Base Load Power Hub (BLPH)

ELECTRICAL CABLES

FAT PROCEDURE - ELECTRICAL CABLES

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Table of Contents

SH.	DESCRIPTION	REVISIONS							
		00	01	02	03				
1	Cover	X	X	X	X				
2	Table of Contents	X	X	X	X				
3	Revision / Change Log / Hold List	X	X	X	X				
4	FAT	X	X	X	X				

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Revision / Change Log

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No.	Description
1.	
2.	
3.	
4.	

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FACTORY TEST PROCEDURES

450/750V Wires

POSITION FROM 290 TO 340

CONTENTS	TITLE N.
Test procedure for Conductor Resistance	1
Test procedure for High Voltage Test	2
Test Procedure for Spark Test on Insulation	3
Test Procedure for Conductor Examination	4
Test Procedure for Measurement of Thickness	5
Test Procedure for Over-all Diameter	6
Test Procedure for Insulation Resistance	7

1 – Title: Test Procedure for Conductor Resistance

1. TEST EQUIPMENT

1. Resistance measuring equipment - Micro Ohm meter

2. METHOD OF TESTING

- Remove sufficient length of the insulation from both end of the wire.
- The insulation of the conductor has to be removed about 30mm from the end of the cable.
- Connect the testing clamp of the resistomat to the both ends of the conductor.
- Adjust suitable range for the same required value.
- Adjust the cable temperature on the resistance-measuring unit for compensation at 20°C for manual measurement or connect the temperature sensor to the measuring unit for auto compensation.
- Calculate the observed resistance value per kilometers by using the following formula:

$$R = \frac{R_1 \times 1000}{L}$$

Where : R = Resistance per kilometers
R_1 = Measured Resistance
L = Length of the cable

3. REQUIREMENT

- As per data sheet.

Note : In the case of manual measurement, to calculate resistance at 20 deg.C, measured resistance at ambient temperature shall be multiplied by the temperature correction factor.

2 – Title: Test Procedure for High Voltage test

1. TEST EQUIPMENT

- HV transformer
- Water tank
- Timer chronometer

2. METHOD OF TESTING

2.1 Method of Testing

Minimum length of 10 meters has to be immersed in water tank for one hour and temperature of water tank (20±5)^{0}C . AC test voltage (49 to 61 Hz) shall be applied between the water and the conductor. The water shall be earthed.

2.2.1 High voltage Test

- Apply the 2.5 kV between conductor & to water for 5 minutes.

2.2.1.1 Requirement

- No breakdown of the insulation shall occur during the testing period

Note: the test will be performed if requested by the customer. Otherwise, we consider the spark test procedure to be valid.
Grade of voltage during extrusion according to IEC 62230

3 – Title: Test Procedure for Spark Test on Insulation

1. TEST EQUIPMENT

- Spark Tester

2. METHOD OF TESTING

- Spark test on insulation is subjected to a specified AC test voltage applied over the outer surface of insulation against conductor.
- The voltage shall be applied through out the length during manufacturing process.

- Test voltage shall be according to IEC 62230 (see Table 1)

3. REQUIREMENT

- No break down on insulation shall occur.

Table A.1 provides the test voltages that are recommended for cables that have voltages between 300 V e 3 000 V. The current to be applied to the electrodes can be AC, DC or HF

Recommended Minimum Voltages for Spark-Testing for Cables with Voltage (U0) between 300 V and 3000 V

Tabulated radial thickness of layer under test mm		Test voltage kV			
From	Up to	a.c.	d.c.	h.f.	Pulse
0	0,25	3	5	4	5
0,26	0,50	5	7	6	7
0,51	0,75	6	9	7	9
0,76	1,00	7	11	8	11
1,01	1,25	9	13	10 [a]	13
1,26	1,50	10	15	11 [a]	15
1,51	1,75	10	17	13 [a]	17
1,76	2,00	10	20	14 [a]	20
2,01	2,25	10	22	15 [a]	
2,26	2,50	10	24	17 [a]	
2,51	2,75	10	26	18 [a]	
2,76	3,00	10	28	20 [a]	

[a] h.f. voltage testing for layer thicknesses greater than 1,0 mm should be limited to frequencies between 500 Hz and 4 kHz.

