TIS 11-2531(1988)

Thai Industrial Standard
For
PVC Insulated Copper Cables

1. Scope

1.1 This standard specifics types, sizes, materials and construction, requirements, packing, mark and label, sampling and criteria for conformity, and testing for PVC insulated copper cables of rated voltages not exceeding 750V which shall be referred to be hereinafter as "cables".

1.2 This standard covers cables for use at conductor temperature not exceeding 70°C having from 1 to 4 cores (excluding ground conductor) which are intended for use with an a.c.current system not exceeding 60 Hz in frequency and with direct current; it does not include PVC sheathed copper cables which are covered by a particular standard.

2. Definitions

For the purpose of this standard, the following definitions apply.

2.1 POLYVINYL CHLORIDE COMPUND or PVC : Combination of materials suitably selected, proportioned and treated, of which the characteristic constituent is the plastomer polyvinyl chloride or one of its copolymers. The same term also designates compounds containing both polyvinyl chloride and certain of its polymers.

2.2 RATED VOLTAGE : The voltage expressed by the r.m.s. value or the d.c. core to core voltage.

Note : 1. In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended.

2. In a direct current system, the nominal voltage of the system shall be at least 0.7 times the rated voltage of the cable.

3. The operating voltage of a system may permanently exceed the nominal voltage of such a system by 10%. A cable can be used at a 10% higher operating voltage than its rated voltage if the latter is at least equal to the nominal voltage of the system.

2.3 CONDUCTOR : Copper wire of circular cross-section, whether singular of standard in bundle.

2.4 STRANDED CONDUCTOR : A group of seven or more wires concentrically stranded.

2.5 INSULATION : An electrical insulating medium which prevents, direct contact between the conductor and conductor or other objects.

2.6 CORE : A single conductor of a cable with its insulation.

2.7 SHEATH : An outer protective covering of polyvinyl chloride or other applied to the core; a single layer of the covering shall be referred to as the sheath, two layers shall be referred to as inner or outer covering.

2.8 CABLE : A length of insulated solid or stranded conductor single, or more, laid together and might have some kind of covering for the purpose of protection.

2.9 CORD : A cable containing not more than 4 cores excluding ground conductor, each formed of a group of wires, the diameter of the core and of the wire being sufficiently small to afford flexibility.

2.10 FLAT CABLE : A sheathed flat cable or cord containing two or more cores excluding ground conductor.

2.11 FLAT TWIN CORD : A non-sheathed flat cord containing two cores (excluding ground conductor) connected together.

2.12 STRANDED CORE : Two or more single-core cords twisted together, non sheathed.

2.13 LAY RATIO : The ratio of the axial length of complete turn of the helix, formed by core of a cable or a wire of a stranded conductor, to the mean outside diameter of the helix.

2.14 MEDIAN VALUE : When several test results have been obtained and ordered in an increasing or decreasing succession, the middle value if the number of available values is odd, and is the mean of the two middle values if the number is even.

3. Types

Cables in this standard are classified into 2 types according to the rated voltage as follows :

3.1 Cables having a rated voltage of not exceeding 300 V

3.2 Cables having a rated voltage of not exceeding 750 V

4. Sizes

4.1 The sizes and particulars of cables shall be as given in Tables 1 to 17.

Table 1
Insulated cables, single-core, rated voltage 300 V
(clause 4.1)

Nominal cross-sectional area **mm^2**	Number and diameter of wires in conductor **No./mm**	Thickness of Insulation **mm**	Diameter of cable **Mm**	Resistance of insulation at 70°C min **MΩ.km**
0.5	1/0.80	0.6	2.6	0.014 6
1	1/1.13	0.6	2.9	0.011 5
1	7/0.40	0.6	3.1	0.011 0
1.5	1/1.38	0.6	3.2	0.010 0
1.5	7/0.50	0.6	3.4	0.009 4
2.5	1/1.78	0.7	3.8	0.009 2
2.5	7/0.67	0.7	4.1	0.008 4
4	1 /2.25	0.8	4.5	0.008 6
4	7/0.85	0.8	4.9	0.007 8
6	7/1.04	0.8	5.6	0.006 6
10	7/1.35	1.0	7.0	0.006 4
16	7/1.70	1.0	8.2	0.005 3
25	7/2.14	1.2	10.0	0.005 1
35	19/1.53	1.2	11.5	0.004 3
50	19/1.78	1.4	13.0	0.004 4
70	19/2.14	1.4	15.0	0.003 7
95	19/2.52	1.6	17.5	0.003 6
120	37/2.03	1.6	19.0	0.003 2
150	37/2.25	1.8	21.5	0.003 3

Table 2
Insulated and sheathed cables, single-core. flat two-core
and flat three-core, rated voltage 300 V
(clause 4.1)

Nominal cross-sectional area **mm^2**	Number and diameter of wires in conductor **No./mm**	Thickness of wire **mm**	Thickness of sheath **mm**			Diameter of cable, mm					Resistance of insulation at 70°C,max. **MΩ.km**
			Single core	Two core	Three core	Single Core	Flat two-core		Flat three-core		
							Lower limit	Upper limit	Lower limit	Upper limit	
0.5	1/0.80	0.6	0.9	0.9	0.9	4.4	3.6 x 5.6	4.4 x 6.8	3.6 x 7.4	4.4 x 9.0	0.014 6
1	13	0.6	0.9	0.9	0.9	4.8	4.0 x 6.2	4.8 x 7.4	4.0 x 8.4	4.8 x 10.0	0.011 5
1	7/0.40	0.6	0.9	0.9	0.9	5.0	4.0 x 6.4	5.0 x 7.8	4.0 x 8.6	5.0 x 10.5	0.011 0
1.5	1/1.38	0.6	0.9	1.2	1.2	5.2	4.8 x 7.2	5.8 x 8.6	4.8 x 9.8	5.8 x 11.5	0.010 0
1.5	7/0.50	0.6	0.9	1.2	1.2	5.4	4.9 x 7.4	6.0 x 9.2	4.9 x 10.0	6.0 x 12.5	0.009 4
2.5	1/1.78	0.7	0.9	1.2	1.2	5.8	5.4 x 8.4	6.4 x 10.0	5.4 x 11.5	6.4 x 13.5	0.009 2
2.5	7/0.67	0.7	0.9	1.2	1.2	6.2	5.6 x 8.8	6.8 x 10.5	5.6 x 12.0	6.8 x 14.5	0.008 4
4	1 /2.25	0.8	0.9	1.2	1.2	6.6	6.0 x 9.8	7.2 x 11.5	6.0 x 13.5	7.2 x 16.0	0.008 6
4	7/0.85	0.8	0.9	1.2	1.2	7.0	6.2 x 10.0	7.6 x 12.0	6.2 x 14.0	7.6 x 16.5	0.007 8
6	7/1.04	0.8	0.9	1.2	1.2	7.6	6.8 x 11.0	8.2 x 13.5	6.8 x 16.0	8.2 x 18.5	0.006 6
10	7/1.35	0.9	0.9	1.2	1.2	8.6	8.0 x 13.5	9.4 x 16.0	8.0 x 19.0	9.4 x 22.0	0.005 9
16	7/1.70	1.0	1.2	1.2	1.4	11.0	9.2 x 16.0	11.0 x 18.5	9.6 x 23.0	11.5 x 26.5	0.005 3
25	7/2.14	1.2	1.2	1.4	-	12.5	11.0 x 19.5	13.0 x 22.5	-	-	0.005 1
35	19/1.53	1.2	1.2	1.4	-	14.0	12.0 x 22.0	14.5 x 25.0	-	-	0.004 3

Table 3
Insulated and sheathed multi-core cables, rated voltage 300 V
(clause 4.1)

Nominal Cross-sectional area **mm^2**	Number and diameter of wires in conductor **No./mm**	Thickness of insulation **mm**	Thickness of sheath **mm**			Diameter of cable **mm**			Resistance of insulation at 70°C, min. **MΩ.km**
			2- core	3-core	4-core	2-core	3-core	4-core	
0.5	1/0.80	0.6	0.9	0.9	0.9	6.8	7.2	7.8	0.014 6
1	1/1.13	0.6	0.9	0.9	0.9	7.6	8.0	8.6	0.011 5
1	7/0.40	0.6	0.9	0.9	0.9	8.0	8.4	9.0	0.011 0
1.5	1/1.38	0.6	1.2	1.2	1.2	8.8	9.2	10.0	0.010 0
1.5	7/0.50	0.6	1.2	1.2	1.2	9.2	9.6	10.5	0.009 4
2.5	1/1.78	0.7	1.2	1.2	1.2	10.0	10.5	11.5	0.009 2
2.5	7/0.67	0.7	1.2	1.2	1.2	11.0	11.5	12.5	0.008 4
4	1 /2.25	0.8	1.2	1.2	1.2	11.5	12.5	13.5	0.008 6
4	7/0.85	0.8	1.2	1.2	1.2	12.5	13.0	14.0	0.007 8
6	7/1.04	0.8	1.2	1.2	1.2	13.5	14.5	15.5	0.006 6
10	7/1.35	0.9	1.2	1.2	1.4	16.0	17.0	19.0	0.005 9
16	7/1.70	1.0	1.4	1.4	1.4	19.0	20.0	22.0	0.005 3
25	7/2.14	1.2	1.4	1.8	1.8	22.5	25.0	27.5	0.005 1
35	19/1.53	1.2	1.4	1.8	1.8	25.5	28.0	30.5	0.004 3

Table 4
Insulated cables, single-core, rated voltage 750 V
(clause 4.1)

Nominal cross-sectional area **mm^2**	Number and diameter of wires in conductor **No./mm**	Thickness of insulation **mm**	Diameter of cable **mm**	Resistance of insulation at 70°C min **MΩ.km**
0.5	1/0.80	0.8	3.0	0.017 5
1	1/1.13	0.8	3.3	0.014 1
1	7/0.40	0.8	3.5	0.013 5
1.5	1/1.38	0.8	3.6	0.012 3
1.5	7/0.50	0.8	3.8	1.011 6
2.5	1/1.78	0.8	4.0	0.010 2
2.5	7/0.67	0.8	4.3	0.009 3
4	1 /2.25	0.9	4.8	0.009 4
4	7/0.85	0.9	5.2	0.008 5
6	7/1.04	0.9	5.8	0.007 3
10	7/1.35	1.1	7.2	0.006 9
16	7/1.70	1.1	8.4	0.005 7
25	7/2.14	1.3	10.5	0.005 4
35	19/1.53	1.3	11.5	0.004 7
50	19/1.78	1.5	13.5	0.004 6
70	19/2.14	1.5	15.5	0.003 9
95	19/2.52	1.7	18.0	0.003 8
120	37/2.03	1.7	19.5	0.003 4
150	37/2.25	1.9	21.5	0.003 4
185	37/2.52	2.1	24.0	0.003 4
240	61/2.25	2.3	27.0	0.003 3
300	61/2.52	2.5	30.0	0.003 2
400	61/2.85	2.7	33.5	0.003 0
500	61/3.20	3.1	38.0	0.003 1

Table 5
Insulated and sheathed cables, single-core. flat two-core
rated voltage 750 V
(clause 4.1)

