LIBAN CABLES

Quality • Reliability • Innovation

ISO 9001 CERTIFIED
BY AFAQ No. QUAL / 1997 / 7034

HIGH VOLTAGE CABLES
FROM 38/66 (72.5) KV TO 130/225 (245) KV

CERTIFICATION

AFAQ

N° QUAL/1997/7034

Le Système Qualité adopté par :
The Quality System developed by :

LIBAN CABLES SAL

pour les activités suivantes :
for the following activities :

CONCEPTION, DEVELOPPEMENT, PRODUCTION ET COMMERCIALISATION DE FILS, CORDES ET CABLES NUS ET ISOLES : ELECTRIQUES (BASSE, MOYENNE ET HAUTE TENSION) ET DE TELECOMMUNICATION (A CONDUCTEUR CUIVRE ET A FIBRE OPTIQUE), LE TOUT A USAGE PUBLIC, DOMESTIQUE, INDUSTRIEL ET SPECIAL.

DESIGN, DEVELOPMENT, PRODUCTION AND MARKETING AND SALES OF WIRES, BARE AND INSULATED ROPES AND CABLES : ELECTRICAL (LOW, MEDIUM AND HIGH VOLTAGE) AND OF TELECOMMUNICATION (COPPER CONDUCTOR AND OPTICAL FIBER), FOR PUBLIC, DOMESTIC, INDUSTRIAL AND SPECIAL USE.

exercées sur le(s) site(s) suivant(s) :
carried out in the following location(s) :

Siège Social : Sanayeh Rue Justinien Immeuble CCI BP 11
9008 BEYROUTH LIBAN
Usine : Nahr Ibrahim LIBAN

a été évalué et jugé conforme aux exigences de la norme :
has been assessed and found to conform to the requirements of the standard :

ISO 9001 (1994)

Le certificat correspondant a été délivré dans les conditions d'application fixées par AFAQ le :
The corresponding certificate has been delivered under AFAQ application rules on :

2000-02-06

(année-mois-jour) Il est valable jusqu'au/ *It is valid until* **2003-02-05** (year-month-day)

Le Président du Comité de Certification	Le Directeur Général d'AFAQ	Le Représentant de l'Entreprise
The President of the Certification Committee	The Managing Director of AFAQ	On Behalf of the Firm
A. PIGEONNIER	O. PEYRAT	G. SOULBOL

AFAQ – 116, AVENUE ARISTIDE BRIAND - BP 40 / F-92225 BAGNEUX CEDEX FRANCE

5.5.2 - STANDARDS REQUIREMENTS - TECHNICALCHARACTERISTICS

Designation	IEC 840	AIEC Standards CS7-93		HN 33 - s - 52 Standard	HN 33-s-53 Standard	
1. Rated voltage of cable Uo/U (Um) 1.1 Definitions In accordance with IEC 183 Uo: U: Um:	The rated r.m.s. power frequency voltage between each conductor and screen or sheath for which cables and accessories are designed. The rated r.m.s. power frequency voltage between any two conductors for which cables and accessories are designed The maximum rated r.m.s. power frequency voltage between any two conductors for which cables and accessories are designed. It is the highest voltage that can be sustained under normal operating conditions at any time and at any point in a system. It excludes temporary voltage variations due to fault conditions and the sudden disconnection of large loads.					
1.2 Standard voltage range - Minimum rated voltages ..... - Maximum rated voltages	>18/30 (36) KV ≤ 87/150 (170) KV	U ≥ 69KV U ≤ 138 KV		> 18/30 (36) KV ≤ 87/150 (170) KV	> 87/150 (170) KV ≤ 290 / 500 (525) KV	
2. Maximum conductor temperature - in normal operation (Tc) - in short-circuit operation (Tn) - in emergency operation (TE)	90˚C 250˚C under consideration	90˚C 250˚C 105˚C (up to 130˚C when applicable) No more than 72 hours per emergency period in any 12 months and for a total of 1500 hours cumulaive during the life of the cable.		The mean duration of annual emergencies during the life of the cable shall not exceed 72 hours, without exceeding 216 hours in any one period of 12 months.	90˚C 250˚C 100˚C	
3. Maximum electrical field stress within the insulation in KV/mm For a network voltage U, and a cable under normal operating conditions, at voltage Uo:	Not mentionned	U = 69 KV	115 ≤ U ≤ 138	30 < U ≤ 150	150 < U ≤ 300	300 < U ≤ 500
- on the internal semi-conducting layer ..		6	8	7	11	16
- on the outer semi-conducting layer				4	5.5	7

5.5.2 - STANDARDS REQUIREMENTS - TECHNICAL CHARACTERISTICS (cont.)