Note: In each test report, the value (KV) set in spark tester is declared,according to the material thickness,during the production process and the related result :

EXAMPLE : insulation Thickness 1.0 mm

Spark Test Isolamento IEC 62230 Insulation Spark Test	7 KV	OK

4 – Title: Test Procedure for Conductor examination

1. TEST EQUIPMENT

- Vernier Cliper

2. METHOD OF TESTING

- Take a sample have length of 30 cm approximately.
- The average of two measurements taken at right angles shall be taken as the diameter.
- Average of three measurements at different places shall be considered as the diameter.
- Measurement must be taken up to two decimal places to avoid any over usage of material
- Count the number of wires / strands in the conductor

3. REQUIREMENT

- As per IEC 60228

Table 2 – Class 2 stranded conductors for single-core and multi-core cables

1	2	3	4	5	6	7	8	9	10
Nominal cross-sectional area	Minimum number of wires in the conductor						Maximum resistance of conductor at 20°C		
	Circular		Circular compacted		Shaped		Annealed copper conductor		Aluminium or aluminium alloy conductor[c]
	Cu	Al	Cu	Al	Cu	Al	Plain wires	Metal-coated wires	
mm²							Ω/km	Ω/km	Ω/km
0,5	7	-	-	-	-	-	36,0	36,7	-
0,75	7	-	-	-	-	-	24,5	24,8	-
1,0	7	-	-	-	-	-	18,1	18,2	-
1,5	7	-	6	-	-	-	12,1	12,2	-
2,5	7	-	6	-	-	-	7,41	7,56	-
4	7	-	6	-	-	-	4,61	4,70	-
6	7	-	6	-	-	-	3,08	3,11	-
10	7	7	6	6	-	-	1,83	1,84	3,08
16	7	7	6	6	-	-	1,15	1,16	1,91
25	7	7	6	6	6	6	0,727	0,734	1,20
35	7	7	6	6	6	6	0,524	0,529	0,868
50	19	19	6	6	6	6	0,387	0,391	0,641
70	19	19	12	12	12	12	0,268	0,270	0,443
95	19	19	15	15	15	15	0,193	0,195	0,320
120	37	37	18	15	18	15	0,153	0,154	0,253
150	37	37	18	15	18	15	0,124	0,126	0,206
185	37	37	30	30	30	30	0,0991	0,100	0,164
240	37	37	34	30	34	30	0,0754	0,0762	0,125
300	61	61	34	30	34	30	0,0601	0,0607	0,100
400	61	61	53	53	53	53	0,0470	0,0475	0,0778
500	61	61	53	53	53	53	0,0366	0,0369	0,0605
630	91	91	53	53	53	53	0,0283	0,0286	0,0469
800	91	91	53	53	-	-	0,0221	0,0224	0,0367
1 000	91	91	53	53	-	-	0,0176	0,0177	0,0291
1 200	[b]						0,0151	0,0151	0,0247
1 400 [a]	[b]						0,0129	0,0129	0,0212
1 600	[b]						0,0113	0,0113	0,0186
1 800 [a]	[b]						0,0101	0,0101	0,0165
2 000	[b]						0,0090	0,0090	0,0149
2 500	[b]						0,0072	0,0072	0,0127

[a] These sizes are non-preferred. Other non-preferred sizes are recognized for some specialized applications but are not within the scope of this standard.

[b] The minimum number of wires for these sizes is not specified. These sizes may be constructed from 4, 5 or 6 equal segments (Milliken).

[c] For stranded aluminium alloy conductors having the same nominal cross-sectional area as an aluminium conductor the resistance value should be agreed between the manufacturer and the purchaser.

5 – Title: Test Procedure for Measurement of Thickness

1. TEST EQUIPMENT

- Profile Projector / vernier caliper

2. METHOD OF TESTING

- Prepare each test piece of insulation in the form of a thin slice along a place perpendicular to the axis of the conductor or cable.
- Place the test piece under the measuring equipment with the plane of the cut, perpendicular to the optical axis.
- Make six measurements at 60° to each other.
- If the inner profile of the sample is irregular or uneven take six readings radically at a position where the thickness is thinnest.
- Take the reading in millimeter to two decimal places if the thickness is greater than 0.50 mm and to three decimal places if the thickness is less than 0.50 mm.

3. REQUIREMENT

- As per relevant standards and as per data sheet

This case according to EN 50525.3.31

1	2	3	4	5	6
Numero e sezione nominale dei conduttori [a]	Classe del conduttore (EN 60228)	Spessore dell'isolante Valore prescritto	Diametro esterno medio		Resistenza di isolamento minima alla temperatura nominale
			Limite inferiore	Limite superiore	
mm^2		mm	mm	mm	MΩ.km
1,5	1	0,7	2,6	3,2	0,011
2,5	1	0,8	3,2	3,9	0,010
4	1	0,8	3,6	4,4	0,008 7
6	1	0,8	4,1	5,0	0,007 4
10	1	1,0	5,3	6,4	0,007 2
1,5	2	0,7	2,7	3,3	0,010
2,5	2	0,8	3,3	4,0	0,009 9
4	2	0,8	3,8	4,6	0,008 2
6	2	0,8	4,3	5,2	0,007 0
10	2	1,0	5,6	6,7	0,006 7
16	2	1,0	6,4	7,8	0,005 6
25	2	1,2	8,1	9,7	0,005 3
35	2	1,2	9,0	10,9	0,004 6
50	2	1,4	10,6	12,8	0,004 6
70	2	1,4	12,1	14,6	0,004 0
95	2	1,6	14,1	17,1	0,003 9
120	2	1,6	15,6	18,8	0,003 5
150	2	1,8	17,3	20,9	0,003 5
185	2	2,0	19,3	23,3	0,003 5
240	2	2,2	22,0	26,6	0,003 4
300	2	2,4	24,5	29,6	0,003 3
400	2	2,6	27,5	33,2	0,003 1
500	2	2,8	30,5	36,9	0,003 0
630	2	2,8	34,0	41,1	0,002 7
800	2	2,8	37,8	45,7	0,002 4
1 000	2	3,0	42,1	51,0	0,002 3