Nominal cross-sectional area **mm^2**	Number and diameter of wires in conductor **No./mm**	Thickness of insula-tion **mm**	Thickness of sheath, **mm**		Diameter of cable, **mm**			Resistance of insulation at 70°C, min **MΩ.km**
			Single core	Flat two-core	Single core	Flat two-core		
						Lower limit	Upper limit	
1	1/1.13	0.8	1.0	1.4	5.4	5.2 x 8.0	6.4 x 9.4	0.014 1
1	7/0.40	0.8	1.0	1.4	5.6	5.4 x 8.0	6.6 x 9.8	0.013 5
1.5	1/1.38	0.8	1.0	1.4	5.8	5.6 x 8.4	6.6 x 10.0	0.012 3
1.5	7/0.50	0.8	1.0	1.4	6.0	5.6 x 8.6	7.0 x 10.5	0.011 6
2.5	1/1.78	0.8	1.2	1.4	6.6	5.8 x 9.2	7.2 x 11.0	0.010 2
2.5	7/0.67	0.8	1.2	1.4	7.0	6.2 x 9.6	7.4 x 11.5	0.009 3
4	1 /2..25	0.9	1.2	1.4	7.4	6.6 x 10.5	7.8 x 12.5	0.009 4
4	7/0.85	0.9	1.2	1.4	7.8	6.8 x 11.0	8.2 x 13.0	0.008 5
6	7/1.04	0.9	1.4	1.4	8.8	7.4 x 12.0	8.8 x 14.5	0.007 3
10	7/1.35	1.1	1.4	1.5	10.5	8.8 x 15.0	10.5 x 17.0	0.006 9
16	7/1.70	1.1	1.5	1.5	11.5	9.8 x 17.0	11.5 x 19.5	0.005 7
25	7/2.14	1.3	1.5	1.6	13.5	11.5 x 20.5	13.5 x 23.5	0.005 4
35	19/1.53	1.3	1.6	1.7	15.0	13.0 x 23.0	15.0 x 26.5	0.004 7

Table 6
Insulated and sheathed cables, single-core, rated voltage 750 V
(clause 4.1)

Nominal cross-sectional area **mm^2**	Number and diameter of wires in conductor **No./mm**	Thickness of insulation **mm**	Thickness of sheath **mm**	Diameter of cable **mm**	Resistance of insulation at 70°C min **MΩ.km**
1	1/1.13	1.5	1.8	8.6	0.020 7
1	7/0.40	1.5	1.8	8.8	0.020 0
1.5	1/1.38	1.5	1.8	9.0	0.018 4
1.5	7/0.50	1.5	1.8	9.2	0.017 5
2.5	1/1.78	1.5	1.8	9.4	0.015 7
2.5	7/0.67	1.5	1.8	9.8	0.014 6
4	1 /2.25	1.5	1.8	10.0	0.013 5
4	7/0.85	1.5	1.8	10.5	0.012 4
6	7/1.04	1.5	1.8	11.0	0.010 7
10	7/1.35	1.5	1.8	12.0	0.008 8
16	7/1.70	1.5	1.8	13.0	0.007 4
25	7/2.14	1.5	1.8	14.5	0.006 1
35	19/1.53	1.5	1.8	16.0	0.005 3
50	19/1.78	1.5	1.8	17.0	0.004 6
70	19/2.14	1.5	1.8	19.0	0.003 9
95	19/2.52	1.7	1.8	21.5	0.003 8
120	37/2.03	1.7	1.8	23.0	0.003 4
150	37/2.25	1.9	2.0	26.0	0.003 4
185	37/2.52	2.1	2.0	28.0	0.003 4
240	61/2.25	2.3	2.2	31.5	0.003 3
300	61/2.52	2.5	2.2	35.0	0.003 2
400	61/2.85	2.7	2.2	38.5	0.003 0
500	61/3.20	3.1	2.4	43.0	0.003 1

Table 7
Insulated multi-core cables, with inner and outer coverings,
rated voltage 750 V
(clause 4.1)

Nominal cross-sectional area **mm^2**	Number and diameter of wires in conductor **No./mm**	Thickness of insulation **mm**	Thickness of inner coverings, **mm**			Thickness of outer covering, **mm**			Diameter of cable **mm**			Resistance of insulation at 70°C, min **MΩ.km**
			2- core	3-core	4-core	2-core	3-core	4-core	2-core	3-core	4-core	
1	1/1.13	0.8	0.8	0.8	0.8	1.8	1.8	1.8	12.0	12.5	13.5	0.014 1
1	7/0.40	0.8	0.8	0.8	0.8	1.8	1.8	1.8	12.5	13.0	14.0	0.013 5
1.5	1/1.38	0.8	0.8	0.8	0.8	1.8	1.8	1.8	12.5	13.0	14.0	0.012 3
1.5	7/0.50	0.8	0.8	0.8	0.8	1.8	1.8	1.8	13.0	13.5	14.5	0.011 6
2.5	1/1.78	0.8	0.8	0.8	0.8	1.8	1.8	1.8	13.5	14.0	15.0	0.010 2
2.5	7/0.67	0.8	0.8	0.8	0.8	1.8	1.8	1.8	14.0	15.0	16.0	0.009 3
4	1 /2.25	0.9	0.8	0.8	0.8	1.8	1.8	1.8	15.0	15.5	17.0	0.009 4
4	7/0.85	0.9	0.8	0.8	0.8	1.8	1.8	1.8	15.5	16.5	17.5	0.008 5
6	7/1.04	1.9	0.8	0.8	0.8	1.8	1.8	1.8	17.0	18.0	19.0	0.007 3
10	7/1.35	1.1	0.8	0.8	0.8	1.8	1.8	2.0	19.5	20.5	23.0	0.006 9
16	7/1.70	1.1	0.8	1.2	1.2	2.0	2.0	2.0	22.5	24.5	26.5	0.005 7
25	7/2.14	1.3	1.2	1.2	1.2	2.0	2.0	2.0	27.0	28.5	31.0	0.005 4
35	19/1.53	1.3	1.2	1.2	1.5	2.0	2.0	2.2	29.5	31.5	35.0	0.004 7
50	19/1.78	1.5	1.2	1.5	1.5	2.2	2.2	2.2	33.5	36.0	39.5	0.004 6
70	19/2.14	1.5	1.5	1.5	1.5	2.2	2.2	2.4	38.0	40.5	44.5	0.003 9
95	19/2.52	1.7	1.5	1.5	1.8	2.2	2.4	2.6	42.5	46.0	51.5	0.003 8
120	37/2.03	1.7	1.5	1.8	1.8	2.4	2.6	2.8	46.5	50.5	56.0	0.003 4
150	37/2.25	1.9	1.8	1.8	2.0	2.6	2.8	3.0	52.0	56.0	62.0	0.003 4
185	37/2.52	2.1	1.8	2.0	2.0	2.8	3.0	3.2	57.0	61.5	68.0	0.003 4
240	61/2.25	2.3	2.0	2.0	2.2	3.0	3.2	3.4	64.0	69.0	76.5	0.003 3
300	61/2.52	2.5	2.0	2.2	2.2	3.2	3.4	3.8	70.5	76.0	85.0	0.003 2

Table 8
Insulated three-core cables, with inner and outer coverings and neutral conductor
rated voltage 750 V
(clause 4.1)

Nominal cross-sectional area, **mm^2**		Number and diameter of wires in conductor **No./mm**		Thickness of insulation **mm**		Thickness of inner covering	Thickness of outer covering	Diameter of cable	Resistance of insulation at 70°C, min
Phase	Neutral	Phase	Neutral	Phase	Neutral	**mm**	**mm**	**mm**	**MΩ.km**
6	4	7/1.04	7/0.85	0.9	0.9	0.8	1.8	19.0	0.007 3
10	6	7/1.35	7/1.04	1.1	0.9	0.8	2.0	23.0	0.006 9
16	10	7/1.70	7/1.35	1.1	1.1	1.2	2.0	26.5	0.005 7
25	16	7/2.14	7/1.70	1..3	1.1	1.2	2.0	31.0	0.005 4
35	16	19/1.53	7/1.70	1.3	1.1	1.5	2.2	35.0	0.004 7
50	25	19/1.78	7/2.14	1.5	1.3	1.5	2.2	39.5	0.004 6
70	35	19/2.14	19/1.53	1.5	1.3	1.5	2.4	44.5	0.003 9
95	50	19/2.52	19/1.78	1.7	1.5	1.8	2.6	51.5	0.003 8
120	70	37/2.03	19/2.14	1.7	1.5	1.8	2.8	56.0	0.003 4
150	70	37/2.25	19/2.14	1.9	1.5	2.0	3.0	62.0	0.003 4
185	95	37/2.52	19/2.52	2.1	1.7	2.0	3.2	68.0	0.003 4
240	120	61/2.25	37/2.03	2.3	1.7	2.2	3.4	76.5	0.003 3
300	150	61/2.52	37/2.25	2.5	1.9	2.2	3.8	84.5	0.003 2

Note : The colour grey shall be used for identifcation of core intended for use as neutral conductor.

Table 9
Insulated and sheathed multi-core cords, rated voltage 750 V
(clause 4.1)

Nominal Cross-sectional area **mm^2**	Number and diameter of wires in conductor **No./mm**	Thickness of insulation **mm**	Thickness of sheath **mm**				Diameter of cable **mm**				Resistance of insulation at 70°C, min **MΩ.km**
			1-core	2- core	3-core	4-core	1-core	2-core	3-core	4-core	
0.5	16/0.20	0.8	1.0	1.2	1.2	1.4	5.4	8.8	9.2	10.5	1.016 0
0.75	24/0.20	0.8	1.0	1.2	1.2	1.4	5.6	9.2	9.6	11.0	0.014 0
1	32/0.20	0.8	1.2	1.2	1.4	1.6	6.2	9.6	10.5	12.0	0.012 7
1.5	30/0.25	0.8	1.2	1.4	1.4	1.6	6.6	11.0	11.5	12.5	0.011 1
2.5	50/0.25	0.8	1.2	1.4	1.4	1.6	7.4	12.5	13.0	15.0	0.009 2
4	56/0.30	0.9	1.4	1.6	1.6	1.8	8.6	14.5	15.5	17.0	0.008 4
6	84/0.30	0.9	1.4	1.6	1.8	2.0	9.4	16.0	17.5	19.5	0.007 1
10	80/0.40	1.1	1.8	1.8	2.0	2.2	12.0	20.0	21.5	24.0	0.006 8
16	126/0.40	1.1	1.8	2.2	2.4	2.6	13.5	23.0	25.0	28.0	0.005 0
25	196/0.40	1.3	2.2	2.4	2.6	2.8	16.0	27.5	30.0	33.0	0.004 8
35	276/0.40	1.3	2.2	2.6	2.8	3.1	17.5	31.0	33.5	37.0	0.004 1
50	396/0.40	1.5	2.6	-	-	-	21.0	-	-	-	0.004 0
70	360/0.50	1.5	2.6	-	-	-	23.0	-	-	-	0.003 4
95	475/0.50	1.7	3.0	-	-	-	26.5	-	-	-	0.003 4

Table 10
Stranded core cables and flat twin cables, rated voltage 300 V
(clause 4.1)

Nominal cross-sectional area, **mm^2**	Number and diameter of wires in conductor **No./mm**	Thick-ness of insula-tion **mm**	Diameter of cable, mm			Resistance of Insulation at 70°C, min **MΩ.km**
			Strand-ed core	Flat twin		
				Lower limit	Upper limit	
0.5	16/0.20	0.8	3.2	2.4 x 4.9	3.2 x 6.2	0.016 0
0.5	28/0.15	0.8	3.2	2.4 x 4.8	3.2 x 6.2	0.016 0
0.75	24/0.20	0.8	3.4	2.6 x 5.2	3.4 x 6.6	0.014 0
0.75	42/0.15	0.8	3.4	2.6 x 5.2	3.4 x 6.6	0.014 0
1	32/0.20	0.8	3.6	2.8 x 5.6	3.6 x 7.0	0.012 7
1.5	30/0.25	0.8	3.9	3.0 x 6.0	3.9 x 7.6	0.011 1
2.5	50/0.25	0.8	4.8	3.5 x 7.0	4.8 x 9.4	0.009 2

Table 11
Flat two- and three-core cable, with ground conductor,
rated voltage 300 V
(clause 4.1)

