procedure laid down in IS: 10810 (Part – 39). Zinc coating of the tape shall be sufficiently adherent to the base material. Compliance is checked on gauge length of 200 mm sample. Zinc coating shall show no cracks and no particles of the coating shall be detached by rubbing with a bare finger.

5.8.5 (i) TESTS FOR ZINC COATING (Applicable for power cable only)

a) TEST FOR MASS OF ZINC COATING

This test shall be carried out according to the procedure laid down in IS: 10810 (part 41). The minimum weight of zinc coating shall be 110 gm / m^2 for wire/strips.

b) TEST FOR UNIFORMITY OF ZINC COATING

This test shall be carried out according to the procedure laid down in IS : 10810 (Part -40). The sample shall not show any red deposit of copper upon the base metal.

5.8.5 (ii) TESTS FOR ZINC COATING (Applicable for Signalling Cable only)

a) TEST FOR MASS OF ZINC COATING

This test shall be carried out according to the procedure laid down in IS: 6745. The minimum weight of zinc coating shall be 110 gm / m^2 for wire. In case of tapes, the minimum weight of zinc coating shall be 210 gm / m^2 on each side.

b) TEST FOR UNIFORMITY OF ZINC COATING

This test shall be carried out according to the procedure laid down in IS : 10810 (Part -40). The sample shall not show any red deposit of copper upon the base metal. The sample should meet the following requirements:

Type of sample	**Minimum No. of dips**		
	Face	Face	Edge
	1-minute	½-minute	½-minute
	dips	dips	Dips
Tape	2	-	1
Wire	-	1	-

5.8.6 RESISTIVITY TEST

The resistivity of the armour wires/strips shall be measured, in accordance with IS : 10810 (Part - 42). The resistivity of the wire/strip shall not exceed 14.5 x 10^{-6} ohm - cm.

5.8.7 TEST FOR CLOSENESS OF ARMOUR WIRES / STRIPS

Applicable for power cable only	**Applicable for Signalling Cable only**
A length of 1.5m of finished cable shall be taken and its outer sheath shall be removed for a length of about 50 mm approximately in the middle of the sample	A length of 1.5m of finished cable shall be taken and its outer sheath shall be removed for a length of about 50 mm approximately in the middle of the sample length. Care

length. Care shall be taken not to disturb or damage the armour wires/ strips while removing the outer sheath. The maximum gap between adjacent wires/ strips shall not exceed the limits laid down in Cl. 3.5.4.	shall be taken not to disturb or damage the armour wires while removing the outer sheath. The cumulative gap between adjacent wires shall not exceed the limits laid down in Clause 3.5.4.

5.8.8 TEST FOR CLOSENESS OF ARMOUR TAPE
(Applicable for Signalling Cable only)

A window shall be cut at least 1.5 meters from the end or at any place in the finished cable without disturbing the armour. The inner sheath shall not be visible throughout the length of the cable.

5.9. TEST FOR THICKNESS OF INSULATION AND SHEATH

5.9.1 Determination of thickness of insulation of round cores and sheaths shall be made on a representative sample of the cable approximately 1 metre long taken not less than 300mm from the end of a factory length of the cable.

5.9.2 The measurement in case of core insulation and outer sheath shall be made at 3 different points, at intervals of not less than 75mm along the length of the sample. At each point, the minimum thickness (of the insulation) will be measured along with 2 more readings made at equi-distant points around the periphery. The minimum thickness at any point and the average thickness at the 3 points selected will comply with the requirements given in Clause 3.2.4 and 3.6.3.

5.9.3 In case of inner sheath, measurement shall be made at 3 different points at intervals of not less than 75 mm along the length of the sample. At each point, measurement will be taken for the minimum thickness of the sheath. The minimum thickness of sheath at any of the 3 points taken will comply with the requirements laid down in Clause 3.4.4.

Note :- For thickness of insulation of shaped cores and in case of dispute regarding measurements for round cores, the method specified in IS :10810 (Part-6) shall be adopted.

5.10 PHYSICAL TESTS FOR INSULATION, INNER & OUTER SHEATHS

5.10.1(i) Tensile strength and elongation at break **(for power cable only)** - This test shall be conducted in accordance with IS: 10810 (Part -7). The material shall fulfil the requirements indicated below:

		Insulation	Inner & Outer Sheath
a)	**Before Ageing:**		
1)	Min. Tensile strength, kg / cm2	150	150
2)	Min. elongation percentage	150	200
b)	**After ageing in air oven at 80 ± 2ºC for 168 hours:**		
1)	Min. tensile strength kg / cm2	150	150
2)	Min. elongation percentage	150	200

The maximum variation after ageing shall be within ± 20% of the values obtained before ageing. For tests before and after ageing, samples shall be from the same drum in case of sheaths, and from the same core in case of insulation.

However, value after ageing for tensile strength and % elongation shall not be less than given in Cl. 5.10.1 (i) (b)
Tensile strength and elongation at a break after ageing shall be conducted in case of type test and optional in case of acceptance test.

5.10.1(ii) Tensile strength and elongation at break **(for Signalling Cable only) :** This test shall be conducted in accordance with IS: 10810 (Part -7)- The material shall fulfil the requirements indicated below:

		Insulation	Inner & Outer Sheath
a)	**Before Ageing:**		
1)	Min. Tensile strength, kg / cm2	150	150
2)	Min. elongation percentage	150	200
b)	**After ageing in air oven at 80 ± 2ºC for 168 hours:**		
1)	Min. tensile strength kg / cm2	150	150
2)	Min. elongation percentage	150	200

- For acceptance test accelerated ageing may be done for which air oven temperature shall be 130 $\pm 2^{o}$ C for 5 hours.

The maximum variation after ageing shall be within ± 20% of the values obtained before ageing. For tests before and after ageing, samples shall be from the same drum in case of sheaths, and from the same core in case of insulation.

However, value after ageing for tensile strength and % elongation shall not be less than given in **Cl. 5.10.1 (ii) (b)**

Tensile strength and elongation at a break after ageing shall be conducted in case of type test and acceptance test.

5.10.2 SHRINKAGE TEST

This test shall be conducted in accordance with IS: 10810 (Part- 12). The insulation or sheath shrinkage shall not exceed 2% of the original length. During the test no cracks shall occur in the insulation or sheath.