[a] Non tutti i tipi di cavi sono specificati in tutte le dimensioni indicate qui. Vedi l'articolo specifico della norma ed anche l'art. 1 della EN 50525-1.

6 – Title: Test Procedure for Measurement of Overall Diameter

1. TEST EQUIPMENT

Y Vernier Caliper

2. METHOD OF TESTING

Y Take a sample have length of 30 cm approximately from the completed wires.
Y The average of two measurements taken at right angles shall be taken as the diameter.
Y Average of three measurements at different places shall be considered as the diameter.
Y Measurement must be taken up to two decimal places to avoid any over usage of material

3. REQUIREMENT

Y As per relevant specifications and as per data sheet

This case according to EN 50525.3.31

1	2	3	4	5	6
Numero e sezione nominale dei conduttori [a]	Classe del conduttore (EN 60228)	Spessore dell'isolante	Diametro esterno medio		Resistenza di isolamento minima alla temperatura nominale
		Valore prescritto	Limite inferiore	Limite superiore	
mm^2		mm	mm	mm	MΩ.km
1,5	1	0,7	2,6	3,2	0,011
2,5	1	0,8	3,2	3,9	0,010
4	1	0,8	3,6	4,4	0,008 7
6	1	0,8	4,1	5,0	0,007 4
10	1	1,0	5,3	6,4	0,007 2
1,5	2	0,7	2,7	3,3	0,010
2,5	2	0,8	3,3	4,0	0,009 9
4	2	0,8	3,8	4,6	0,008 2
6	2	0,8	4,3	5,2	0,007 0
10	2	1,0	5,6	6,7	0,006 7
16	2	1,0	6,4	7,8	0,005 6
25	2	1,2	8,1	9,7	0,005 3
35	2	1,2	9,0	10,9	0,004 6
50	2	1,4	10,6	12,8	0,004 6
70	2	1,4	12,1	14,6	0,004 0
95	2	1,6	14,1	17,1	0,003 9
120	2	1,6	15,6	18,8	0,003 5
150	2	1,8	17,3	20,9	0,003 5
185	2	2,0	19,3	23,3	0,003 5
240	2	2,2	22,0	26,6	0,003 4
300	2	2,4	24,5	29,6	0,003 3
400	2	2,6	27,5	33,2	0,003 1
500	2	2,8	30,5	36,9	0,003 0
630	2	2,8	34,0	41,1	0,002 7
800	2	2,8	37,8	45,7	0,002 4
1 000	2	3,0	42,1	51,0	0,002 3

[a] Non tutti i tipi di cavi sono specificati in tutte le dimensioni indicate qui. Vedi l'articolo specifico della norma ed anche l'art. 1 della EN 50525-1.

7 – Title: Test Procedure for Insulation Resistance

1. TEST EQUIPMENT

Y Megger

2. METHOD OF TESTING

Y Connect the ' + ' lead of the megger to core and ' - ' to water
Y Apply 500 V DC for 1 minute and measure the reading.

3. REQUIREMENT

Y Insulation resistance as per data sheets

Note: the test is to be considered as type test of the used material in order to define the value of the constant insulation Ki, to be used to state the value of insulation resistance of the other size of the cable. (tested on 10 mt length of cable type).

Table B.1 — Cables with rigid conductor (450/750 V)

1	2	3	4	5	6
Nominal cross-sectional area of conductors [a]	Class of conductor (EN 60228)	Thickness of insulation	Mean overall diameter		Minimum insulation resistance at rated temperature
		Specified value	Lower limit	Upper limit	
mm^2		mm	mm	mm	MΩ.km
1,5	1	0,7	2,6	3,2	0,011
2,5	1	0,8	3,2	3,9	0,010
4	1	0,8	3,6	4,4	0,008 7
6	1	0,8	4,1	5,0	0,007 4
10	1	1,0	5,3	6,4	0,007 2
1,5	2	0,7	2,7	3,3	0,010
2,5	2	0,8	3,3	4,0	0,009 9
4	2	0,8	3,8	4,6	0,008 2
6	2	0,8	4,3	5,2	0,007 0
10	2	1,0	5,6	6,7	0,006 7
16	2	1,0	6,4	7,8	0,005 6
25	2	1,2	8,1	9,7	0,005 3
35	2	1,2	9,0	10,9	0,004 6
50	2	1,4	10,6	12,8	0,004 6
70	2	1,4	12,1	14,6	0,004 0
95	2	1,6	14,1	17,1	0,003 9
120	2	1,6	15,6	18,8	0,003 5
150	2	1,8	17,3	20,9	0,003 5
185	2	2,0	19,3	23,3	0,003 5
240	2	2,2	22,0	26,6	0,003 4
300	2	2,4	24,5	29,6	0,003 3
400	2	2,6	27,5	33,2	0,003 1
500	2	2,8	30,5	36,9	0,003 0
630	2	2,8	34,0	41,1	0,002 7
800	2	2,8	37,8	45,7	0,002 4
1 000	2	3,0	42,1	51,0	0,002 3