Nominal cross- sectional area **mm^2**		Number and diameter of wires in conductor **No./mm**		Thickness of insulation **mm**		Thickness of sheath **mm**		Diameter of cable, mm				Resistance of insulation at 70°C, min.
								Flat two-core		Flat three-core		
Phase	Ground	Phase	Ground	Phase	Ground	2-core	3-core	Lower limit	Upper limit	Lower limit	Upper limit	**MΩ.km**
1	1	1/1.13	1/1.13	0.6	0.6	0.9	0.9	4.0 x 8.4	4.8 x 10.0	4.0 x 10.5	4.8 x 12.5	0.011 5
1	1	7/0.40	7/0.40	0.6	0.6	0.9	0.9	4.0 x 8.6	5.0 x 10.5	4.0 x 11.0	5.0 x 13.5	0.011 0
1.5	1	1/1.38	1/1.13	0.6	0.6	1.2	1.2	4.8 x 9.4	5.8 x 11.5	4.8 x 12.0	5.8 x 14.0	0.010 0
1.5	1	7/0.50	7/0.40	0.6	0.6	1.2	1.2	4.9 x 9.8	6.0 x 12.0	4.9 x 12.5	6.0 x 15.0	0.009 4
2.5	1.5	1/1.78	1/1.38	0.7	0.6	1.2	1.2	5.4 x 10.5	6.4 x 13.0	5.4 x 14.0	6.4 x 16.5	0.009 2
2.5	1.5	7/0.67	7/0.50	0.7	0.6	1.2	1.2	5.6 x 11.5	6.8 x 14.0	5.6 x 14.5	6.8 x 17.5	0.008 4
4	2.5	1/ 2.25	1/ 1.78	0.8	0.6	1.2	1.2	6.0 x 12.5	7.2 x 15.0	6.0 x 16.0	7.2 x 19.0	0.008 6
4	2.5	7/0.85	7/0.67	0.8	0.6	1.2	1.2	6.2 x 13.0	7.6 x 16.0	6.2 x 17.5	7.6 x 20.5	0.007 8
6	4	7/1.04	7/0.85	0.8	0.6	1.2	1.2	6.8 x 15.0	8.2 x 17.5	6.8 x 19.5	8.2 x 22.5	0.006 6
10	4	7/1.35	7/0.85	0.9	0.6	1.2	1.2	8.0 x 17.0	9.4 x 20.0	8.0 x 22.5	9.4 x 26.0	0.005 9
16	6	7/1.70	7/1.04	1.0	0.6	1.2	1.4	9.2 x 20.0	11.0 x 23.0	9.6 x 27.5	11.0 x 31.5	0.005 3
25	6	7/2.14	7/1.04	1.2	0.6	1.4	-	11.0 x 24.0	13.0 x 27.0	-	-	0.005 1
35	10	19/1.53	7/1.35	1.2	0.6	1.4	-	12.0 x 27.0	14.5 x 31.0	-	-	0.004 3

Table 12
Insulated and sheathed cable, multi-core, with ground conductor,
rated voltage 300 V
(clause 4.1)

Nominal cross-sectional area **mm^2**		Number and diameter of wires in conductor **No./mm**		Thickness of insulation **mm**		Thickness of sheath **mm**			Diameter of cable **mm**			Resistance of insulation at 70°C, min.
Phase	Ground	Phase	Ground	Phase	Ground	2-core	3-core	4-core	2-core	3-core	4-core	**MΩ.km**
1	1	1/1.3	1/1.13	0.6	0.6	0.9	0.9	0.9	8.0	8.6	9.2	0.011 5
1	1	7/0.40	7/0.40	0.6	0.6	0.9	0.9	0.9	8.4	9.0	9.8	0.011 0
1.5	1	1/1.38	1/1.13	0.6	0.6	1.2	1.2	1.2	9.2	10.0	11.0	0.010 0
1.5	1	7/0.50	7/0.40	0.6	0.6	1.2	1.2	1.2	9.6	10.5	11.5	0.009 4
2.5	1.5	1/1.78	1/1.38	0.7	0.6	1.2	1.2	1.2	10.5	11.5	12.5	0.009 2
2.5	1.5	7/0.67	7/0.50	0.7	0.6	1.2	1.2	1.2	11.5	12.5	13.5	0.008 4
4	2.5	1/2.25	1/1.78	0.8	0.6	1.2	1.2	1.2	12.5	13.5	14.5	0.008 6
4	2.5	7/0.85	7/0.67	0.8	0.6	1.2	1.2	1.2	13.0	14.0	15.5	0.007 8
6	4	7/1.04	7/0.85	0.8	0.6	1.2	1.2	1.2	14.5	15.5	17.0	0.006 6
10	4	7/1.35	7/0.85	0.9	0.6	1.2	1.2	1.4	16.0	18.5	20.5	0.005 9
16	6	7/1.70	7/1.04	1.0	0.6	1.4	1.4	1.4	19.0	22.0	24.5	0.005 3
25	6	7/2.14	7/1.04	1.2	0.6	1.4	1.8	1.8	22.5	27.5	30.0	0.005 1
35	10	19/1.53	7/1.35	1.2	0.6	1.4	1.8	1.8	25.5	30.5	33.5	0.004 3

Table 13
Flat two-core cable with ground conductor, rated voltage 750 V
(Clause 4.1)

Nominal cross-sectional area **mm^2**		Number of wires in conductor **No./mm**		Thickness of insulation **mm**		Thickness of sheath **mm**	Diameter of cable **mm**		Resistance of insulation at 70°C, min. **MΩ.km**
Phase	Ground	Phase	Ground	Phase	Ground		Lower limit	Upper Limit	
1	1	1/1.13	1/1.13	0.8	0.6	1.4	5.2 x 10.0	6.4 x 12.0	0.014 1
1	1	7/0.40	7/0.40	0.8	0.6	1.4	5.4 x 10.0	6.6 x 12.5	0.013 5
1.5	1	1/1.38	1/1.13	0.8	0.6	1.4	5.6 x 10.5	6.6 x 12.5	0.012 3
1.5	1	7/0.50	7/0.40	0.8	0.6	1.4	5.6 x 11.0	7.0 x 13.0	0.011 6
2.5	1.5	1/1.78	1/1.38	0.8	0.6	1.4	5.8 x 11.5	7.2 x 14.0	0.010 2
2.5	1.5	7/0.67	7/0.50	0.8	0.6	1.4	6.2 x 12.0	7.4 x 14.5	0.009 3
4	2.5	1/ 2.25	1/ 1.78	0.9	0.6	1.4	6.6 x 13.0	7.8 x 15.5	0.009 4
4	2.5	7/0.85	7/0.67	0.9	0.6	1.4	6.8 x 14.0	8.2 x 16.5	0.008 5
6	4	7/1.04	7/0.85	0.9	0.6	1.4	7.4 x 15.0	8.8 x 18.5	0.007 3
10	4	7/1.35	7/0.85	1.1	0.6	1.5	8.8 x 18.5	10.5 x 21.5	0.006 9
16	6	7/1.70	7/1.04	1.1	0.6	1.5	9.8 x 21.0	11.5 x 24.5	0.005 7
25	6	7/2.14	7/1.04	1.3	0.6	1.6	11.5 x 24.5	13.5 x 28.0	0.005 4
35	10	19/1.53	7/1.35	1.3	0.6	1.7	13.0 x 28.0	15.0 x 32.0	0.004 7

Table 14
Insulated cable, with inner and outer coverings, multi-core,
With ground conductor, rated voltage 750 V
(clause 4.1)

Nominal cross-sectional area **mm^2**		Number and diameter of wires in conductor **No./mm**		Thickness of insulation **mm**		Thickness of inner covering **mm**			Thickness of outer covering **mm**			Diameter of cable **mm**			Resistance of insulation at 70°C, min.
Phase	Ground	Phase	Ground	Phase	Ground	2-core	3-core	4-core	2-core	3-core	4-core	2-core	3-core	4-core	**MΩ.km**
1	1	1/1.13	1/1.13	0.8	0.6	0.8	0.8	0.8	1.8	1.8	1.8	12.5	13.5	14.0	0.014 1
1	1	7/0.40	7/0.40	0.8	0.6	0.8	0.8	0.8	1.8	1.8	1.8	13.0	14.0	14.5	0.013 5
1.5	1	1/1.38	1/1.13	0.8	0.6	0.8	0.8	0.8	1.8	1.8	1.8	13.0	14.0	15.0	0.012 3
1.5	1	7/0.50	7/0.40	0.8	0.6	0.8	0.8	0.8	1.8	1.8	1.8	13.5	14.5	15.5	0.011 6
2.5	1.5	1/1.78	1/1.38	0.8	0.6	0.8	0.8	0.8	1.8	1.8	1.8	14.0	15.0	16.0	0.010 2
2.5	1.5	7/0.67	7/0.50	0.8	0.6	0.8	0.8	0.8	1.8	1.8	1.8	15.0	16.0	17.0	0.009 3
4	2.5	1/ 2.25	1/ 1.78	0.9	0.6	0.8	0.8	0.8	1.8	1.8	1.8	15.5	17.0	18.0	0.009 4
4	2.5	7/0.85	7/0.67	0.9	0.6	0.8	0.8	0.8	1.8	1.8	1.8	16.5	17.0	19.0	0.008 5
6	4	7/1.04	7/0.85	0.9	0.6	0.8	0.8	0.8	1.8	1.8	1.8	18.0	19.0	20.5	0.007 3
10	4	7/1.35	7/0.85	1.1	0.6	0.8	0.8	0.8	1.8	1.8	2.0	19.0	22.5	25.0	0.006 9
16	6	7/1.70	7/1.04	1.1	0.6	1.2	1.2	1.2	2.0	2.0	2.0	22.5	26.5	28.5	0.005 7
25	6	7/2.14	7/1.04	1.3	0.6	1.2	1.2	1.2	2.0	2.0	2.0	27.0	31.0	33.5	0.005 4
35	10	19/1.53	7/1.35	1.3	0.6	1.2	1.2	1.5	2.0	2.0	2.2	29.5	34.0	38.5	0.004 7
50	10	19/1.78	7/1.35	1.5	0.6	1.2	1.5	1.5	2.2	2.2	2.2	33.5	36.0	43.0	0.004 6
70	10	19/2.14	7/1.35	1.5	0.6	1.5	1.5	1.5	2.2	2.2	2.4	38.0	40.5	44.5	0.003 9
95	16	19/2.52	7/1.70	1.7	0.6	1.5	1.5	1.8	2.2	2.4	2.6	42.5	46.0	51.5	0.003 8
120	16	37/2.03	7/1.70	1.7	0.6	1.5	1.8	1.8	2.4	2.6	2.8	46.5	50.5	56.0	0.003 4
150	25	37/2.25	7/2.14	1.9	0.6	1.8	1.8	2.0	2.6	2.8	3.0	52.0	56.0	62.0	0.003 4
185	25	37/2.52	7/2.14	2.1	0.6	1.8	2.0	2.0	2.8	3.0	3.2	57.0	61.5	68.0	0.003 4
240	35	61/2.25	19/1.53	2.3	0.6	2.0	2.0	2.2	3.0	3.2	3.4	64.0	69.0	76.5	0.003 3
300	35	61/2.52	19/1.53	2.5	0.6	2.0	2.2	2.2	3.2	3.4	3.8	70.5	76.0	84.5	0.003 2

Table 15
Insulated and sheathed cords, multi-core, with ground conductor,
Rated voltage 750 V
(clause 4.1)

Nominal cross-sectional area **mm^2**		Number and diameter of wires in conductor **No./mm**		Thickness of insulation **mm**		Thickness of sheath **mm**			Diameter of cable **mm**			Resistance of insulation at 70°C, min.
Phase	Ground	Phase	Ground	Phase	Ground	2-core	3-core	4-core	2-core	3-core	4-core	MΩ.km
1	1	32/0.20	32/0.20	0.8	0.6	1.2	1.4	1.6	10.5	11.5	13.0	0.012 7
1.5	1	30/0.25	32/0.20	0.8	0.6	1.4	1.4	1.6	11.5	12.5	13.5	0.011 1
2.5	1.5	50/0.25	30/0.25	0.8	0.6	1.4	1.4	1.6	13.0	14.5	16.0	0.009 2
4	2.5	56/0.30	50/0.25	0.9	0.6	1.6	1.6	1.8	15.5	17.0	18.5	0.008 4
6	4	84/0.30	56/0.30	0.9	0.6	1.6	1.8	2.0	17.0	19.0	21.0	0.007 1
10	4	80/0.40	56/0.30	1.1	0.6	1.8	2.0	2.2	20.0	23.5	26.0	0.006 8
16	6	126/0.40	84/0.30	1.1	0.6	2.2	2.4	2.6	23.0	27.5	30.5	0.005 0
25	6	196/0.40	84/0.30	1.3	0.6	2.4	2.6	2.8	27.5	32.5	36.0	0.004 8
35	10	276/0.40	80/0.40	1.3	0.6	2.6	2.8	3.1	31.0	36.5	40.5	0.004 1