5.10.3 HOT DEFORMATION TEST

This test shall be conducted in accordance with IS: 10810 (Part- 15) and the material shall fulfil the requirements laid down in IS : 5831-84.

5.10.4 LOSS OF MASS TEST

This test shall be conducted in accordance with IS :10810 (Part – 10). The sample shall be kept in air oven at 80 ± 2ºC for 168 hours*. The loss of mass shall be 2 mg / cm^2 maximum.
*For acceptance test, accelerated ageing may be done for which air oven temperature shall be 130 ±2^o C for 5 hours

5.10.5 COLOUR FASTNESS TO DAY-LIGHT EXPOSURE

This test shall be conducted in accordance with IS : 10810 (Part - 18).
The minimum rating shall be 4.

5.10.6 COLOUR FASTNESS TO WATER

A piece about 100mm long is cut into small pieces and immersed for 48 hours in about 10 times its own volume of distilled water at 70 ± 2ºC. At the end of the period, the water shall be examined. It shall be free from any trace of colour.

5.10.7. BLEEDING AND BLOOMING TEST

This test shall be conducted in accordance with IS : 10810 (Part-19).
There shall be no appreciable staining of indicator compound.

5.10.8 COLD BEND TEST

This test shall be conducted in accordance with IS : 10810 (Part-20).
The sample shall be cooled in air in refrigerator at a temperature –15 ± 2ºC for a specified period. There shall be no signs of cracks or scales.

5.10.9 COLD IMPACT TEST

This test shall be conducted in accordance with IS : 10810 (Part-21)

The sample shall be cooled in air in refrigerator at a temperature –5 ± 2ºC for a specified period and tested. There shall be no signs of cracks or scales.

5.10.10 HEAT SHOCK TEST

This test shall be conducted in accordance with IS : 10810 (Part-14).
The sample shall be placed in an oven at temperature 150 ± 2ºC for one hour. There shall be no signs of cracks or scales.

5.10.11 THERMAL STABILITY TEST

This test shall be conducted in accordance with IS: 5831and shall meet the requirements indicated there in.

Note :- A minimum of two samples shall be taken from each type of PVC material in each colour used. There shall be no failure.

5.10.12 SPECIFIC GRAVITY TEST FOR PVC

The test shall be conducted on PVC insulation/sheath in accordance with BS: 6469 with distilled water. The test samples shall be taken from the finished cable.

5.11 FLAMMABILITY TEST

5.11.1 The test shall be conducted in accordance with IS : 10810 (Pt-53) The period of burning after removal of flame shall not be more than 60 seconds and decomposed length of sample shall not be more than 200mm

5.12 HIGH VOLTAGE TEST

5.12.1

Applicable for power cable only	**Applicable for Signalling Cable only**
This test shall be conducted on complete drum lengths. The cable shall withstand an AC voltage of 4 KV (rms) or a DC voltage of 12 KV. The AC voltage used for testing shall be approximately of sine wave form at any convenient frequency between 40 and 60 Hz. The connections and test periods shall be according to **Table 8 (i).**	This test shall be conducted on complete drum lengths. The cable shall withstand an AC voltage of 4 KV (rms) or a DC voltage of 12 KV. The AC voltage used for testing shall be approximately of sine wave form at any convenient frequency between 40 and 60 Hz. The connections and test periods shall be according to **Table 8 (ii).**

5.12.1.1 For Signalling Cable only : In case of cable of 12 core and above, all the drums except covered in **Clause 5.12.1** shall be subjected to a voltage of 4 KV applied between all cores bunched together against armouring for a period of one minute.

5.12.2 SPARK TEST (Routine Test Only)

Spark test shall be conducted in accordance with IS : 10810 (Part-44) . All cores to be used in a cable shall be subjected to this test by the manufacturer before the laying up process. The test electrode shall make an intimate contact with the surface of the core. The speed at which the core passes through the electrode shall be such that every point of it remains in contact with the electrode for not less than 0.1 second. The conductor of the core shall be earthed and the potential applied between the electrode and the conductor shall be as specified below.

Thickness of insulation (mm)	Test voltage KV (rms)
Upto and including 1.0mm	6
Above 1.0 and upto and including 1.5mm	10

The fault detector shall be arranged so as to maintain its indication even after the fault has passed out of the electrode. The sensitivity of the test apparatus shall comply with the requirement given in IS :10810 (Part-44).

5.13 INSULATION RESISTANCE TEST

5.13.1

Applicable for power cable only	Applicable for Signalling Cable only
This test shall be carried out on drums which have been subjected to the High Voltage test	This test shall be carried out on sample length or drums which have been subjected to the High Voltage test.

5.13.2

Applicable for Power Cable only.	Applicable for Signalling Cable only.
Insulation Resistance test may be conducted on factory lengths between each conductor and all other conductors in accordance and shorted with the armouring in air at the prevailing temperature. The drum shall be in the test room at a reasonably constant temperature for sufficient time to ensure that the core insulation is at ambient temperature. The DC test voltage shall be 500V and shall	Insulation Resistance test may be conducted on factory lengths between each conductor and all other conductors in accordance and shorted with the armouring in air at the prevailing temperature. The drum shall be in the test room at a reasonably constant temperature for sufficient time to ensure that the core insulation is at ambient temperature. The DC test voltage shall be 500V and shall be applied for one minute to reach steady state. The value of

be applied for one minute to reach steady state. The value of insulation resistance of each core shall not be less than 5 Mega ohm/km at 50º C irrespective of the size of conductor. For converting measured value of insulation resistance at any temperature to insulation resistance at 50º C, multiplier constants given in Table 9 shall be used	insulation resistance of each core shall not be less than 10 Mega ohm/km at 50ºC for cable conductor sizes upto 2.5 sq. mm. For cable conductor sizes more than 2.5 sq.mm, the insulation resistance shall not be less than 5 mega ohm/km at 50º C. For converting measured value of insulation resistance at any temperature to insulation resistance at 50º C, multiplier constants given in Table 9 shall be used.