[a] Not all cable types are specified in all the sizes given here. See the specific clause of the standard, and also of Clause 1 of EN 50525-1.

FACTORY TEST PROCEDURES

L.V.Electrical Power Cables 0,6/1KV

POS FROM 20 TO 280 - FROM 350 TO 390

CONTENTS	TITLE N.
Test procedure for High Voltage Test	1
Test procedure for Spark Test on Insulation & Sheath	2
Test procedure for Conductor Resistance	3
Test procedure for Insulation Resistance	4
Test procedure for Conductor Examination	5
Test Procedure for Measurement of Thickness of Insulation and Sheaths	6
Test Procedure for Armour / Wire Measurement if provided	7
Test Procedure of diameter under armour and overall	8
Test Procedure for Hot Set Test	9
Fire Resistant & Flame Retardant	10

1 – Title: Test Procedure for High Voltage test

1. TEST EQUIPMENT

1. HV transformer
2. Timer Chronometer

2. METHOD OF TESTING

2.1 Method of Testing

→ Testing will be carried out at ambient temperature.
→ Remove sufficient length of outer jacket, armour and inner sheath from both end of the cable.
→ Connect the high voltage source to the conductor.
→ Connect metallic armour to the ground.
→ Test voltage shall be applied between conductor and metallic armour.

2.2 Low Voltage cables

2.2.1 High voltage Test

→ Apply the 3.5 kV between each conductor and between conductor and metallic armour for 5 minutes.

2.2.1.1 Requirement

→ No breakdown of the insulation shall occur during the testing period

2 – Title: Test Procedure for Spark Test on Insulation & Sheath

1. TEST EQUIPMENT

1. **Spark Tester**

2. METHOD OF TESTING

→ Spark test on insulation & sheath is subjected to a specific AC test voltage applied over the outer surface of insulation & sheath against conductor.
→ The voltage shall be applied through out the length during manufacture process.
→ Test voltage shall be according to IEC 62230 (see Table 1)

3. REQUIREMENT

→ No break down on insulation shall occurr.

Tabulated radial thickness of layer under test mm		Test voltage kV			
From	Up to	a.c.	d.c.	h.f.	Pulse
0	0,25	3	5	4	5
0,26	0,50	5	7	6	7
0,51	0,75	6	9	7	9
0,76	1,00	7	11	8	11
1,01	1,25	9	13	10 [a]	13
1,26	1,50	10	15	11 [a]	15
1,51	1,75	10	17	13 [a]	17
1,76	2,00	10	20	14 [a]	20
2,01	2,25	10	22	15 [a]	
2,26	2,50	10	24	17 [a]	
2,51	2,75	10	26	18 [a]	
2,76	3,00	10	28	20 [a]	

[a] h.f. voltage testing for layer thicknesses greater than 1,0 mm should be limited to frequencies between 500 Hz and 4 kHz.

3 – Title: Test Procedure for Conductor Resistance

1. TEST EQUIPMENT

1. Resistance measuring equipment - Micro Ohm meter.

2. METHOD OF TESTING

→ Remove sufficient length of the outer jacket, armour and inner sheath from both end of the cable.
→ The insulation of the conductor has to be removed about 30mm from the end of the cable.
→ Connect the testing clamp of the resistomat to the both ends of the conductor.
→ Adjust suitable range for the same required value.
→ Adjust the cable temperature on the resistance-measuring unit for compensation at 20°C for manual measurement or connect the temperature sensor to the measuring unit for auto compensation.
→ Calculate the observed resistance value per kilometers by using the following formula:

$$R = \frac{R_1 \times 1000}{L} \text{ (ohm/Km)}$$

Where : R = Resistance per kilometers
R_1 = Measured Resistance
L = Length of the cable

3. REQUIREMENT

→ As per relevant specification (IEC 60228).

Note : In the case of manual measurement, to calculate resistance at 20 deg.C, measured resistance at ambient temperature shall be multiplied by the temperature correction factor.