Table 16
Flat twin cord with ground conductor, rated voltage 300 V
(clause 4.1)

Nominal cross-sectional area **mm^2**		Number and diameter of wires in conductor **No./mm**		Thickness of insulation **mm**		Diameter of cable **mm**		Resistance of insulation at 70°C, min.
Phase	Ground	Phase	Ground	Phase	Ground	Lower limit	Upper limit	**MΩ.km**
1	1	32/0.20	32/0.20	0.8	0.6	2.8 x 8.0	3.6 x 9.8	0.012 7
1.5	1	30/0.25	32/0.20	0.8	0.6	3.0 x 8.6	3.9 x 10.5	0.011 1
2.5	1.5	30/0.25	30/0.25	0.8	0.6	3.5 x 9.6	4.8 x 12.5	0.009 2

Table 17
Flat cord, 2-core and 3-core, rated voltage 300 V
(clause 4.1)

Nominal cross-sectional area **mm^2**	Number and diameter of wires in conductor **No./mm**	Thick-ness of insula-tion **mm**	Thickness of sheath **mm**		Diameter of cable **mm**				Resistance of insulation at 70°C, min. **MΩ.km**
					2-core		3-core		
			2-core	3-core	Lower limit	Upper limit	Lower limit	Upper limit	
0.5	16/0.20	0.6	0.9	0.9	3.8 x 5.8	4.7 x 7.2	3.8 x 7.8	4.7 x 9.6	0.013 2
0.5	28/0.15	0.6	0.9	0.9	3.8 x 5.8	4.7 x 7.2	3.8 x 7.8	4.7 x 9.6	0.013 3
1	32/0.20	0.6	0.9	0.9	4.1 x 6.6	5.2 x 8.0	4.1 x 9.0	5.2 x 11.0	0.010 4
1.5	30/0.25	0.6	1.2	1.2	5.0 x 7.6	6.2 x 9.4	5.0 x 10.0	6.2 x 12.5	0.009 0
2.5	50/0.25	0.7	1.2	1.2	5.6 x 9.0	7.2 x 11.5	5.6 x 12.0	7.2 x 16.0	0.008 3
4	56/0.30	0.8	1.2	1.2	6.4 x 10.0	8.0 x 13.0	6.4 x 14.5	8.0 x 18.5	0.007 6
6	84/0.30	0.8	1.2	1.2	6.8 x 11.5	8.8 x 14.5	6.8 x 16.0	8.8 x 20.5	0.006 5
10	80/0.40	0.9	1.2	1.2	8.0 x 13.5	10.5 x 17.5	8.0 x 19.5	10.5 x 25.5	0.005 7
16	126/0.40	1.0	1.2	1.4	9.8 x 17.5	12.0 x 20.5	10.0 x 25.5	12.5 x 29.0	0.004 7
25	196/0.40	1.2	1.4	-	12.0 x 21.5	14.5 x 25.0	-	-	0.004 5
35	276/0.40	1.2	1.4	-	13.5 x 24.0	16.0 x 28.0	-	-	0.003 8

5. Materials and construction

5.1 Conductor

5.1.1 Conductor shall consist of annealed copper wires.

5.1.2 The diameter of a cable with single wire conductor shall not be less than the value specified in Table 18.

5.1.3 The average diameter of the wires in a stranded conductor shall not be less than the value specified in Table 18.

5.1.4 The lay ratio of a stranded conductor shall not exceed 20 and the successive layers shall have opposite directions of lay, the outermost being of the left-hand lay.

5.1.5 The number of conductor wires for cables and cords shall be as given in Table 18 and Table 19, respectively.

5.1.6 The diameter of conductor wires for cords shall not exceed the value given in Table 19.

Compliance is checked by visual inspection and in accordance with clause 10.1.

5.2 Insulation

5.2.1 The insulation shall be so applied that it fits closely on the conductor and it shall be possible to remove it without damage to the conductor.

Compliance is checked by visual inspection.

5.2.2 The mean value of the thickness of insulation shall be not less than the specified value for each type and size of cable shown in Tables 1 to 17. The thickness at any place may be less than the specified value provided that the difference does not exceed 0.1 mm + 10% of the specified value.

The mean value of the thickness of insulation between conductors of flat twin cords shall not be less than the sum of the insulation thickness of two adjacent cores.

Compliance is checked by the test of clause 10.2.1.

5.3 Stranding

The lay ratio shall not exceed 20 and the direction of stranding should be left handed.

Compliance is checked by appropriate measurement.

5.4 Sheath

The mean value of the thickness of sheath shall not be less than the specified value for each type and size of cable shown in the tables 1 to 17. The thickness at any place may be less than the specified value provided that the difference does not exceed 0.1 mm + 15% of the specified value, unless otherwise specified.

Compliance shall be checked by the test given in clause 10.2.2.

Table 18
Conductor of single- and multi- core cables
(clause 5.1)

Nominal cross-sectional area **mm^2**	Number of wires in conductor	Diameter of wire in conductor **mm**	D.C. resistance of conductor at 20°C, max **Ω/km**
0.5	1	0.80	36.0
1	1	1.13	18.1
1	7	0.40	18.1
1.5	1	1.38	12.1
1.5	7	0.50	12.1
2.5	1	1.78	7.41
2.5	7	0.67	7.41
4	1	2.25	4.61
4	7	0.85	4.61
6	7	1.04	3.08
10	7	1.35	1.83
16	7	1.70	1.15
25	7	2.14	0.727
35	19	1.53	0.524
50	19	1.78	0.387
70	19	2.14	0.268
95	19	2.52	0.193
120	37	2.03	0.153
150	37	2.25	0.124
185	37	2.52	0.099 1
240	61	2.25	0.075 4
300	61	2.52	0.060 1
400	61	2.85	0.047 0
500	61	3.20	0.036 6

Table 19
Conductor of single- and multi-core cords
(clause 5.1)

Nominal cross-sectional area **mm^2**	Number of wires in conductor **min**	Diameter of wire in conductor max **mm**	D.C. resistance of conductor at 20°C, max **Ω/km**
0.5	16	0.21	39.0
0.5	28	0.16	39.0
0.75	24	0.21	26.0
0.75	42	0.16	26.0
1	32	0.21	19.5
1.5	30	0.26	13.3
2.5	50	0.26	7.98
4	56	0.31	4.95
6	84	0.31	3.30
10	80	0.41	1.91
16	126	0.41	1.21
25	196	0.41	0.780
35	276	0.41	0.554
50	396	0.41	0.386
70	360	0.51	0.272
95	475	0.51	0.206

5.5 Diameter of cable

5.5.1 The mean overall diameter of the cables shall be within the limits specified in Tables 1 to 17, except that for sheathed cables with two or more cores the limits may be exceeded but by not more than 5%.

5.5.2 The difference between the maximum and the minimum values of the overall diameter of cables at the same cross-section shall not exceed 15% of the limit for the mean overall diameter specified in Tables 1 to 17 ; this does not apply to flat cords and cables with diameter greater than 15 mm.
Compliance is checked by the test given in clause 10.2.3.

6. Requirements

6.1 Indelibility of markings
Marking on cables shall be indelible and not easily obliterated.
Compliance is checked by the test given in clause 10.3.

6.2 Insulation and sheath

6.2.1 Tensile strength and elasticity before ageing
The median tensile strength shall be not less than 12.5 Mpa for cables and not less than 10.0 Mpa for cords.
The median elasticity shall be not less than 125% for cables and not less than 150% for cords
Compliance is checked by the tests of clauses 10.4.1 and 10.5.1, respectively.

6.2.2 Tensile strength and elasticity after ageing

The median tensile strength and elasticity for cbles and cords shall be as given in clause 6.2.1.

The difference between the value before and after ageing shall not exceed 20% of the value before ageing.

Compliance is checked by the tests of clauses 10.4.2 and 10.5.2, respectively.

6.2.3 Loss of mass

After the insulation is tested in accordance with clause 10.4.3 and the sheath with clause 10.5.3, the loss of mass shall not exceed 2.0 mg/cm^2

6.2.4 Heat shock

After the insulation is tested in accordance with clause 10.4.4 and the sheath with clause 10.5.4, the insulation or sheath shall not crack.

6.2.5 Pressure test at high temperature

After the insulation is tested in accordance with clause 10.4.5 and the sheath with clause 10.5.5, the median depth of penetration shall not exceed 50% of the men thickness of the test piece when measured in accordance with clause 10.4.5.4 and clause 10.5.5.4, respectively.

6.3 Cables

6.3.1 Resistance of conductors

The maximum d.c. resistance of conductor at 20° shall not exceed the value specified in Tables 18 and 19.

Compliance is checked by the test given in clause 10.6.1.

6.3.2 Voltage test of cables

After test on the insulation and/or sheath in accordance with clause 10.6.2, no breakdown or flashover shall result.

6.3.3 Voltage test of cores

After test on the insulation and/or sheath in accordance with clause 10.6.3, no breakdown or flashover shall result.

6.3.4 Resistance of insulation

The insulation resistance at 70°C shall not be less than the value specified in Tables 1 to 17.

Compliance is checked by the test given in clause 10.6.4. Ground conductor shall be exempted from this test.

6.3.5 Bending of cords

During the test of clause 10.6.5, with carrier C making 15 000 backward and forward movements (30 000 single strokes), neither interruption of the current nor short circuit shall occur.

After this test the sample shall be checked by the test of clause 10.6.2.

6.3.6 Adhesion of cores of flat cords

The force used for separation of cores shall be between 3 and 30 N.

Compliance is checked by the test given in clause 10.6.6.

6.3.7 Flame retardance

After test as of clause 10.6.7, the charred portion shall not have reached within 50 mm of the lower edge of the top clamp.

7. Packing

7.1 Cables shall be packed in units which may be drums, rolls, coils, etc.
The length of cable per packing unit shall be agreed to between the purchaser and the supplier.

7.2 In packing of cables, adequate protection shall be provided so as to prevent damage during handling and shipment and shall be as agreed to between the purchaser and the supplier.

8. Mark and label

8.1 Cable in each packing unit shall at least be marked, at intervals of not exceeding 200 mm for insulated cables and not exceeding 500 mm for sheathed cables, with number, letter or mark indicating noticeably, clearly and indelibly the following information.

(1) The term "PVC 70°C"
(2) Type
(3) Number of cores and nominal cross-sectional area of conductor
(4) Number of relevant table (1 to 17)
(5) Name of manufacturer or factory, or trade mark

8.2 Each packing unit shall bear at least number, letter or mark indicating noticeably, clearly and indelibly the following information.

(1) The term "PVC 70°C
(2) Type
(3) Number of cores and nominal cross-sectional area of conductor
(4) Number of relevant table (1 to 17)
(5) Length in metres
(6) Net weight in kilogrammes and, if packed in drums, total weight
(7) Month and year of manufacture
(8) If packed in drums, arrows indicating direction of roll and position of cable end
(9) Name of manufacturer or factory, or trade mark

8.3 In case foreign language is used, the meaning shall correspond to that in Thai specified above.

8.4 For cables with two or more cores, identification of the cores shall be achieved by the use of coloured insulation, each core having only one colour, except as specified in clauses 8.6, 8.7 and 8.8.

8.5 Colour scheme for core identification

(1) Two-core cable : grey and black.
(2) Three-core cable: light grey, black, and red
(3) Four-core cable : light grey, black, red and blue

The colour scheme in this clause does not apply to insulation of ground conductor.