5.13.3

Applicable for Power Cable only.	**Applicable for Signalling Cable only.**
A three metre length of cable shall be taken and all cores removed without damage to the insulation. These cores shall be immersed in water at 50 ± 2º C for a period of not less than 2 hours. The insulation resistance between each conductor and water in which the cores are immersed shall then be measured by using a suitable insulation tester. The measurements of insulation shall be made after one minute electrification at 500V DC. The value of insulation resistance of each core shall not be less than 5 Mega ohm per km irrespective of the size of the conductor.	A three metre length of cable shall be taken and all cores removed without damage to the insulation. These cores shall be immersed in water at 50 ± 2º C for a period of not less than 2 hours. The insulation resistance between each conductor and water in which the cores are immersed shall then be measured by using a suitable insulation tester. The measurements of insulation shall be made after one minute electrification at 500V DC. The value of insulation resistance of each core shall not be less than 7.5 Mega ohm/km for cable conductor sizes upto 2.5 sq.mm. For cable conductor sizes more than 2.5 sq.mm, the insulation resistance shall not be less than 5 mega ohm/km at 50ºC.

5.14 WATER IMMERSION

5.14.1 AC TEST

Applicable for power cable only	**Applicable for Signalling Cable only**
The core or cores shall be carefully removed from the samples approximately 3 metres long taken from the finished cable. The cores shall be so immersed in a water bath at 60 ± 3ºC that their ends protrude at least 200mm above the water level. After 24 hours, a voltage of 4 KV (rms) shall be applied between all the	The core or cores shall be carefully removed from the samples approximately 3 metres long taken from the finished cable. The cores shall be so immersed in a water bath at 60 ± 2ºC that their ends protrude at least 200mm above the water level. After 24 hours, a voltage of 4 KV (rms) shall be applied between all the conductors bunched

conductors bunched together and water. This voltage shall be raised to 8 KV (rms) within 10 sec. and held constant at this value for 5 minutes. The sample shall successfully withstand this voltage.	together and water. This voltage shall be raised to 8 KV (rms) within 10 sec. and held constant at this value for 5 minutes. The sample shall successfully withstand this voltage.

5.14.2 DC TEST (Type Test Only)

The cores which have passed the preliminary test given in Cl. 5.14.1 shall be subsequently tested with a DC voltage of 1.2 KV in the same water bath at the same temperature. The conductors shall be connected to a negative pole and the water to the positive pole of DC supply by means of a copper electrode. The core shall withstand this DC voltage test for 240 hours without breakdown.

5.15 VISUAL INSPECTION TEST

5.15.1

Applicable for power cable only	Applicable for Signalling Cable only
The physical condition of the cable shall be visually inspected by transferring it to another drum. The cable shall be reasonably circular throughout its length and shall be free from any physical defects. The measured length of cable on any drum shall not be less by more than one meter of the declared length. The cable shall conform the requirements of Cl. 4.2.	The physical condition of the cable shall be visually inspected by transferring it to another drum. The cable shall be reasonably circular throughout its length and shall be free from any physical defects. The measured length of cable on any drum shall not be less by more than one meter for nominal cable length upto 500 metres and 2 metres for cable length more than 500 metres. The cable shall conform the requirements of Cl. 4.2.

6. PACKING

6.1. Single core cables may be supplied in coils of 100 ± 0.5 meters unless otherwise specified by the purchaser. Multi-core cables shall be wound on drums, unless otherwise specified. The timber used for the manufacture of drums shall be seasoned, reasonably straight grained, uniform in thickness, free from insect attack, splits, wrapping and other defects which may reduce the overall strength of the drums. The timber shall be treated with suitable fungicide.

6.2

Applicable for power cable only	Applicable for Signalling Cable only
The drums shall be of general construction as shown in Fig. 1. The dimensions D, X and Y shall be suitable for the size of the cable. Dimensions D	The drums shall be of general construction as shown in Fig. 1. The dimensions D, X, X_i, and Y shall be suitable for the size of the cable and the ratio of X_i to Y shall not be

shall not be less than 20 times the overall diameter of the cable. The size of drum must be such that when packed, the outermost layer of cable is 50mm below the flange tip.	greater than 0.65. Dimensions D shall not be less than 20 times the overall diameter of the cable. The size of drum must be such that when packed, the outermost layer of cable is 50mm below the flange tip.

6.3 Nails used in the manufacture of drums shall be of the clout headed type to IS:723. They shall be properly clenched and shall be so driven as to avoid splitting of the wood. The ends shall not protrude into the surface where the cable has to be wound.

6.4 Unless otherwise specified, the cable upto 12 cores can be supplied in length of 500 metres or 1000 metres each. Cable above 12 cores shall be supplied in length of 500 meters only. The tolerance shall be +4% and -2% irrespective of the length being 500 meters or 1000 metres. Non-standard lengths each of not less than 200 metres shall be acceptable upto 2% of the total quantity ordered. Unless otherwise specified by the purchaser, the tolerance on total quantity shall be ± 2%.

6.5 Before despatch the drums shall be effectively lagged with suitable closely fitted batons of thickness 25mm minimum. Every baton shall be secured to prevent it from getting displaced or damaged during transit and storage. The lagging shall further be strengthened by steel straps bound circumferentially over the drum. The steel strapping of not less than 12mm wide and 0.6mm thick shall be used.

6.6

Applicable for power cable only	**Applicable for Signalling Cable only**
For the thickness in the flange portion of the drum, there shall be 2 batons upto flange diameter 1070 mm and 3 batons above 1070 mm irrespective of the size of the cable.	The flange portion of drum shall be made of two batons. The thickness of each baton shall be 25 mm for flange dia. upto 1070 mm. If the flange dia. exceeds 1070 mm, the baton thickness shall be 37.5 mm.

6.7 The batons on the drums to be removed for obtaining access to the cable end shall be painted red.

6.8

Applicable for power cable only	**Applicable for Signalling Cable only**
The cable ends shall be sealed to prevent ingress of moisture. Inner ends of cable shall be firmly secured to the outer side of the drum flange in a groove with suitable protective arrangement to prevent damage during transit. Outer end of the cable shall also be firmly fastened to prevent damage. The initial and final sequential	Both the ends of the cable shall be firmly secured and brought to the outer layer of the drum with suitable protective arrangement to prevent damage during testing and transit. In the inside portion of one side flange, suitable arrangement to guide lower end of the cable upto the top must be provided. The initial and final sequential

marking in length for the cable shall be put outside the flange of the drum. A red adhesive tape shall be put around the initial and final sequential number for easy location.	length marking shall be properly visible at the outer layer. The batons coming above the top and bottom Sequential length marking (SLM) shall be marked with red paint.

7. SAMPLING

7.1 All cable drums having cable of same conductor diameter number of cores and similar construction shall constitute a lot.