<table>
<tr><th>Designation</th><th>IEC - AEIC</th><th>HN 33-S-52 and HN 33-S-53 Standards</th></tr>
<tr><td>4. Maximum short-circuit current in the mettalic shield</td><td>Not mentionned</td><td>• The short-circuit current is the sum of two components:
- a sinusoidal component: Is
- an aperiodic component: Ia

The maximum value I_M is reached for the maximum asymmetry.

• Hypothesis for thermal calculation:
- initial shield temperature = 80˚C
- final shield temperature = 210˚C (up to 250˚C when applicable)

<table>
<tr><th rowspan="2">EDF Network Rated voltage U (KV)</th><th colspan="2">Short-circuit current (r.m.s. value)</th><th rowspan="2">Duration (s)</th></tr>
<tr><th>Is (kA)</th><th>I_M (kA)</th></tr>
<tr><td>63</td><td>8.0</td><td>8.4</td><td>1.7</td></tr>
<tr><td>90</td><td>10.3</td><td>10.8</td><td>1.7</td></tr>
<tr><td>225</td><td>31.5</td><td>35.0</td><td>0.5</td></tr>
<tr><td>400</td><td>40.0
or
63.0</td><td>44.5
or
70.0</td><td>0.5

0.5</td></tr>
</table>
</td></tr>
<tr><td>5. Minimum thickness of the lead alloy sheath (when applicable)</td><td>Not mentionned</td><td>If the cable has a lead alloy sheath, its average thickness shall not fall below the nominal thickness given in the table.

<table>
<tr><th>Outer diameter D of cable before lead sheathing mm</th><th>Minimal nominal Thickness of lead sheath mm</th></tr>
<tr><td>65 ≤ D < 70</td><td>1.7</td></tr>
<tr><td>70 ≤ D < 75</td><td>1.8</td></tr>
<tr><td>75 ≤ D < 80</td><td>1.8</td></tr>
<tr><td>80 ≤ D < 85</td><td>1.9</td></tr>
<tr><td>85 ≤ D < 90</td><td>1.9</td></tr>
<tr><td>90 ≤ D < 95</td><td>2.0</td></tr>
<tr><td>95 ≤ D < 100</td><td>2.1</td></tr>
<tr><td>100 ≤ D < 105</td><td>2.2</td></tr>
<tr><td>105 ≤ D < 110</td><td>2.3</td></tr>
<tr><td>110 ≤ D < 115</td><td>2.4</td></tr>
<tr><td>115 ≤ D</td><td>to be considered</td></tr>
</table>
</td></tr>
</table>