8.6 The colours green and yellow shall be the means of identification of the core intended for use as earth connection. The distribution of the colours shall comply with the following : one colour shall cover at least 30% and not more than 70% of the surface of the core, the other colour covering the remainder.

8.7 For flat twin cord and stranded core cords, if only one colour is used for the insulation, any colour may be chosen provided a white or gray identification strip or thread shall be displayed on one core. The strip may be continuous or

alternated with the marking a of clause 8.1. If white or gray is used for coloring the insulation, the strip or thread shall be black.

8.8 For stranded conductor containing 3 or more cores, if the same colour is used for coloring insulation for core identification, a colour strip or thread shall be displayed on the core; the colour scheme shall be as given in clause 8.5 except that one core shall not require a colour strip or thread if the colour of the insulation is one of those given in clause 8.5.

8.9 Any person who manufactures products complying with this standard may use the Standards Mark in connection with his products only after having received a licence from the Industrial Products Standards Council.

9. Sampling and criteria for conformity

9.1 Lot : In this standard, cables of the same type referred to in the same table having the same cross-sectional area, number and diameter of conductor wires and number of cores, which are manufactured in the same continuous rum or intended as one consignment or purchase.

9.2 Sampling and criteria for conformity shall comply with the sampling plan specified below or with other technically equivalent plan.

9.2.1 Sampling

A sample of 30 metres shall be taken at random from the packing units of cable of each lot.

9.2.2 Criteria for conformity

Provided the sample meets all the requirements of clauses 4, 5, 6 and 8, that lot of wires shall be deemed to comply with this standard.

10. Tests

10.1 Sizes and number of wires in conductor

10.1.1 Apparatus

A micrometer accurate to 0.01 mm

10.1.2 Preparation of test specimens

The sample as of clause 9.2.1 shall be cut at both ends and the middle to obtain from each place a test specimen of at least 200 mm length.

10.1.3 Procedure

10.1.3.1 Diameter of cable with single wire conductor

The diameter of the wire at a given place shall be measured by means of the micrometer at two positions perpendicular to each other and the average obtained.

10.1.3.2 Diameter of wire in a stranded conductor

Measure and obtain the average of the diameter of each wire as in clause 10.1.3.1 and obtain the average of all wires in that strand.

10.1.3.3 Diameter of wire in conductor for cords

In case of conductor with up to 50 wires, measure the diameter of each individual wire. In case of conductor with more wires, measure the diameter of 50 wires.

Measure the diameter of wire at both ends by means of the micrometer, twice at each place perpendicular to each other and obtain the average.

10.1.3.4 Number of wires

Total number of wires shall be counted.

10.1.4 Report

10.1.4.1 Diameter of cables with single wire conductor

The average of the measurement shall be reported.

10.1.4.2 Diameter of wire in stranded conductor

The average of all wires in the strand shall be reported.

10.1.4.3 Diameter of wire in conductor for cords

The maximum average of the measurement shall be reported.

10.1.4.4 Number of wires

The total count shall be reported.

10.2 Construction

10.2.1 Thickness of insulation

10.2.1.1 A measuring microscope allowing a reading of 0.01 mm or a suitable measuring projector with a magnification power of at least 10. In case of doubt, the microscope measuring procedure shall be applied.

10.2.1.2 Preparation of test pieces

From every core of cables, 3 samples shall be cut at intervals of at least 1 m.

Any covering shall be removed from the insulation, and the conductor shall be withdrawn, care being taken to avoid damage of the insulation. The test piece shall consist of a thin slice of insulation cut with a suitable device, such as sharp knife or razor blade, along a plane perpendicular to the axis of the conductor.

If a marking is stamped into the insulation, thus giving rise to a local reduction of thickness, the test piece shall be taken so as to include such marking.

10.2.1.3 Procedure

The test piece shall be placed under the measuring equipment with the plane of the cut perpendicular to the optical axis.

(1) When the inner profile of the test piece is a circle, six measurements shall be made radially, as far as possible equally spaced around the circumference.

(2) When the insulation is taken from a stranded conductor, six measurements shall be made radially in the positions where the insulation is thinnest, i.e. between the ridges caused by strands, as shown in Figure 1(A).

(3) When the outer profile shows unevenness, the cross-wire of the microscope shall be adjusted as shown in Figure 1(B).

(4) Flat twin cords shall be measured according to Figure 1(C) and at place where the insulation is thinnest.

In measuring as in (1) to (3), the first measurement shall be made at the place where the insulation is thinnest.

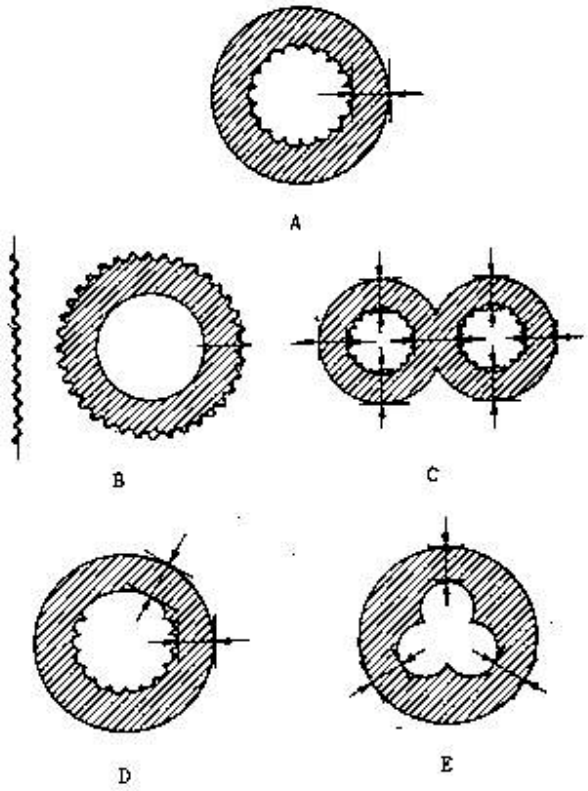


Figure 1 Measurement of thickness of insulation and sheath
(clauses 10.2.1.3, 10.2.2.3, 10.4.3.3 and 10.5.5.3)

10.2.1.4 Report

The mean of the 18 values obtained from the three test pieces from each core shall be calculated to two decimal places and rounded off to one decimal place and this shall be taken as the mean value of the thickness of insulation. If in the calculation the second decimal figure is 5 or more, the first decimal figure shall be raised to the next number, the second decimal figure of less than 5 shall be discarded.

The lowest of all values obtained shall be taken as the minimum thickness of insulation at any place.

In case of flat cords, the minimum thickness of insulation at any place and the mean value of thickness of insulation between cores shall also be reported.

This test may be combined with the measurement of thickness of clauses 6.2.1 and 6.2.2.

Note : The thickness of insulation obtained may be used for calculation in clause 10.4.1.

10.2.2 Thickness of sheath

10.2.2.1 Apparatus

The same apparatus as given in clause 10.2.1.1.

10.2.2.2 Preparation of test pieces

Samples shall be obtained from 3 places on the cable, spaced at least 1 m from each other. After all materials, if any, inside and outside the sheath have been removed, each test piece shall be prepared by cutting with a

suitable device such as sharp knife or razor blade, a thin slice along a plane perpendicular to the axis of the cable. If a marking is stamped into the sheath, thus giving rise to a local reduction of thickness, the test piece shall taken so as to include such marking.

10.2.2.3 Procedure

The test piece shall be placed under the measuring equipment with the plane of the cut perpendicular to the optical axis.

(1) When the inner profile of the test piece is circle, six measurements shall be carried out radially, equally spaced, as far as possible, around the circumference.

(2) If the inner substantially circular surface is not regular or smooth, the six measurements shall be made in the positions where the sheath is thinnest placing the cross-wire of the microscope as shown in Figure 1 (d).

(3) When the inner profile is not circular, an appropriate number of measurements (up to six) shall be carried out radially where the sheath is thinnest, i.e. at the hollow of the grooves caused by the cores as shown in Figure 1(E).

In all cases, the first measurement shall be made at the place where the sheath is thinnest.

10.2.2.4 Report

The mean of all the values obtained from the three test pieces of sheath shall be calculated to two decimal places and rounded off as in clause 10.2.1.4, and this shall be taken as the mean value of the thickness of sheath.

The lowest of all values obtained shall be taken as the minimum thickness of sheath at any place.

This test may be combined with other measurement of thickness of clauses 6.2.1 and 6.2.2.

Note : The thickness of sheath obtained may be used for calculation as in clause 10.5.1.

10.2.3 Diameter of cables

10.2.3.1 Apparatus

(1) For diameters up to and including 15 mm, the apparatus used shall be as given in clause 10.2.1.1.

10.2.3.2 Preparation of test pieces

Clause 10.2.1.2 or 10.2.2.2 shall apply.

10.2.3.3 Procedure

(1) For diameters up to and including 15 mm, 2 measurements shall be made on the same test piece used as in clauses 10.2.1.3 and 10.2.2.3, perpendicular to each other.

(2) For diameters exceeding 15 mm, except flat cords and flat cables, the circumference of the cables shall be measured to the nearest 0.1 mm.

(3) For flat cords, flat cables and flat twin cords, a micrometer, a profile projector or similar appliance shall be used.

10.2.3.4 Report

(1) For diameters up to and including 15 mm, the mean of the values obtained shall be taken as the mean diameter.

(2) For diameters exceeding 15 mm, the value calculated from the three values obtained shall be taken as the mean diameter.

(3) For flat cords, flat cables and flat twin cords, the mean of the values obtained from the three measurements shall be taken as the mean diameter.

10.3 Indelibility of marking

Rub lightly, the marking on the cable, ten times with a piece of cotton cloth soaked in water. Printed marking shall adhere firmly and be indelible.

10.4 Insulation

10.4.1 Tensile strength and elongation before ageing

10.4.1.1 Apparatus

(1) A microscope or its equivalent producing a contact pressure not exceeding 7 N/cm^2

(2) A tensile testing machine with rate of separation of 250±50 mm/min.

10.4.1.2 Preparation of test pieces

Five test pieces of each and every core shall be taken, cut to the shape as given in (1) or (2). (5 more test pieces shall be required for test after ageing treatment, cut from adjacent places. The tensile test with the unaged pieces shall be made at the sometime as the test with the aged pieces.) Core of flat twin cords shall not be separated. Damaged samples shall not be used for making test pieces.

(1) Dumb-bell test pieces

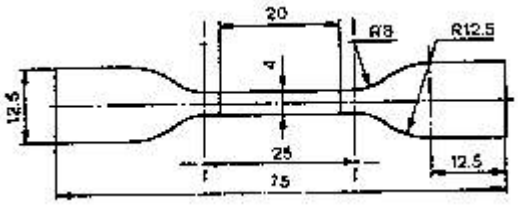
The insulation shall be cut open in the direction of the axis and the conductor shall be removed. Each sample of insulation shall be cut into pieces, of sufficient size for the test and the pieces marked to identify the sample from which they are cut and their positions relative to each other in the original sample.

The pieces of insulation shall be ground or cut, so as to obtain two parallel surfaces between the marker lines, care being taken to avoid undue heating. After grinding or cutting, the thickness of the pieces shall be not less than 0.8 mm and not more than 2.0 mm.

A dumb-bell test piece in accordance with Figure 2 shall then be punched from each prepared piece of insulation, or if possible, two dumb-bell test pieces shall be punched side by side.

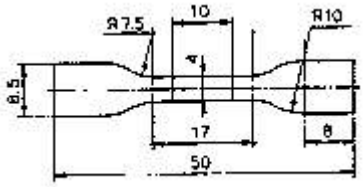
When the diameter of the core is too small to allow the dumb-bell in accordance with Figure 2 to be used, then a smaller dumb-bell test piece in accordance with Figure 3 shall be punched from each prepared piece of insulation.

The central 20 mm for the larger dumb-bells, or 10 mm for the smaller dumb-bells, shall be marked by two lines on each test piece, as shown in Figures 2 and 3.