7.2 For taking samples, drums will be chosen at random from the lot. From each of these drums, one sample of cable shall be taken. The length of the sample shall be sufficient so as to provide test pieces of required lengths as laid down in various test clauses.

7.3

Applicable for power cable only	Applicable for Signalling Cable only
The number of drums to be randomly selected for taking samples shall be as per column 3 of Table 10 (i). The number of drums has been expressed as a percentage of the total number of drums in the lot.	The number of drums to be randomly selected for taking samples shall be as per column 3 of Table 10 (ii). The number of drums has been expressed as a percentage of the total number of drums in the lot.

7.4

Applicable for power cable only	Applicable for Signalling Cable only
The number of Test pieces to be taken from each sample shall be as per Column 4 of Table 10 (i). The number of test pieces has been expressed as a percentage of the number of cores in the sample.	The number of Test pieces to be taken from each sample shall be as per Column 4 of Table 10 (ii). The number of test pieces has been expressed as a percentage of the number of cores in the sample.

8. INFORMATION TO BE SUPPLIED BY THE PURCHASER

8.1 IRS Specification number.

8.2 Number of cores and nominal cross sectional area of the conductor.
Note : - In case of non-standard sizes, wire diameter, insulation thickness & the tolerance thereon shall also be specified. Maximum conductor resistance shall also be specified.

8.3 Number marking on the core.

8.4 Type of cable (whether armoured or unarmoured)

8.5 Any other requirements.

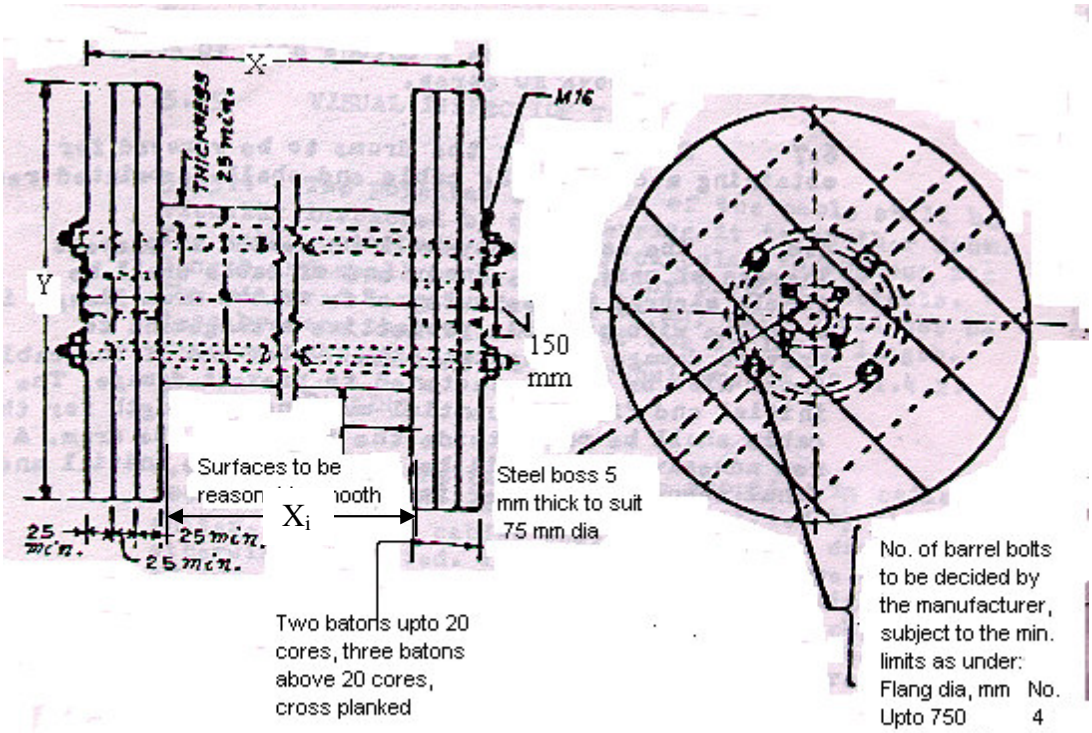


Fig. 1 - CABLE DRUM

8.6 Identification for core has to be indicated by the purchaser either given in clause 3.2.5 or in clause 3.2.6.

Note:

1. All Dimensions in millimetres.
2. (i) **For power cable:** Dimension marked D, X and Y shall be made to suit the size of the cable.
   (ii) **For Signalling Cable :** Dimension marked D, X, X_i and Y shall be made to suit the size of the cable. Ratio of X_i and Y shall not be more than 0.65.
3. Diameter 'D' shall be minimum 20 times the over all cable diameter.
4. Steel strapping of not less than 12 mm wide and 0.6mm thick shall be used.
5. Hexagonal head bolts shall be used for fitting of steel boss. The bolt dia shall not be less than 10mm.
6. Steel boss shall be painted with red oxide.
7. Steel boss shall be fitted with its diagonal at right angle to wooden planks of flange and shall not be fitted over not less than 2 wooden planks of flange.
8. Flange made of wooden planks shall not be less than 25mm thick. Wooden planks shall also be closely fitted and the gap in between planks shall not be more than 5mm only to cater for unevenness in the wooden surface.
9. The thickness of batons fitted on the circumference of the cable drum shall not be less than 25mm and the gap in between the batons shall not be more than 5mm only to cater for unevenness in the wooden surface.