Table 2 – Class 2 stranded conductors for single-core and multi-core cables

1	2	3	4	5	6	7	8	9	10
Nominal cross-sectional area	Minimum number of wires in the conductor						Maximum resistance of conductor at 20°C		
	Circular		Circular compacted		Shaped		Annealed copper conductor		Aluminium or aluminium alloy conductor[c]
	Cu	Al	Cu	Al	Cu	Al	Plain wires	Metal-coated wires	
mm²							Ω/km	Ω/km	Ω/km
0,5	7	-	-	-	-	-	36,0	36,7	-
0,75	7	-	-	-	-	-	24,5	24,8	-
1,0	7	-	-	-	-	-	18,1	18,2	-
1,5	7	-	6	-	-	-	12,1	12,2	-
2,5	7	-	6	-	-	-	7,41	7,56	-
4	7	-	6	-	-	-	4,61	4,70	-
6	7	-	6	-	-	-	3,08	3,11	-
10	7	7	6	6	-	-	1,83	1,84	3,08
16	7	7	6	6	-	-	1,15	1,16	1,91
25	7	7	6	6	6	6	0,727	0,734	1,20
35	7	7	6	6	6	6	0,524	0,529	0,868
50	19	19	6	6	6	6	0,387	0,391	0,641
70	19	19	12	12	12	12	0,268	0,270	0,443
95	19	19	15	15	15	15	0,193	0,195	0,320
120	37	37	18	15	18	15	0,153	0,154	0,253
150	37	37	18	15	18	15	0,124	0,126	0,206
185	37	37	30	30	30	30	0,0991	0,100	0,164
240	37	37	34	30	34	30	0,0754	0,0762	0,125
300	61	61	34	30	34	30	0,0601	0,0607	0,100
400	61	61	53	53	53	53	0,0470	0,0475	0,0778
500	61	61	53	53	53	53	0,0366	0,0369	0,0605
630	91	91	53	53	53	53	0,0283	0,0286	0,0469
800	91	91	53	53	-	-	0,0221	0,0224	0,0367
1 000	91	91	53	53	-	-	0,0176	0,0177	0,0291
1 200	[b]						0,0151	0,0151	0,0247
1 400 [a]	[b]						0,0129	0,0129	0,0212
1 600	[b]						0,0113	0,0113	0,0186
1 800 [a]	[b]						0,0101	0,0101	0,0165
2 000	[b]						0,0090	0,0090	0,0149
2 500	[b]						0,0072	0,0072	0,0127

[a] These sizes are non-preferred. Other non-preferred sizes are recognized for some specialized applications but are not within the scope of this standard.

[b] The minimum number of wires for these sizes is not specified. These sizes may be constructed from 4, 5 or 6 equal segments (Milliken).

[c] For stranded aluminium alloy conductors having the same nominal cross-sectional area as an aluminium conductor the resistance value should be agreed between the manufacturer and the purchaser.

4 – Title: Test Procedure for Insulation Resistance

1. TEST EQUIPMENT

1 . Megger

2. METHOD OF TESTING

→ Connect the ' + ' lead of the megger to core and ' - ' lead to all other cores, metallic screen & armour.

→ Apply 500 V DC for 1 minute and measure the reading.

→ Calculate the observed insulation resistance value per kilometers by using the Following formula:

Ri = R1x L (MohmxKm)

Where Ri : Insulation resistance x kilometers
R1: Measured resistance Megaohm
L : Length of the cable kilometers

3. REQUIREMENT

→ Insulation resistance as per data sheet

Note: In the case of manual measurement, to calculate resistance at 20 deg.C, measured insulation resistance at ambient temperature shall be multiplied by the temperature correction factor of insulation material

Table 3 – Electrical requirements of insulation compounds

Designation of the insulating compound	EPR	HEPR	XLPE	HF90	S 95
Insulation resistance constant Ki (MΩ.km) (see 7.2 of IEC 60092-350:—)					
– at 20 °C, minimum,	3 670	3 670	3 670	550	1 850
– at maximum operating temperature, minimum.	3,67	3,67	3,67	0,55	1,85
Volume resistivity ρ(Ω.cm) (see 7.2 of IEC 60092-350:—)					
– at 20 °C, minimum,	$1,0 \times 10^{15}$	$1,0 \times 10^{15}$	$1,0 \times 10^{15}$	$1,5 \times 10^{14}$	$5,0 \times 10^{13}$
– at maximum operating temperature, minimum.	$1,0 \times 10^{12}$	$1,0 \times 10^{12}$	$1,0 \times 10^{12}$	$1,5 \times 10^{11}$	$5,0 \times 10^{10}$

5 – Title: Test Procedure for Conductor examination

1. TEST EQUIPMENT

1. Vernier Cliper

2. METHOD OF TESTING

- → Take a sample have length of 30 cm approximately.
- → The average of two measurements taken at right angles shall be taken as the diameter.
- → Average of three measurements at different places shall be considered as the diameter.
- → Measurement must be taken up to two decimal places to avoid any over usage of material
- → Count the number of wires / strands in the conductor

3. REQUIREMENT

- → As per IEC 60228.