Units in millimetres

Figure 2 Dumb-bell test pieces
(clauses 10.4.1.2, 10.4.1.5 and 10.4.3.3)



Units in millimetres

Figure 3 Small dumb-bell test pieces
(clauses 10.4.1.2, 10.4.1.5 and 10.4.3.3)

(2) Tubular test pieces

Tubular test pieces shall be used only when the core is of such small size that it is not possible to prepare dumb-bell test pieces.

The samples of core shall be cut into pieces approximately 100 mm long and the conductor and any outer coverings removed, care being taken not to damage the insulation. The tubes shall be marked to identify the sample from which they were prepared and their relative positions in the sample. The central 20 mm shall be marked by two lines.

10.4.1.3 Determination of cross-sectional area of dumb-bell test piece

(1) Cross-sectional area of dumb-bell test piece

The cross-sectional area of each dumb-bell test piece shall be calculated from the width and the smallest thickness of three measurements of the piece between the marker lines.

If there is doubt about the uniformity of the width, this shall be measured at the same three positions as the thickness at both surfaces of the test piece, taking the mean of the two measurements as the width at each position.

The smallest of the three cross-sections thus found shall be used for the calculation of the tensile strength.

(2) Cross-sectional area of tubular test piece

The cross-sectional area A, in square millimetres, of each tubular test piece shall be determined by one of the following methods. In case of doubt, the second method(b) shall be used.

(a) From the dimensions, using the formula :

*** $A = \P(D - i)\ i$

where:

D = mean value of the outer diameter of the test piece, in millimetres, determined as specified in clause 10.2.3.3(2) to 2 decimal places.

i = mean value of the thickness of the insulation, in millimetres, determined as specified in clause 10.2.1 and rounded off to two decimal places.

(b) From the density, the mass and the length, using the formula :

$$A = \frac{1\ 000m}{d\,x\,L}$$

where :

m = mass of the test piece, in grams, to three decimal places

d = density, measured in accordance with Appendix B, in grams per cubic centimetre, to three decimal places.

L = length, in millimetres, to one decimal place

10.4.1.4 Conditioning of test pieces

Before the tensile test, all test pieces shall be kept for at least 3 h at a temperature of 23± 2°C.

10.4.1.5 Procedures

(1) Test temperature

The test shall be carried out at room temperature and each test shall be completed within 5 min of the removal of the test piece from the conditioning chamber. In case of doubt for PVC insulation, the test shall be repeated at 23± 2°C.

(2) Distance between the grips

The total length between the grips shall be about :

34 mm for small dumb-bells as illustrated in Figure 3

50 mm for dumb-bells as illustrated in Figure 2

50 mm for tubes, if tested with self-tightening grips

85 mm for tubes, if tested with non-self-tightening grips.

(3) Measurements

The breaking load and the distance between the two marker lines at rupture shall be measured.

An unsatisfactory result due to any test piece breaking due to damage in the grips shall be ignored. In this event, at least four valid results shall be obtained in order to calculate the tensile strength and elongation-at-break; otherwise the test shall be repeated.

10.4.1.6 Report

The values of tensile strength and elongation-at-break-recorded shall be the median values of the results for each property as follows :

(1) Tensile strength, Mpa

$$= \frac{\text{Breaking load, N}}{\text{Original cross-sectional area of test piece, mm}^2}$$

(2) Elongation, %

$$= \frac{\text{Gauge length at rupture} - \text{Original guage length}}{\text{Original guage length}} \times 100$$

10.4.2 Tensile strength and elongation after ageing

10.4.2.1 Apparatus

An oven with natural air flow or air flow by pressure. The air shall enter the oven in such a way that it flows over the surface of the test pieces and leaves near the top of the oven.

The oven shall have flow rate not less than eight and not more than 20 times of the complete oven volume per hour at the specified ageing temperature. A fan shall not be used inside the oven.

10.4.2.2 Preparation of test pieces

(1) For dumb-bell or tubular test pieces, clause 10.4.1.2 shall be complied with.

(2) For pieces of complete cable, three pieces of complete cable about 200 mm long shall be taken from a position close to those where the samples for the tensile tests without ageing are taken.

10.4.2.3 Determination of cross-sectional area of test pieces

In accordance with clause 10.4.1.3

10.4.2.4 Conditioning of test piece

In accordance with clause 10.4.1.4

10.4.2.5 Procedure

(1) Dumb-bell or tubular test pieces

The test pieces shall be suspended vertically and substantially in the middle of the oven so that each piece is at least 20 mm from any other piece, for a duration of 7 days (168 h). As soon as the ageing period is completed, the test pieces shall be removed from the oven and left at ambient temperature, avoiding direct sunlight, for at least 16 h. The tensile test shall then be carried out in accordance with clause 10.4.1.5.

(2) Test pieces of complete cables

The pieces of cable shall be suspended substantially in the middle of the oven at least 20 mm away from each other for a duration of 7 days (168 h). They shall not occupy more than 2% of the volume of the oven.

As soon as the specified heating period is completed, the pieces of cable shall be removed from the oven and left at ambient temperature, avoiding direct sunlight, for a least 16h.

The three pieces of cable shall then be dismantled. Two test pieces shall be prepared from the insulation of each core (up to a maximum of three cores) and from the sheath of each piece of cable, as specified in clause 10.4.1.2, so that there are six test pieces from each core and from the sheath.

If the test pieces need to be cut or ground to reduce their thickness to not more than 2 mm, this operation shall be effected, so far as possible, on the side which was not facing a material of different type in the complete cable.

If ridges must be cut or ground on the side which was facing the different type of material, the material removed on that side shall be the minimum compatible with adequate smoothing.

The test pieces shall be subjected to the tensile and elongation tests, all in accordance with clause 10.4.1.5.

10.4.2.6 Report

In accordance with clause 10.4.1.6.

10.4.3 Loss of mass

10.4.3.1 Apparatus

(1) An oven as in clause 10.4.2.1.
(2) An analytical balance with a sensitivity of 0.1 mg.
(3) A desiccator with silica gel or similar material.

10.4.3.2 Preparation of test pieces

(1) Three samples of each core shall be taken in accordance with clause 10.4.1.2 except that marker lines are not required.
Dumb-bell test pieces shall have two parallel surfaces over the whole length, their thickness shall be 1.0±0.2 mm.
Tubular test pieces shall have inner diameter not exceeding 12.5 mm and total surface area not less than 5 cm^2.

(2) Flat twin cords provided with a groove on both sides between the cores shall be tested without separation of the cores. For calculation of its surface of evaporation, the twin cord may be considered as being two separated tubular pieces.

10.4.3.3 Calculation of the evaporation area

The surface area A, in square centimetres, of each test piece shall be determined before conducting the test using the following formulae :

(1) Tubular test pieces

Surface A = outer surface + inner surface + cut surface

$$A = \frac{2¶(D - i) \times (L + i)}{100}$$

where :

D = mean outer diameter of the test piece, in millimetres, to one decimal place
i = average thickness of the test piece, in millimetres, to one decimal place
L = length of the test piece, in millimetres, to one decimal place;

Both i and D being measured as specified in the test method in clauses 10.2.1 and 10.2.3 on a thin slice cut from the end of each tubular test piece.

The formula may be applied also to a tubular test piece having a cross-section as shown in Figure 1(a).

(2) For dumb-bell test piece size of Figure 2.

$$A = \frac{1\,256 + (180\ i)}{100}$$

Where i is the mean thickness of the strips, in mm, determined as specified in clause 10.4.1.3(1).

(3) For dumb-bell test piece size of Figure 3

$$A = \frac{624 + (118\ i)}{100}$$

Where i is the mean thickness of the strips, in mm, determined as specified in clause 10.4.1.3(1).

10.4.3.4 Procedure

(1) The prepared test pieces shall be placed for at least 20 h at ambient temperature in a desiccator. Immediately after removal from the desiccator, each test piece shall be weighed accurately, in milligrams, to one decimal place.

(2) Thereafter, the test pieces shall be suspended vertically 20 mm from any other piece, in air at atmospheric pressure for 7 days (168 h) at 80± 2°C. Not more than 0.5% of the oven volume shall be occupied by the test pieces.

(3) After this heat treatment, the test pieces shall again be placed for 20 h in a desiccator at ambient temperature and each test piece shall then be reweighed.

The difference between the weights determined in (1) and in (3), for each test piece, shall be calculated and rounded-off to the nearest milligram.

10.4.3.5 Report

The median value of the results obtained by dividing, for each test piece, its weight difference by its surface area A shall be reported.

10.4.4 Heat shock

10.4.4.1 Preparation of test pieces

Each core to be tested shall be represented by two samples of suitable length taken from two places separated by at least 1 m. External covering, if any, shall be removed from the insulation, and the test pieces prepared as follows

(1) For cores with an overall diameter not exceeding 12.5 mm, each test piece shall consist of a piece of core.

(2) For cores with an overall diameter exceeding 12.5 mm, each test piece shall consist of a strip taken from the insulation whose width shall be at least 1.5 times its thickness, but not less than 4 mm. The strip shall be cut in the direction of the axis of the conductor.

10.4.4.2 Procedure

Each test piece shall be tautly wound and fixed, at ambient temperature, on a mandrel to form a close helix.

The diameter of the mandrel and the number of turns are given :

(1) Table 20 shall apply for test pieces prepared in accordance with clause 10.4.4.1(1); for flat cables and cords, the mandrel diameter shall be based on the minor dimension of the cord, which is wound on with its minor axis perpendicular to the mandrel;

(2) Table 21 shall apply for test pieces prepared in accordance with clause 10.4.4.1(2). In this case, the inner surface of the test piece shall be in contact with the mandrel.

Each test piece, on its mandrel, shall be placed in an air-oven pre-heated to a temperature of 150 ± 2°C and maintained at that temperature for 1 h. After the test pieces have been allowed to attain approximately ambient temperature, they shall be examined while still on the mandrel. The test pieces shall show no crack.

Table 20
Diameter of mandrel and number of turns
(clauses 10.4.4.2(1) and 10.5.4.2(1))

External diameter of test piece (mm)	Mandrel diameter (mm)	Number of turns
Up to and including 2.5	5	6
Over 2.5 up to and including 4.5	9	6
Over 4.5 up to and including 6.5	13	6
Over 6.5 up to and including 9.5	19	4
Over 9.5 up to and including 12.5	40	2

Note : Diameter of each test piece shall be measured by means of callipers or other suitable measuring instrument.

Table 21
Diameter of mandrel and number of turns
(clauses 10.4.4.2(2) and 10.5.4.2(2))

Thickness of test piece (mm)	Mandrel diameter (mm)	Number of turns
Up to and including 1	2	6
Over 1 up to and including 2	4	6
Over 2 up to and including 3	6	6
Over 3 up to and including 4	8	6
Over 4 up to and including 5	10	6

Note : The diameter or thickness of each test piece shall be measured by means of callipers or other suitable measuring instrument.

10.4.5 Pressure test at high temperature

10.4.5.1 Apparatus

The indentation device is shown in Figure 4, and consists of a rectangular blade with an edge 0.70 ± 0.01 mm wide, which can be pressed against the test piece.

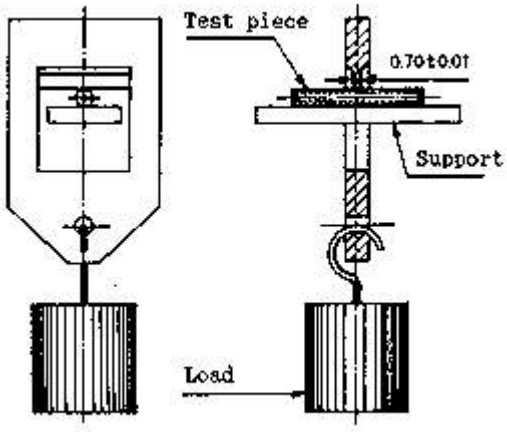
10.4.5.2 Preparation of test pieces

For each core to be tested, three adjacent pieces shall be taken from a sample having a length of 250 mm to 500 mm. The length of each piece shall be 50 mm to 100 mm.