TABLE 1 - CABLE FOR FIXED INSTALLATIONS, CIRCULAR COPPER CONDUCTORS
(CLAUSE 3.1.1)

Nominal cross sectional area.	Number of wires in conduc - -tors.	Diameter of wires.	Tolerance on diameter of wire.	Weight per Km.	Standard resistance of conductor per km. at 20º C.	Max. allowable resistance of each conductor per km. at 20º C.	
						Single core cables	Twin and multi core cables
(1) **mm²**	(2) **-**	(3) **mm**	(4) **mm**	(5) **Kg.**	(6) **Ohms**	(7) **Ohms**	(8) **Ohms**
1.00	1	1.13	+0.020	8.89	17.241	17.689	18.04
1.5	1	1.40	+0.025 -0.015	13.68	11.20	11.54	11.77
2.5	1	1.80	+0.035 -0.015	22.62	6.775	6.978	7.118
2.5	3	1.06	±0.016	23.55	6.644	6.843	6.980
4	1	2.24	+0.045	35.03	4.375	4.506	4.596
4	7	0.85	+0.012	35.28	4.414	4.591	4.683
6	1	2.80	+0.055 -0.035	54.74	2.800	2.884	2.942
10	7	1.40	+0.025 -0.015	97.47	1.627	1.660	1.693
16	7	1.70	+0.030	143.7	1.104	1.124	1.149
25	7	2.24	±0.045	249.8	0.6357	0.6484	0.6614
35	7	2.50	+0.050	310.7	0.5103	0.5205	0.5309
50	19	1.80	+0.035	437.8	0.3633	0.3706	0.3780

TABLE 2 - THINCKNESS OF INSULATION
(CLAUSE 3.2.4)

Nominal Area of Conductor (1) **mm²**	Nominal Thickness of insulation (tı)	
	Single core (2) mm	Multi core (3) mm
1.0	1.5	0.8
1.5	1.5	0.8
2.5	1.5	0.9
4	1.5	1.0
6	1.5	1.0
10	1.5	1.0
16	1.5	1.0
25	1.5	1.2
35	1.5	1.2
50	1.5	1.4

TABLE 3 - LAY-UP OF CORES
(CLAUSE 3.3.2)

No. of Cores. (1)	**Lay-up. (2)**	**No. of Cores. (1)**	**Lay-up. (2)**	**No. of Cores. (1)**	**Lay-up. (2)**
2	2	36	0-6-12-18	70	2-8-14-20-26
3	3	37	1-6-12-18	71	2-8-14-20-27
4	4	38	1-6-12-19	72	2-8-14-21-27
5	5	39	1-6-13-19	73	3-9-15-20-26
6	6	40	1-7-13-19	74	3-9-15-21-26
7	1-6	41	1-7-13-20	75	3-9-15-21-27
8	1-7	42	2-8-13-19	76	3-9-15-21-28
9	1-8	43	2-8-14-19	77	3-9-15-22-28
10	2-8	44	2-8-14-20	78	4-10-15-21-28
11	3-8	45	2-8-14-21	79	4-10-16-22-27
12	3-9	46	2-9-14-20	80	4-10-16-22-28
13	3-10	47	3-9-15-20	81	4-10-16-22-29
14	4-10	48	3-9-15-21	82	4-10-16-23-29
15	5-10	49	3-9-15-22	83	4-10-17-23-29
16	5-11	50	3-9-16-22	84	5-11-17-23-28
17	5-12	51	4-10-16-21	85	5-11-17-23-29

No. of Cores. (1)	Lay-up. (2)	No. of Cores. (1)	Lay-up. (2)	No. of Cores. (1)	Lay-up. (2)
18	0-6-12	52	4-10-16-22	86	5-11-17-23-30
19	1-6-12	53	4-10-16-23	87	5-11-17-24-30
20	1-7-12	54	4-10-17-23	88	5-11-18-24-30
21	1-7-13	55	4-11-17-23	89	0-6-11-18-24-30
22	2-7-13	56	5-11-17-23	90	0-6-12-18-24-30
23	2-8-13	57	5-11-17-24	91	1-6-12-18-24-30
24	2-8-14	58	5-11-18-24	92	1-6-12-18-24-31
25	2-8-15	59	5-12-18-24	93	1-6-12-18-25-31
26	3-9-14	60	0-6-12-18-24	94	1-6-12-19-25-31
27	3-9-15	61	1-6-12-18-24	95	1-6-13-19-25-31
28	3-9-16	62	1-6-12-18-25	96	1-7-13-19-25-31
29	4-10-15	63	1-7-12-18-25	97	1-7-13-19-26-31
30	4-10-16	64	1-7-13-18-25	98	2-8-13-19-25-31
31	4-10-17	65	1-7-13-19-25	99	2-8-14-19-25-31
32	5-11-16	66	1-7-13-19-26	100	2-8-14-20-25-31
33	5-11-17	67	2-8-13-19-25	-	-
34	5-11-18	68	2-8-14-19-25	-	-
35	5-12-18	69	2-8-14-20-25	-	-

Note 1 : - The figures indicate the number of cores in each successive layer, for example,

5-11-18 means 5 cores in the first, 11 cores in the second and 18 cores in the third layer, etc.

TABLE 4 - THICKNESS OF INNER SHEATH
(CLAUSE 3.4.4) (Applicable for power cable only)

Calculated Diameter over the lay up cores		Thickness of inner sheath (minimum)
Over (1) mm	Upto and including. (2) mm	(3) mm
-	25	0.3
25	35	0.4
35	45	0.5
45	55	0.6
55	-	0.7

Note : The thickness of binder tape shall not be construed as part of the inner sheath.

Table 5 (i) - DIMENSIONS OF ARMOUR- ROUND WIRES AND STRIPS
(CLAUSE 3.5.6)
(Applicable for power cable only)

Calculated Diameter of cable under Armour		Thickness of steel strip ± 10%	Diameter of round wire
Over	Upto & including		
(1) mm	(2) mm	(3) mm	(4) mm
-	13	-	1.40 ± 0.06
13	25	0.8	1.60 ± 0.08
25	40	0.8	2.00 ± 0.08
40	55	1.4	2.50 ± 0.10
55	70	1.4	3.15 ± 0.12
70	-	1.4	4.00 ± 0.12

Table 5 (ii) - DIMENSIONS OF ARMOUR- ROUND WIRES AND TAPES
(CLAUSE 3.5.6)
(Applicable for Signalling Cable only)

Calculated Diameter of cable under Armour		Cable cores	Size of DST (Width x Thickness) ± 10% on thickness and ±5% on width	Diameter of round wire
Over	Upto & including			
(1) mm	(2) Mm	(3) mm	(4) mm	(5) mm
-	13	-	-	1.40 **± 0.06**
13 and above	-	-	20 x 0.5 or 25 x 0.5	-
-	-	24 core and above	32 x 0.5 or 35 x 0.5	-

TABLE 6 - THICKNESS OF OUTER SHEATH
(CLAUSE 3.6.3)