Table 2 – Class 2 stranded conductors for single-core and multi-core cables

1	2	3	4	5	6	7	8	9	10
Nominal cross-sectional area	Minimum number of wires in the conductor						Maximum resistance of conductor at 20°C		
	Circular		Circular compacted		Shaped		Annealed copper conductor		Aluminium or aluminium alloy conductor[c]
	Cu	Al	Cu	Al	Cu	Al	Plain wires	Metal-coated wires	
mm²							Ω/km	Ω/km	Ω/km
0,5	7	-	-	-	-	-	36,0	36,7	-
0,75	7	-	-	-	-	-	24,5	24,8	-
1,0	7	-	-	-	-	-	18,1	18,2	-
1,5	7	-	6	-	-	-	12,1	12,2	-
2,5	7	-	6	-	-	-	7,41	7,56	-
4	7	-	6	-	-	-	4,61	4,70	-
6	7	-	6	-	-	-	3,08	3,11	-
10	7	7	6	6	-	-	1,83	1,84	3,08
16	7	7	6	6	-	-	1,15	1,16	1,91
25	7	7	6	6	6	6	0,727	0,734	1,20
35	7	7	6	6	6	6	0,524	0,529	0,868
50	19	19	6	6	6	6	0,387	0,391	0,641
70	19	19	12	12	12	12	0,268	0,270	0,443
95	19	19	15	15	15	15	0,193	0,195	0,320
120	37	37	18	15	18	15	0,153	0,154	0,253
150	37	37	18	15	18	15	0,124	0,126	0,206
185	37	37	30	30	30	30	0,0991	0,100	0,164
240	37	37	34	30	34	30	0,0754	0,0762	0,125
300	61	61	34	30	34	30	0,0601	0,0607	0,100
400	61	61	53	53	53	53	0,0470	0,0475	0,0778
500	61	61	53	53	53	53	0,0366	0,0369	0,0605
630	91	91	53	53	53	53	0,0283	0,0286	0,0469
800	91	91	53	53	-	-	0,0221	0,0224	0,0367
1 000	91	91	53	53	-	-	0,0176	0,0177	0,0291
1 200	[b]						0,0151	0,0151	0,0247
1 400 [a]	[b]						0,0129	0,0129	0,0212
1 600	[b]						0,0113	0,0113	0,0186
1 800 [a]	[b]						0,0101	0,0101	0,0165
2 000	[b]						0,0090	0,0090	0,0149
2 500	[b]						0,0072	0,0072	0,0127

[a] These sizes are non-preferred. Other non-preferred sizes are recognized for some specialized applications but are not within the scope of this standard.

[b] The minimum number of wires for these sizes is not specified. These sizes may be constructed from 4, 5 or 6 equal segments (Milliken).

[c] For stranded aluminium alloy conductors having the same nominal cross-sectional area as an aluminium conductor the resistance value should be agreed between the manufacturer and the purchaser.

6 – Title: Test Procedure for Measurement of Thickness of Insulation and Sheaths

1. TEST EQUIPMENT

1. Profile Projector / Vernier caliper

2. METHOD OF TESTING

→ Prepare each test piece of insulation and sheaths in the form of a thin slice along a place perpendicular to the axis of the conductor or cable.
→ Place the test piece under the measuring equipment with the plane of the cut, perpendicular to the optical axis.
→ Make six measurements at 60° to each other.
→ If the inner profile of the sample is irregular or uneven take six readings radically at a position where the thickness is thinnest.
→ Take the reading in millimeter to two decimal places if the thickness is greater than 0.50 mm and to three decimal places if the thickness is less than 0.50 mm.
→ For the sheath direct over the insulation cores the number of readings shall be the same number of cores but limited to six measurements points.

3. REQUIREMENT

→ As per data sheet.
Data Sheets approved available during FAT.

7 – Title: Test Procedure for Armour / Wire Measurement

1. TEST EQUIPMENT

1. Micrometer

2. METHOD OF TESTING

→ Take a sample have length of 30cm approximately.
→ The average of two measurement taken at right angles shall be taken as the diameter of wire / width & Thickness of tape.
→ Average of three measurements at different places shall be considered as the diameter of wire / width & thickness of tape.
→ Measurement must be taken up two decimal places to avoid any over usage of material

3. REQUIREMENT

→ As per relevant data sheet.
Data Sheets approved available during FAT.