The cores of flat cords without sheath shall not be separated.

10.4.5.3 Procedure

Each test piece shall be placed in the position shown in Figure 4. Flat twin cords shall be laid on their flat side. Test pieces having a small diameter shall be fixed on the support in such a manner that they do not curve under pressure of the blade. The force shall be applied in a direction perpendicular to the axis of the core; the blade shall also be perpendicular to the axis of the core.



Units in millimetres

Figure 4 Indentation device
(clauses 10.4.5 and 10.5.5.3)

The force F, which shall be exerted is given by the formula :

$$F = k\sqrt{2Di - i^2}$$

where : F = the force exerted, N
k = factor = 0.6 for cores with D $\leq$ 10 mm, for flexible cords and cables
= 0.8 for cores with D > 10 mm, for cables
D = mean value of the outer diameter of the test piece, mm
i = mean value of the thickness of the insulation of the test piece, mm

i and D are both expressed in millimetres, to one decimal place, and measured as specified in the test method in clauses 10.2.1 and 10.2.3 on a thin slice cut from the end of the test piece. The force applied upon the test piece of flat cord without sheath shall be twice the value given by the above formula, where D is the mean value of the minor dimension of the test piece. The calculated force may be rounded off downwards by not more than 3%.

The loaded, but not preheated, test piece shall be kept in the test position for the following duration:

- 4 h for cores of cables having a conductor cross-section not exceeding 35 mm^2;
- 6 h for cores of cables exceeding the above limits

in the oven maintained at

70 ± 2ºC for flexible cords
80 ± 2ºC for cables

At the end of the specified durations, the test piece shall be chilled under load. In the heating cabinet, this operation may be carried out by spraying

the test piece with cold water on the spot where the blade is pressing. The test piece shall be removed from the apparatus when it has cooled to a temperature where recovery of the insulation no longer occurs; the test piece shall then be cooled further by immersion in cold water.

10.4.5.4 Measurement of indentation

Immediately after cooling, the test piece shall be prepared for determining the depth of indentation. The conductor shall be withdrawn leaving the test piece in the form of a tube. A narrow strip shall be cut from the test piece in the direction of the axis of the core, perpendicular to the indentation as shown in Figure 5. The strip shall be laid flat under a measuring microscope or a measuring projector and the cross-wire shall be adjusted to the bottom of the indentation and the outside of the test piece as shown in Figure 5.

Small test pieces, up to about 6 mm external diameter, shall be cut transversely at and near the indentation, as shown in Figure 6, and the depth of the indentation shall be determined by difference from the microscope measurements on sectional views 1 and 2 as shown in the Figure 6.

All measurements shall be made in millimeters to two decimal places.

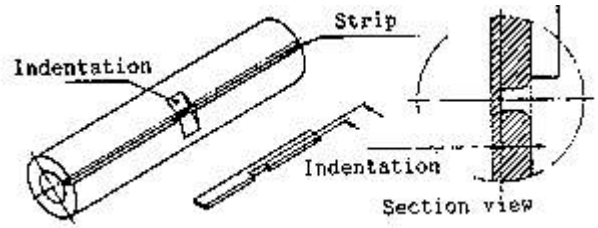


Figure 5 Measurement of indentation
(clause 10.4.5.4)

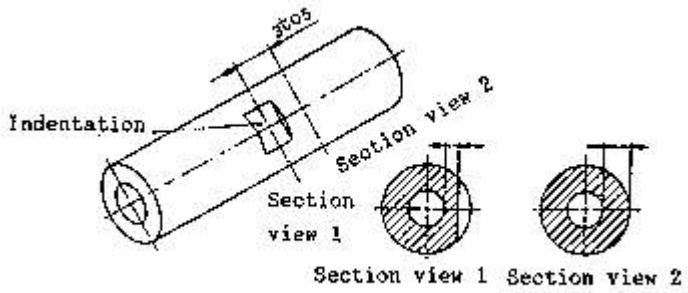


Figure 6 Measurement of indentation for
test piece up to 6 mm external diameter
(clause 10.4.5.4)

10.4.5.5 Report

The median of the indentation values, measured on the three test pieces shall be reported in percent of the mean value of the thickness of the insulation of the test piece as measured in accordance with clause 10.4.5.3.

10.5 Sheath

10.5.1 Tensile strength and elongation before ageing

10.5.1.1 Apparatus

The same as given in clause 10.4.1.1

10.5.1.2 Preparation of test pieces

Five test pieces shall be prepared from each sample to the shape specified in clause 10.4.1.2. (Five more test pieces shall be required for test after ageing, cut from positions adjacent to the test pieces used for the test without ageing and the tensile tests on the aged and unaged test pieces shall be made in immediate succession.) Any sample that shows signs of mechanical damage shall not be used for the tests.

If the sheath has ridges caused by the cores on the inside, then, in the preparation of dumb-bell test pieces, the sheath shall be cut in the direction of the ridges for removal from the cable and the effect of the ridges shall be eliminated by grinding or cutting.

In the preparation of tubular test pieces, all the components of the cable inside the sheath, including cores, fillers and inner covering , shall be removed.

10.5.1.3 Determination of cross-sectional area

The cross-sectional area of each test piece shall be determined by the same method specified in clause 10.4.1.3 except that the thickness and diameter of the sheath, measured in accordance with clause 10.2.2 for thickness and clause 10.2.3.3 for diameter, shall be used in the method (a), and that the density shall be measured on an additional piece of the same sheath in the method (b) and that if the sheath has ridges, the method (b) only shall be used.

10.5.1.4 Conditioning of test pieces

In accordance with clause 10.4.1.4.

10.5.1.5 Procedure

As specified in clause 10.4.1.5.

10.5.1.6 Report

As specified in clause 10.4.1.6.

10.5.2 Tensile strength and elongation after ageing

As specified in clause 10.4.2.

10.5.3 Loss of mass

10.5.3.1 Apparatus

The same as given in clause 10.4.3.1.

10.5.3.2 Preparation of test pieces

The core or other materials, if any, both inside and outside the sheath small be removed, taking care not to damage the sheath, and the test pieces prepared in accordance with clause 10.4.3.2.

10.5.3.3 Calculation of the evaporation area

The surface of evaporation shall be calculated by the formula given in clause 10.4.3.3 for tubular specimens with the cross-sections as shown in Figure 1 (B) and Figure 1 (D). The inner and outer surfaces of evaporation of sheaths of flat cords and cables shall be calculated from the dimensions of the cross-section of the sheath. These dimensions shall be determined in millimetres to two decimal places. The inner side of flat sheaths, having a wedge-shaped ridge, may be considered as being flat.

10.5.3.4 Procedure

In accordance with clause 10.4.3.4.

10.5.3.5 Report

In accordance with clause 10.4.3.5.

10.5.4 Heat shock

10.5.4.1 Preparation of test pieces

Each sheath to be tested shall be represented by two samples of cable of suitable length taken from two places, separated by at least 1 m.

Any external covering shall be removed, and the test pieces prepared as follows :

(1) For cables with an overall diameter not exceeding 12.5 mm, each test piece shall consist of a piece of cable,

(2) For cables with an overall diameter exceeding 12.5 mm, each test piece shall consist of a strip taken from the sheath, whose width shall be at least 1.5 times its thickness but not less than 4 mm; the strip shall be cut in the direction of the axis of the cable.

(3) In the case of flat cords, the test piece shall consist of a piece of cord where the minor dimension of the cord does not exceed 12.5 mm or shall be prepared as in (2) if the minor dimension exceeds 12.5 mm.

10.5.4.2 Procedure

Each test piece shall be tautly wound and fixed at ambient temperature on a mandrel to form a close helix. The diameter of the mandrel and the number of turns are given:

(1) Table 20 shall apply for test pieces prepared in accordance with clause 10.5.4.1(1) and 10.5.4.1(3)

(2) Table 21 shall apply for test pieces prepared in accordance with clause 10.5.4.1(2) and 10.5.4.1(3) from flat cords exceeding 12.5 mm.

Each test piece, on its mandrel, shall be placed into an oven pre-heated to a temperature of 150 ± 2ºC and maintained at that temperature for 1 h. After the test pieces have been allowed to attain approximately ambient temperature, they shall be examined while still on the mandrel. The test pieces shall show no crack when examined.

10.5.5 Pressure test at high temperature

10.5.5.1 Apparatus

The same as given in clause 10.4.5.1.

10.5.5.2 Preparation of test pieces

For each sheath to be tested, three adjacent pieces shall be taken from a sample having a length of 250 mm to 500 mm from which the covering (if any) and all the internal parts (cores, fillers, inner covering, armour, etc. (if any) have been removed. The length of each sheath piece shall be 50 mm to100 mm (the greater values for the larger diameters).

From each sheath piece, strip, enclosing about one-third of the circumference, shall be cut in the direction of the axis of the cable if the sheath does not have ridges.

If the sheath shows ridges caused by cores, the strip shall be cut in the direction of the ridges so that it contains at least one groove which lies approximately in the middle of the strip throughout its length.

10.5.5.3 Procedure

The test piece shall be positioned as shown in Figure 4, supported by a metal pin or tube, which may be halved in the direction of its axis to make a

more stable support. The radius of the pin or tube shall be approximately eqaual to half the inner diameter of the test piece.
The apparatus, the strip and the supporting pin (tube) shall be arranged so that the pin supports the strip and the blade is pressed against the outer surface of the test piece.
The force shall be applied in a direction perpendicular to the axis of the pin and the blade shall also be perpendicular to the axis of the pin or tube.
The force to be applied shall be calculated from the formula:

$$F = k\sqrt{2Di - i^2}$$

where : F = force exerted, N
k = factor = 0.6 for flexible cords and cables with $D \leq 10$ mm
= 0.8 for cables with $D > 10$ mm
D = mean value of the outer diameter of the test piece of the sheath or for the sheath of a flat cable or cord, the minor outer dimension of the test piece of the sheath , mm
i = mean value of the thickness of the test piece, mm

D and i are both expressed in millimetres, to one decimal place, and measured as specified in the test method of clause 10.2.2 and 10.2.3 respectively.
The calculated force may be rounded off downwards by not more than 3%
The test pieces shall be heated in the test position for the following periods:
- 4 h for test pieces having an outer diameter not exceeding 12.5 mm;
- 6 h for test pieces with an outer diameter exceeding 12.5 mm.

at a temperature of
70 ± 2ºC for flexible cords
80 ± 2ºC for cables

At the end of the specified durations, the test piece shall be chilled under load. In the heating cabinet, this operation may be carried out by spraying the test piece with cold water on the spot where the blade is pressing. The test piece shall be removed from the apparatus when it has cooled to a temperature where recovery of the sheath no longer occurs; the test piece shall be cooled further by immersion in cold water.

10.5.5.4 Measurement of indentation
In accordance with clause 10.4.5.4.

10.5.5.5 Report
The median of the indentation values measured on the three test pieces taken from the sheath shall be reported in percent of the mean value of the thickness of the test piece when measured in accordance with clause 10.5.5.3.

10.6 Cables

10.6.1 Electrical resistance of conductors
The resistance of each conductor shall be measured from a sample of cable of at least 1 m in length, and the electrical resistance of the conductor per length of 1 km at 20ºC shall be calculated from the formula :

$$R_{20} = R_1 \frac{254.5}{234.5 + t} x \frac{1000}{L}$$

where

$R_{2.0}$ = resistance at 20ºC, in ohm/kilometre

R_t = resistance at L metres of cable at tºC in ohms

t = temperature of the sample at the moment of measurement, in degree celcius

L = length of the sample of cable, in metres (length of the complete sample and not of the individual cores or wires)

10.6.2 Electrical strength of cables

10.6.2.1 Preparation of test pieces

A test piece of at least 10 m length shall be used.

10.6.2.2 Procedure

The test piece shall be immersed in water at a temperature of 20 ± 5°C for not less than 1 h, with about 250 mm on both of its ends remaining above the water.