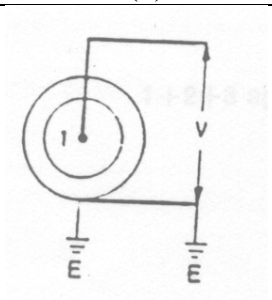
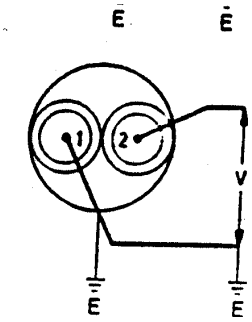
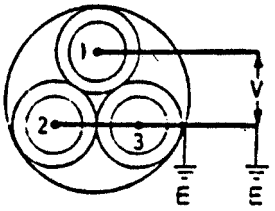
Calculated Diameter under the sheath.		Nominal thickness of sheath (ts).
Over (1) mm	Upto and including. (2) mm	(3) mm
-	15	1.8
15	25	2.0
25	35	2.2
35	40	2.4
40	45	2.6
45	50	2.8
50	55	3.0
55	60	3.2
60	65	3.4
65	70	3.6
70	75	3.8
75	-	4.0

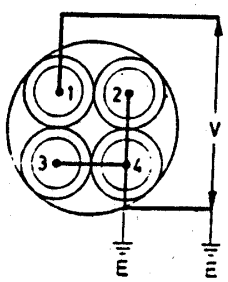
TABLE 7 - TEMPERATURE CORRECTION FACTORS FOR CONDOCTOR RESISTANCE FOR ANNEALED HIGH-CONDUCTVITY COPPER
(CLAUSE 5.7.2)

Temperature (1)	Correction Factor (2)	Temperature (1)	Correction Factor (2)	Temperature (1)	Correction Factor (2)
5	1.0638	30.5	0.9597	56	0.8741
5.5	**1.0615**	31	0.9579	56.5	0.8726
6	1.0593	31.5	0.9560	57	0.8711
6.5	1.0571	32	0.9542	57.5	0.8696
7	1.0549	32.5	0.9524	58	0.8681
7.5	1.0526	33	0.9506	58.5	0.8667
8	1.0504	33.5	0.9488	59	0.8651
8.5	1.0482	34	0.9470	59.5	0.8636
9	1.0460	34.5	0.9452	60	0.8621
9.5	1.0438	35	0.9434	60.5	0.8606
10	1.0417	35.5	0.9416	61	0.8591
10.5	1.0395	36	0.9398	61.5	0.8576
11	1.0373	36.5	0.9380	62	0.8562

11.5	1.0352	37	0.9363	62.5	0.8547
12	**1.0330**	37.5	0.9346	63	0.8532
12.5	1.0309	38	0.9328	63.5	0.8518
13	**1.0288**	38.5	0.9311	64	0.8503
13.5	1.0267	39	0.9294	64.5	0.8489
14	1.0246	39.5	0.9276	65	0.8475
14.5	1.0225	40	**0.9259**	65.5	0.8460
15	1.0204	40.5	0.9242	66	0.8446
15.5	1.0183	41	0.9225	66.5	0.8432
16	1.0163	41.5	0.9208	67	08418
16.5	1.0142	42	0.9191	67.5	0.8403
17	1.0122	42.5	0.9174	68	0.8389
17.5	1.0101	43	0.9158	68.5	0.8375
18	1.0081	43.5	0.9141	69	0.8361
18.5	1.0060	44	0.9124	69.5	0.8347
19	1.0040	44.5	0.9107	70	0.8333
19.5	1.0020	45	0.9091	70.5	0.8319
20	1.0000	45.5	0.9074	71	0.8306
20.5	0.9980	46	0.9058	71.5	0.8292
21	0.9960	46.5	0.9042	72	0.8278
21.5	0.9940	47	0.9025	72.5	0.8264
22	0.9920	47.5	0.9009	73	0.8251
22.5	0.9900	48	0.8993	73.5	0.8237
23	0.9881	48.5	0.8977	74	0.8223
23.5	0.9862	49	0.8961	74.5	0.8210
24	0.9843	49.5	0.8945	75	0.8197
24.5	0.9823	50	0.8929	75.5	0.8183
25	0.9804	50.5	0.8913	76	0.8170
25.5	0.9785	51	0.8897	76.5	0.8157
26	0.9766	51.5	0.8881	77	0.8143
26.5	0.9747	52	0.8865	77.5	0.8130
27	0.9728	52.5	0.8850	78	0.8117
27.5	0.9709	53	0.8834	78.5	0.8104
28	0.9690	53.5	0.8818	79	0.8091
28.5	0.9671	54	0.8803	79.5	0.8078
29	0.9653	54.5	0.8787	80	0.8065
29.5	0.9634	55	0.8772	-	-
30	0.9615	55.5	0.8757	-	-

TABLE 8 (i) - VOLTAGE TEST CONNECTION AND TEST PERIODS
(CLAUSE 5.12.1)
(Applicable for power cable only)

Sl. No. (1)	Type of Cable (2)	Connection Diagram (3)	Test Connection (4)	Test Period (minutes) (5)
1.	Single- core cable.		1 against E	10
2.	Two –core cable.		1 against 2+E 2 against 1+E	10 10
				Total= 20
3.	Three – core cable.		1 against 2+3+E 2 against 3+1+E 3 against 1+2+E	10 10 10
				Total= 30

4.	Four – core cable		(1+3) against (2+4+E) (1+2) against (3+4+E) (1+4) against (2+3+E)	10 10 10
				Total= 30
5.	Multi – core		A) All odd numbered cores of all layers against all even numbered cores of all layers	10
			B) First core against last core in each layer concerned, if in at least one layer the total number of cores is odd and greater than one, otherwise not required.	10
			C) All odd numbered layers against all even numbered layers.	10
				Total= 20 or 30

Note : 1- E = Armouring.

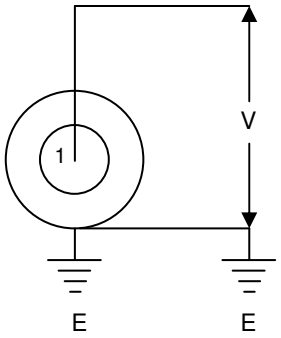
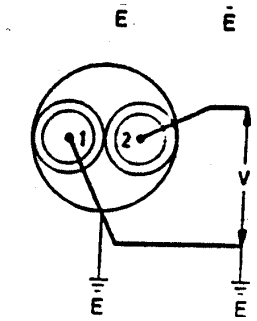
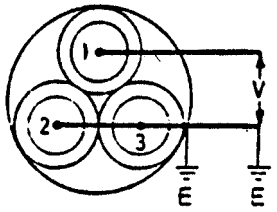
Note : 2- For multi-core unarmoured cables, voltage test shall be done between the conductor and the free core (s) bunched together and earthed as given in Sl. No. 2 to 5.