8 – Title: Test Procedure of diameter under armour and overall

1. TEST EQUIPMENT

1. Vernier caliper

2. METHOD OF TESTING

→ Take a sample have length of 30 cm approximately.
→ The average of two measurements taken at right angles shall be taken as the diameter
→ Average of three measurements at different places shall be considered as the diameter
→ Measurement must be taken up to two decimal places to avoid any over usage of material

3. REQUIREMENT

→ As per relevant specification and data sheet.
Data Sheets approved available during FAT.

4.7 Inner sheath

4.7.1 Material

The inner sheath material shall be selected from one of those listed in IEC 60092-360. The sheathing compound selected shall be compatible with the cable components with which it is in contact and compatible with the operating temperature of the cable.

4.7.2 Application

The inner sheath shall be extruded in one or more closely adherent layers. The inner sheath shall form a compact and homogeneous body and shall be so applied that it fits closely onto the underlying components.

It shall be possible to remove the inner sheath without damaging the underlying insulation and/or screen(s).

4.7.3 Thickness of inner sheath

The thickness of the inner sheath for each size and type of cable shall be as specified in the applicable product standard.

Unless specified in the applicable product standard, the thickness at any point may be less than the specified value, providing the difference does not exceed 0,1 mm + 15 % of the specified value for sheaths applied on a smooth cylindrical surface, or 0,2 mm + 20 % of the specified value for sheaths applied on an irregular cylindrical surface.

The thickness of any tape(s) under or over the inner sheath shall not be included in the measurement of the thickness of the inner sheath.

4.8 Metal braid armour

4.8.1 Material

The metal braid armour shall be made of zinc-coated (galvanized) steel wires complying with the galvanizing test specified in 8.12 and ISO 7989-2, or copper, metal-coated copper or copper-alloy wires.

For high voltage cables described in IEC 60092-354, the use of double steel tape armour and round or flat steel wire armour are permitted. For further guidance on construction, see IEC 60502-2.

4.8.2 Application

The "coverage density" of the braid shall be such that the weight of the braid is at least 90 % of the weight of a tube of the same metal, having an internal diameter equal to the calculated internal diameter under the braid and a thickness equal to the nominal diameter of the wires forming the braid.

The diameter under the braid is calculated with the fictitious method given in Annex A.

NOTE An alternative method for evaluating the "coverage density" of symmetrical braids is given by the following formula giving the "filling factor", F:

$$F = \frac{NPd}{\sin\alpha} \text{ or } \quad (mnd/2\pi D)\ (1 + \pi^2 D^2/L^2)^{1/2}$$

Where

α: is the slope angle between the cable axis and the braid wires;

d: is the diameter of braid wire;

N: is the number of wires per carrier;

P: is the number of picks per millimetre;

m: is the total number of spindles;

n: is the total number of ends per spindle;

D is the mean diameter of the braid;

L is the lay length of the braiding wire.

The corresponding "coverage density", expressed as a percentage, is given by the formula:

$$G = \frac{\pi}{2} \cdot F \cdot 100$$

The coverage density G of (90 %) is reached for a value of filling factor F of 0,573.

4.9 Outer sheath

4.9.1 Material

The sheath shall be selected from one of those listed in IEC 60092-360. The sheathing compound selected shall be compatible with the cable components with which it is in contact and compatible with the operating temperature of the cable.

4.9.2 Application

The outer sheath shall be extruded in one or more closely adherent layers. The outer sheath shall form a compact and homogeneous body and shall be so applied that it fits closely onto the underlying components.

It shall be possible to remove the outer sheath without damaging the underlying insulation and/or screen(s).

4.9.3 Thickness of outer sheath

The thickness of sheath for each size and type of cable shall be as specified in the applicable product standard.

Unless specified in the applicable product standard, the thickness at any point may be less than the specified value if any, providing the difference does not exceed 0,1 mm + 15 % of the specified value for sheaths applied on a smooth cylindrical surface, or 0,2 mm + 20 % of the specified value for sheaths applied on an irregular cylindrical surface.

9 – Title: Test Procedure for Hot Set Test

1. TEST EQUIPMENT

1 Heating Oven.
2 Calibrated weights
3 Sample holding fixture
4 Caliper
5 Timer

2. METHOD OF TESTING

→ Prepare dumbbell test pieces from XLPE insulation with thickness 0.8 to 2.00mm.
→ Mark 20 mm gauge length in the center of the dumbbell. (L_1).
→ Suspend the sample in the oven with a weight of 20 N/cm2 at 200°C for 15 minutes.
→ After the test duration of 15 minutes measure the length between the marks. (L_2)
→ Calculate the elongation, in percentage, under load as follows

$$\frac{L_2 - L_1}{L_1} \times 100$$

→ Remove the load from the test piece and keep in oven at same temperature for 5 minutes.
→ After 5 minutes, remove the sample from oven and allow to cool to room temperature.
→ After the sample attained to room temperature measure the lengths between the marks. (L3)
→ Calculate the elongation, in percentage, without load as follows

$$\frac{L_3 - L_1}{L_1} \times 100$$

3. REQUIREMENT

→ The elongation without load shall not be more than 15%
→ The elongation under load shall not be more than 175%