An a.c. 50 Hz voltage shall be applied in turn between each conductor and all the others connected together and to the water; and then between all conductors connected together and the water, as follows

2 000 V for cable of rated voltages 300 V

2 500 V for cable of rated voltages 750 V

1 500 V for ground conductor

The applied voltage shall be maintains for 5 minutes. During test, no breakdown or flashover shall occur.

10.6.3 Electrical strength of cores

10.6.3.1 Preparation of test pieces

A sample of 5 m length shall be cut from a cable. The sheath and any other covering of filling shall be removed without damaging the cores.

In the case of a flat twin cord, a short cut shall be made between the cores, and the cores shall be separated by hand for a length of 2 m.

10.6.3.2 Procedure

The test shall be in accordance with clause 10.6.2.2 except that a voltage shall be applied between the conductors and the water.

During the test, no breakdown or flashover shall occur.

10.6.4 Insulation resistance

10.6.4.1 Preparation of test pieces

The core samples, 5 m in length, previously submitted to the test described in clause 10.6.3 or, if this is not applicable, to the test described in clause 10.6.2 shall be used.

10.6.4.2 Procedure

The sample shall be immersed in water previously heated to 70±2°C for 2 h, a length of about 250 mm at each end of the sample being kept above the water.

A d.c. voltage of between 80 V and 500 V shall then be applied between the conductor and the water. The insulation resistance shall be measured 1 min after application of the voltage.

10.6.5 Flexibility of cords

The flexing test applies to only flexible cords having a conductor in each core not exceeding 2.5 mm^2 and not more than 4 cores (excluding ground conductor).

10.6.5.1 Apparatus

The flexing apparatus as shown in Figure 7, consisting of a carrier C supporting two pulleys A and B arranged so that the cable is horizontal between the pulleys. The carrier makes a backward and forward movement over a distance of 1 m, at an approximately constant speed of 0.33 m/s.

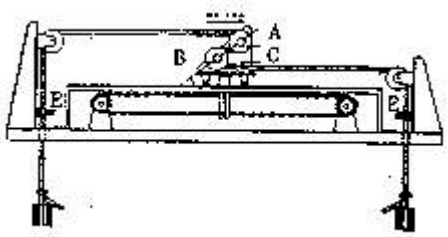


Figure 7 Flexing apparatus
(clause 10.6.5)

10.6.5.2 Preparation of test pieces

The test piece shall consist of a length of about 5 m of flexible cable.

10.6.5.3 Procedure

The test piece shall be stretched over the pulleys, as shown in Figure 7, each end being loaded with a weight. The mass of this weight and the diameter of the pulleys are as shown in the Table 22.

Table 22
Mass of weight and diameter of pulleys
(clause 10.6.5.3)

Type of flexible cable	Mass of weight kg	Diameter of pulleys mm
1. Flat twin cables and cords	1.0	60
2. Sheath cores of nominal cross-sectional area		
- not exceeding 1 mm^2	1.0	80
- 1.5 and 2.5 mm^2	1.5	120

The pulleys have a semi-circular shaped groove for circular cables and a flat groove for flat cables.

The restraining clamps D shall be fixed so that the pull is always applied by the weight from which the carrier is moving away. The carrier makes backward and forward movements.

Each conductor of the sample shall be loaded with a current of about 1 A/mm^2.

For two-core cords, and for sheathed three-core cords, the voltage between the conductors shall be about 220 V a.c.

For all other cables having three or more cores, a three-phase a.c. voltage of about 380 V shall be applied to three conductors, any additional conductors being connected to the neutral.

10.6.6 Separation of cores

10.6.6.1 Apparatus

A tensile testing machine having a rate of separation of about 50 mm/sec.

10.6.6.2 Preparation of test pieces

A test piece of appropriate length shall be used.

10.6.6.3 Procedure

A cut shall be made in the insulation between the cores of the test piece. The force necessary to separate them at a speed of 50 mm/s shall be measured by means of a tensile machine.

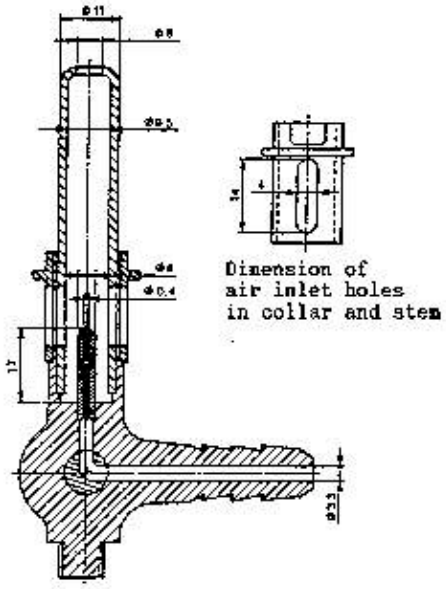
10.6.7 Flame retardance

10.6.7.1 Apparatus

(1) Gas burner

A gas burner capable of being regulated to give a flame approximately 175 mm long with an inner blue cone approximately 55 mm long, complying with clause 10.7.6.2.

An example of appropriate burner is given in Figure 8.



Units in millimetres

Figure 8 Gas burner (sectional view)
(clause 10.6.7.1(1))

For a sample having an overall diameter up to and including 50 mm, one gas burner, shall be positioned as shown in Figure 9.

For a sample having an overall diameter greater than 50 mm, two gas burners shall be arranged round the sample as shown in Figure 9.

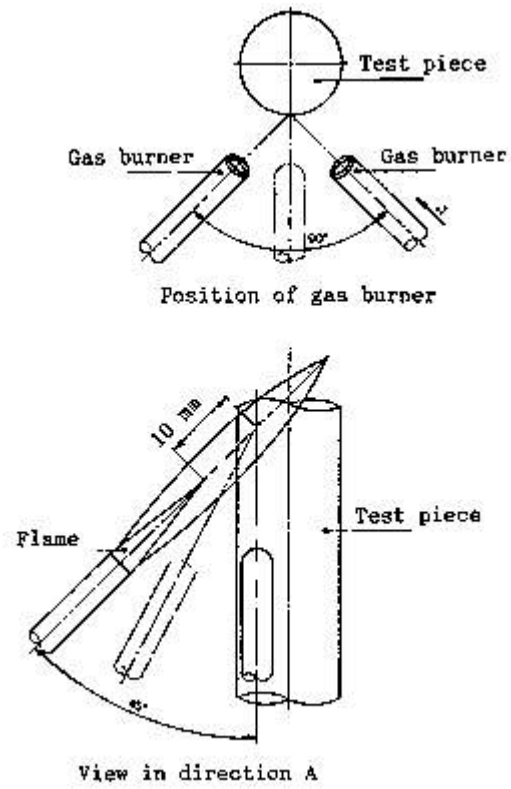


Figure 9 Arrangement of gas burner
(clause 10.6.7.1(1))

10.6.7.2 Check of burner operation

The satisfactory operation of the burner shall be checked as follows : with the axis of the burner being vertical, a bare copper wire, 0.7±0.025 mm in diameter, having a free length of not less than 100 mm shall be inserted horizontal in the flame about 10 mm above the top of the blue cone, so that the free end of the wire is vertically above the edge of the burner on the side remote from the supported end of the wire. The time required for the wire to melt shall be not more than 6 s and not less than 4 s.

10.6.7.3 Preparation of test pieces

The test piece shall be a cable of 600 ± 25 mm length.

10.6.7.4 Procedure

The sample shall be clamped at each end to position it vertically in the middle of a three-sided metallic screen, 1200 ± 25 mm high, 300 ± 25 mm wide and 450 ± 25 mm deep, with open front and closed top and bottom : the base shall be non-metallic.

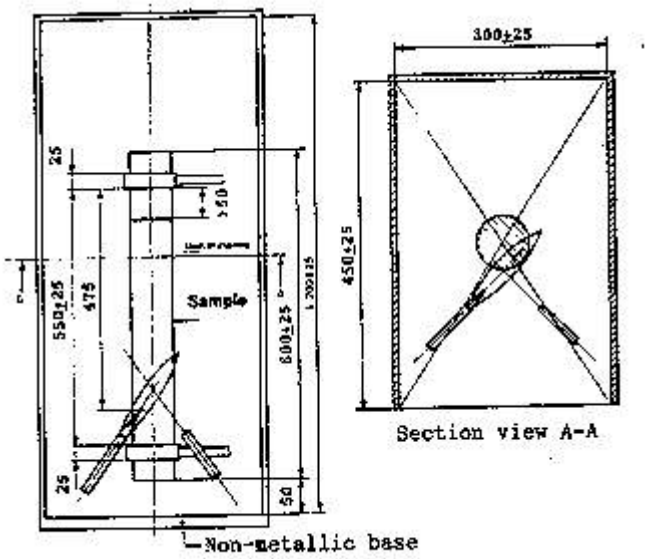
The clamps shall be approximately 25 mm wide and positioned so that the distance between the top of the bottom clamp and the bottom of the top clamp is 550 ± 25 mm.

The test shall be made in an area substantially free from draughts. The sample shall be adjusted so that the bottom of the specimen is approximately 50 mm from the base of the screen.
For the test, the axis of the burner tube shall be at an angle of 45° to the axis of the sample.
When the burner is in use the distance of the burner from the sample shall be such that the inner blue cone of the flame is at a distance of approximately 10 mm, measured along the axis of the flame , from the surface of the cable and 475 mm below the lower edge of the top clamp.
The flame shall be applied for a continuous period of t seconds derived from the formula :

$$t = 60 + \frac{m}{25}$$

Where t is the time of continuous period in s
m the weight in grams of the wire or cable sample corrected to a 600 mm length.

After all burning has cased, the surface of the sample shall be wiped clean and the charred or affected portion examined.



Units in millimetres

Figure 10 Arrangement of sample within three sided screen
(clause 10.6.7.4)

Appendix A
Calculation of insulation resistance
(clause 4.1)

The values of the insulation resistance specified in Tables 1 to 17 are based on a volume resistivity of 1 x 10^8 Ωm; they have been calculated from the formula :

$$R = 0.0367 \log \frac{D}{d}$$

Where :

R = insulation resistance, in megaohmkilometre
D = nominal outer diameter of the insulation, in mm
d = diameter of the circumscribed circle of the conductor, in mm

Appendix B
Measurement of density by the pycnometer method
(clause 10.4.1.3)

B. 1 Apparatus

The apparatus for this method consists of:

B.1.1. a balance with a precision of 0.1 mg;

B.1.2 a pan straddle or other stationary support;

B.1.3 a pycnometer of 50 ml capacity;

B.1.4 a liquid bath provided with a thermostatic control.

B. 2 Preparation of test specimens

The specimen shall be taken from the bare insulation or sheath. The mass of the specimen shall be not less than 1 g and not greater than 5 g. The specimen shall be made by cutting the sample of insulation or sheath shall be cut longitudinally into two or more parts to prevent the enclosure of air bubbles.

B. 3 Conditioning

The specimen shall be at an ambient temperature of 23 ± 2°C .

B. 4 Procedure

After weighing the pycnometer empty and dry, a suitable quantity of the specimen shall be weighed in the pycnometer. The test specimen shall be covered with the immersion liquid (alcohol, 96%) and all air removed from the specimen by, for example, applying a vacuum to the pycnometer standing in a desiccator. Any vacuum applied shall be broken and the pycnometer filled with immersion liquid which shall be brought to a temperature of 23 ± 5°C in a liquid bath, the pycnometer being filled to the limits of its capacity. The pycnometer shal be wiped dry and weighed with its contents, after which it shall be emptied and filled with immersion liquid. Air shall be removed and the weight of the pycnometer and its contents determined at a temperature of 23 ± 5°C.

B. 5 Calculation

The density at 23°C shall be caculated as follows:

$$density\ at\ \ 23^{o}C = \frac{m}{m1 - m2} x\, 0.798\ \ 8$$

where:

m = mass of specimen, in grams

m1 = mass of liquid required to fill the pycnometer, in grams

m2 = mass of liquid required to fill the pycnometer,when containing the specimen, in grams

0.788 8 = density of alcohol, 96% at 23°C, in g/cm^3