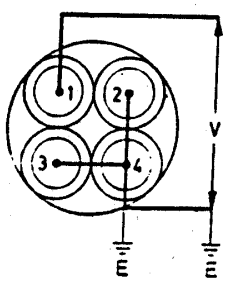
Note : 3- For single-core unarmoured cables, voltage test shall be done between the conductor and the tank with the cable under water.

Note : 4- For multi-core cables, Sl. No. 5, one pole of the power source shall be earthed and the armouring shall be treated as a layer of source.

Note : 5- During high voltage test, one pole of the power source shall be earthed.

TABLE 8 (ii) - VOLTAGE TEST CONNECTION AND TEST PERIODS
(CLAUSE 5.12.1)
(Applicable for Signalling Cable only)

Sl. No. (1)	Type of Cable (2)	Connection Diagram (3)	Test Connection (4)	Test Period (minutes) (5)
1.	Single- core cable.		1 against E	5
2.	Two –core cable.		1 against 2+E 2 against 1+E	5 5
				Total= 10
3.	Three – core cable.		1 against 2+3+E 2 against 3+1+E 3 against 1+2+E	5 5 5
				Total= 15

4.	Four – core cable		(1+3) against (2+4+E) (1+2) against (3+4+E) (1+4) against (2+3+E)	5 5 5
				Total= 15
5.	Multi – core		A) All odd numbered cores of all layers against all even numbered cores of all layers and armour.	5
			B) First core against last core in each layer concerned, if in at least one layer the total number of cores is odd and greater than one, otherwise not required.	5
			C) All odd numbered layers against all even numbered layers.	5
				Total= 10 or 15

Note : 1- E = Armouring.

Note : 2- For multi-core unarmoured cables, voltage test shall be done between the conductor and the free core (s) bunched together and earthed as given in Sl. No. 2 to 5.

Note : 3- For single-core unarmoured cables, voltage test shall be done between the conductor and the tank with the cable under water.

Note : 4- For multi-core cables, Sl. No. 5, one role of the power source shall be earthed

and the armouring shall be treated as a layer of source.

Note : 5- During high voltage test, one pole of the power source shall be earthed.

TABLE 9 – MULTIPLIER CONSTANTS FOR DETERMINING THE INSULATION RESISTANCE VALUES AT 50º C. (CLAUSE 5.13.2)

TEST TEMPERATURE º C	MULTIPLIER CONSTANT.	TEST TEMPERATURE º C	MULTIPLIER CONSTANT.
10	0.001	31	0.080
11	0.0012	32	0.100
12	0.0016	33	0.120
13	0.002	34	0.140
14	0.0026	35	0.170
15	0.0033	36	0.195
16	0.0042	37	0.225
17	0.0047	38	0.260
18	0.0063	39	0.300
19	0.008	40	0.340
20	0.01	41	0.380
21	0.0122	42	0.430
22	0.015	43	0.480
23	0.018	44	0.540
24	0.022	45	0.600
25	0.026	46	0.670
26	0.031	47	0.750
27	0.037	48	0.820
28	0.046	49	0.910
29	0.055	50	1.00
30	0.064	-	

TABLE 10 (i) -SAMPLING PLAN FOR ACCEPTANCE TEST
(CLAUSE 7,IRS:S 63/2014)
(Applicable for Power Cable only)

Sl. No. (1)	**Tests** (2)	**Sample Size (No. Of Drums)** (3)	**No. Of Test Pieces To Be Taken From Each Sample** (4)
1 (a)	Conductor dia (Cl .5.6.1)	10% subject to min. two sample from each lot.	All cores
1 (b)	Thickness of insulation (5.9.1)	-do-	-do-
1 (c)	Annealing (5.6.2)	-do-	100% upto 10 cores. 10+30% of the core in excess of 10 (Specimen shall cover all colors)
2 (a)	T.S and % elongation for armour (5.8.2) (i))	-do-	All wires/strip from two drum & 4 wires/strip from each of the remaining sampled drums.
2 (b)	Torsion test (5.8.3)	-do-	One wire from each of the sampled drums.
2 (c)	Winding test (5.8.4)	-do-	One strip from each of the sampled drum.
2 (d)	Test for zinc coating (5.8.5) (i) (a))	-do-	All wire/strip from two randomly selected drums and 2 wires from each of the other sampled drums
2 (e)	Test for uniformity of zinc coating (5.8.5) (i) (b))	-do-	Four wires/strip from each of the sampled drums.
2 (f)	Resistivity test (5.8.6)	-do-	Two wires from each lot
2 (g)	Test for closeness & overriding of wire/strip (5.8.7)	-do-	All sampled drums
3.	Thickness of insulation and sheath (5.9)	-do-	All sampled drums
4 (a) (i)	T.S. & % elongation of sheath (5.10.1) (i)	-do-	Four samples from each sheath from each sample drum
4 (a) (ii)	Ageing & Loss of Mass Tests of sheaths (5.10.1) (i) & 5.10.4	4%(out of 10% for physical test) subject to min. 2 drums	Four samples from each sheath from each sample drum
4 (b) (i)	T.S. & % elongation of insulation (5.10.1) (i)	10% subject to min. 2 samples from each lot.	100% upto 12 cores. 12+20% of the cores in excess of 12 (Specimen shall cover all colours)
4 (b) (ii)	Ageing & Loss of Mass Tests of insulation (5.10.1 (i) & 5.10.4)	4%(out of 10% for physical test) subject to min. 2 drums	Two samples of cores of each colour from each sampled drum
4 (c)	Specific gravity of insulation (5.10.12)	- do -	Two samples of cores from each sampled drum (sample shall cover all colours)