10 – Title: Test Procedure for Flame Retardant & Fire Resistant

1. SCOPE OF TEST

This test procedure details the test methods to check if cable will pass test for Flame retardant & or Fire Resistant

2. NORMATIVE REFERENCE

IEC 60332.1.2 - IEC 60332.3.22 Flame retardant
IEC 60331.21 Fire Resistant

3. TEST EQUIPMENT

According to IEC 60332.1.2 for Flame Retardant

TEST EQUIPMENT

- A suitable three-sided metallic screen, with open front and closed top and bottom. The base shall be non-metallic
- A clamp suitable to fix the test sample of cables
- One gas burner

TEST SAMPLE

The test sample shall be a piece of the finished cable of cable 600 + - 25 mm long

FLAME CONDITION

When propane is used, the burner being regulated to give a flame approximately 175 mm Long with an inner blue cone approximately 55 mm long

TEST PROCEDURE

The sample shall be clamped at each end to position it vertically in the middle of a three-sided metallic screen and shall be adjusted so that the bottom of sample is approximately 50 mm from the base of the metallic screen.
The axis of the burner shall be at an angle of 45° to the axis of the sample.
The flame is applied for a continuos period of T seconds derived from Table 1:

Table 1 – Time for flame application

Overall diameter of test piece [a] mm	Time for flame application [b] s
$D \leq 25$	60 ± 2
$25 < D \leq 50$	120 ± 2
$50 < D \leq 75$	240 ± 2
$D > 75$	480 ± 2

[a] Where non-circular cables (for example, flat-form constructions) are to be tested, the circumference shall be measured and used to calculate an equivalent diameter, as if the cable were circular.

[b] For flat cables having a ratio of major to minor axis greater than 17:1, the flame application time remains under consideration.

TEST EVALUATION CRITERIA

After the burning has ceased, the surface of sample shall be wiped clean and the charred of affected portion shall not have reached 50 mm of the lower edge of the top clamp.

According to IEC 60331.21 For Fire Resistant

TEST EQUIPMENT

- A suitable chamber, of minimum volume 10 m^3
- A source of heat comprising a horizontally mounted ribbon burner
- A sample supporting systems
- A test wall equipped with thermocouples for verification of the source of heat
- A continuity checking arrangement
- Fuses

TEST SAMPLE

A cable sample at least 4.5m long shall be available from the cable length for test. Each individual test specimen to be tested shall be a piece of cable, taken from the cable sample,
not less than 1200 mm long shall have approximately 100 mm of sheath or outer coverings removed at each end.
At each end of the cable, each conductor shall be suitably prepared for electrical connections, and the exposed conductors shall be spread apart to avoid contact with each other.

TEST CONDITIONS

- Flow rate (at reference conditions of 1 bar and 20°C)
- Propane: (5,0 ± 0,25) litres/minute
- Air: (80 ± 5) litres/minute
- Test temperature: 750 °C
- Voltage applied between the cores: 1000 V a.c.

TEST PROCEDURE

The test specimen shall be held horizontally by means of suitable supports at each end and securely clamped to prevent movement.
The middle portion of the test specimen shall be supported by two metal rings placed approximately 300 mm; these, as well as any other metal parts of the supporting systems, shall be earthed.
At the transformer end of the test sample, ground the neutral conductor and any protective conductors. Any metal screens, drain wire or metallic layer shall be interconnected and grounded. Where a metallic sheath, armour or screen acts as a neutral or protective conductor, it shall be connected as for a neutral or protective conductor.
Each phase conductor is connected to a separate phase of the transformer output by a 2A fuse.
For multicores ≥4, multipairs, and multitriads cables, the conductors have to be divided in groups and each group has to be connected to a separate phase of the transformer output with a 2 A fuse or circuit-breaker with equivalent characteristics in each phase.

Ignite the burner and adjust the propane and air flow rates to those obtained during the verification procedure (see IEC 60331-11).
Switch on the electricity supply and adjust the voltage to the rated voltage of the cable (subject to a minimum voltage of 100 V a.c.), i.e. the test voltage between conductors shall equal the rated voltage between conductors and the test voltage from conductors to earth shall equal the rated voltage from conductor to earth. In the case of single-core cables the voltage shall be applied between the conductor and the earthed supporting apparatus and earthed metallic covering, if present.
The test shall continue for the flame application for 3 hours, if not otherwise specified. After that the flame shall be extinguished but the cable sample shall remain energized for a further 15 min. The total test duration shall be the flame application time together with the 15 min cooling period.

TEST EVALUATION CRITERIA

The criteria for determining the point of failure shall be as follows:

- the voltage is not maintained during the test duration, as indicated by fuse failure
- a conductor rupture during the test duration, as indicated by the lamp extinguishing