4 (d)	Specific gravity of PVC sheath (5.10.12)	- do -	One sample of each sheath from each sampled drum.
4 (e)	Thermal Stability Test for insulation (5.10.11)	- do -	100% for sample taken from in between two sample from each sampled drum. (sample shall cover all colours)
4 (f)	Thermal Stability Test for sheaths (5.10.11)	- do -	Two samples of each sheath from each sampled drum.
5 (a)	Shrinkage test for insulation (5.10.2)	- do -	One sample of core of each colour from each sampled drum.
5 (b)	Shrinkage test for sheath (5.10.2.)	- do -	One sample of each sheath from a lot.
6	Flammability test (5.11)	-	Minimum one sample from the lot.
7	Specific resistance test (5.7.4)	- do -	One sample of core of each colour from a lot.
8	Conductor resistance test (5.7)	25% subject to minimum 2 drums.	All cores.
9 (a)	High voltage test (5.12.1)	- do -	- do -
9 (b)	High voltage test (5.12.1.1)	Not applicable	- -
10 (a)	I.R. test (5.13.2)	All drums except covered under H.V. Test (5.12.1)	All cores.
10 (b)	I.R. test (5.13.3)	4% subject to minimum 2 drums.	- do -
11	Water immersion test (5.14.1)	4% subject to minimum 2 drum.	- do -
12	Visual inspection (5.15) and Sequential marking (4.2)	4% subject to minimum 2 drum.	On complete drum length.

Note: (1) At least one sample to be taken from in between 100mtr to 900mtr length from randomly selected drum computerized generated by DI from his office. This will be one of the sample for all tests.

(2) DI or his authorized person should pick up one small piece of sample from each lot and secure it in their office duly identified. This sample shall be tested after 6 months to see the change in various parameter vis-à-vis specified values. Specified value shall be same as in specification.

(3) Sampling rate shall be doubled for all tests as and when there is rejection of a firm in acceptance test. Normalization should be done when at least 3 lots thereafter pass successfully.

TABLE 10(ii)-SAMPLING PLAN FOR ACCEPTANCE TEST
(CLAUSE 7, IRS:S 63/2014)
(Applicable for Signalling Cable only)

Sl. No. (1)	**Tests** (2)	**Sample Size (No. Of Drums)** (3)	**No. Of Test Pieces To Be Taken From Each Sample** (4)
1 (a)	Conductor dia (Cl .5.6.1)	10% subject to min. two sample from each lot.	All cores
1 (b)	Thickness of insulation (5.9.1)	-do-	-do-
1 (c)	Annealing (5.6.2)	-do-	100% upto 10 cores. 10+30% of the core in excess of 10 (Specimen shall cover all colors)
2 (a)	T.S and % elongation for armour (5.8.2 (ii))	-do-	All wires from two drum & 4 wires from each of the remaining sampled drums. In case of Double steel tape (D.S.T.), both the tapes from each sampled drum.
2 (b)	Torsion test (5.8.3)	-do-	One wire from each of the sampled drums.
2 (c)	Winding test (5.8.4)	-do-	Both the tapes from each sampled drum.
2 (d)	Test for mass of zinc coating (5.8.5 (ii) (a))	-do-	All wire from two randomly selected drums and 2 wires from each of the other sampled drums. In case of D.S.T., both the tapes from each sampled drum.
2 (e)	Test for uniformity of zinc coating (5.8.5 (ii) (b))	-do-	Four wires from each of the sampled drums. In case of D.S.T., both the tapes from each sampled drum.
2 (f)	Resistivity test (5.8.6)	-do-	Two wires from each lot
2 (g)	Test for closeness & overriding of wire (5.8.7)	-do-	All sampled drums
2 (h)	Test of closeness of tapes (5.8.8)	-do-	Both the tapes from each sampled drum.
3.	Thickness of insulation and sheath (5.9)	-do-	All sampled drums
4 (a) (i)	T.S. & % elongation of sheath (5.10.1) (ii)	-do-	Four samples from each sheath from each sampled drum
4 (a) (ii)	Ageing & Loss of Mass Tests of sheaths (5.10.1) (ii) & 5.10.4	4%(out of 10% for physical test) subject to min. 2 drums	Four samples from each sheath from each sampled drum
4 (b) (i)	T.S. & % elongation of insulation (5.10.1) (ii)	10% subject to min. 2 samples from each lot.	100% upto 12 cores. 12+20% of the cores in excess of 12 (Specimen shall cover all colours)

4 (b) (ii)	Ageing & Loss of Mass Tests of insulation (5.10.1) (ii) & 5.10.4	4%(out of 10% for physical test) subject to min. 2 drums	Two samples of cores of each colour from each sampled drum
4 (c)	Specific gravity of insulation (5.10.12)	- do -	Two samples of cores from each sampled drum (sample shall cover all colours)
4 (d)	Specific gravity of PVC sheath (5.10.12)	- do -	One sample of each sheath from each sampled drum.
4 (e)	Thermal Stability Test for insulation (5.10.11)	- do -	100% for sample taken from in between two sample from each sampled drum. (sample shall cover all colours)
4 (f)	Thermal Stability Test for sheaths (5.10.11)	- do -	Two samples of each sheath from each sampled drum.
5 (a)	Shrinkage test for insulation (5.10.2)	- do -	One sample of core of each colour from each sampled drum.
5 (b)	Shrinkage test for sheath (5.10.2.)	- do -	One sample of each sheath from a lot.
6	Flammability test (5.11)	-	Minimum one sample from the lot.
7	Specific resistance test (5.7.4)	4%(out of 10% for physical test) subject to min. 2 drums	One sample of core of each colour from a lot.
8	Conductor resistance test (5.7)	25% subject to minimum 2 drums.	All cores.
9 (a)	High voltage test (5.12.1)	- do -	- do -
9 (b)	High voltage test (5.12.1.1)	All drums except covered under H.V. Test (5.12.1)	- do -
10 (a)	I.R. test (5.13.2)	- do -	- do -
10 (b)	I.R. test (5.13.3)	4% subject to minimum 2 drums.	- do -
11	Water immersion test (5.14.1)	4% subject to minimum 2 drum.	- do -
12	Visual inspection (5.15) and Sequential marking (4.2)	4% subject to minimum 2 drum.	On complete drum length.

Note: (1) At least one sample to be taken from in between 100mtr to 900mtr length from randomly selected drum computerized generated by DI from his office. This will be one of the samples for all tests.

(2) DI or his authorized person should pick up one small piece of sample from each lot and secure it in their office duly identified. This sample shall be tested after 6 months to see the change in various parameter vis-à-vis specified values. Specified value shall be same as in specification

(3) Sampling rate shall be doubled for all tests as and when there is rejection of a firm in acceptance test. Normalization should be done when at least 3 lots thereafter pass successfully.