5.5.2 - STANDARDS REQUIREMENTS (cont.) - TESTS ON DELIVERED CABLE LENGTHS

Tests item in accordance with IEC 840	**IEC Publication 840** 36 KV < Um ≤ 170 KV	**AEIC CS7-93 Standard** 69 KV ≤ U ≤ 138 KV	**HN 33-S-52 and HN 33-S-53 Standards** 36 KV < Um < 300 KV
1. Routine tests (at room temperature)	Frequency range: 49 to 61 Hz - Wave form: substantially sinusoidal - Values quoted: r.m.s. values		
1.1 Partial discharge test	IEC 885-2 - sensitivity ≤ 10 PC	ICEA T-24-380	Partial discharge test not required
- voltage raised at	1.75 Uo for 10s	2.5 Uo for more then 3 minutes	
- discharge magnitude at 1.5 Uo	≤ 10 PC	≤ 5PC	
1.2 Voltage test of the insulation (between conductor and metallic screen ..... * Complementary EDF a.c. test, 24 hours later, at 0.9 α Uo for 1 hour.	at 2.5 Uo - duration: 30 min.	at 2.5 Uo - duration: 30 min. or at 3.0 Uo - duration: 15 min.	EDF Network Um (KV) / Coef.α / Test duration (hour): 36 ≤ Um < 170 — 1.5 — 0.5; 170 ≤ Um < 300 — 2.2 — 1.0
1.3 Electrical test on non-metallic sheath in accordance with IEC 229	d.c. test voltage: 8KV per mm of the extruded sheath, with a maximum of 25 KV - duration: 1 min.		
2. Special tests	Frequency of test: on one length from each manufacturing series of the same type and size of cable - Not more than 10% of the number of lengths in any contract, rounded to the upper unity.		
2.1 Conductor examination and measurement of electrical resistance:	Accordng to IEC 228 when applicable or to contractual values		
2.2 Measurement of thickness of:	t_n: specified nominal thick., t_m/t_M: measured mini. / maxi. Thick. at any point., t_a: measured average thick.		
- insulation	.....: $t_m \geq 0.09\ t_n$ and $(t_M - t_m) / T_M \leq 0.15$		
- metallic sheath	Lead alloy sheath (when applicable): $t_m \geq t_n - (0.1 + 0.05 t_n)$ in mm		
- non-metallic sheath	Extruded PE or PVC sheath	:$t_m \geq t_n - (0.1 + 0.15\ t_n)$ in mm and $t_a \geq t_n$ when applicable	
2.3 Measurement of capacitance	Measured value ≤ 1.08 times the nominal specified value		
2.4 Hot set test	Sampling and procedure in accordance with IEC 811-2-1 clause 9, and IEC 840 table VI		

5.5.2 - STANDARDS REQUIREMENTS (cont.) - ELECTRICAL TYPE TESTS ON COMPLETE CABLE (optional tests)

Tests item in accordance with IEC 840 and chronological order	IEC Publication 840 36 KV < Um ≤ 170 KV	AEIC Standard CS7-93 69 KV ≤ U ≤ 138 KV	HN 33-S-52 and HN 33-S-53 Standards Um ≤ 170 KV / Um > 170 KV
1. Bending test (at room temperature) - Test diameter ø ..... - 3 bends in both directions	Length of the sample ≥ π Ø - d/D: measured diameter of the conductor / external diameter of the cable - Ø ≤ 25 (d + D) + 5%: for cables with lead sheath or overlapped longitudinally applied metal foil - Ø ≤ 20 (d + D) +5 %: for other types (IEC and AEIC)		
2. Partial discharge test (at r.t.) ..... Magnitude of the discharge	IEC 885-2- sensitivity ≤ 5 PC ≤ 5 pC at 1.5 Uo	* ICEA T-24-380 ≤ 50 pC at: Uo, 1.5 Uo, 2.0 Uo	Test not required
3. Tan δ measurement at Uo	tan $\delta \leq 10.10^{4}$ at $T_c = 90 \pm 5^{\circ}C$ (on the same or a different sample)	* tan $\delta \leq 10.10^{4}$ at $T_C = T_E$ (105-130°C) (for XLPE + additives: tan $\delta \leq 50.10^{4}$)	tan $\delta < 10.10^{4}$ / tan $\delta < 8.10^{4}$ at Tc = 90 ± 5°C
4. Heating cycle voltage test	Conductor temperature (T_C): in normal operation (T_N = 90°C), in emergency operation (T_E)		
- Sample arrangement	Cable in a U-bend having the diameter ø (see §1)		Buried cables in trefoil formation
- Heating period: at least 8 h	$100 \leq T_C \leq 105^{\circ}C$ for the last 2 h	$T_C = T_E$(105 - 130°C) for the last 2 h	T_C = 100°C for the first 167 cycles +
- Cooling period: at least 16 h (natural cooling)			T_C = 105°C for the first 83 cycles
- Test requirements	Total number of thermal cycles - 20, a.c. test voltage = 2. Uo		250 cycles and 6000 h. at $\sqrt{\ }$ Jo
5. Partial discharge test	same as §2 above	* after heating cycle voltage test	Test not required

6. Impulse voltage test	Um (kV)	BIL (peak value) (kV)	U (kV)	BIL (kV)	Withstand impulse (kV)	Um (kV)	BIL (peak value) (kV)
- Front time: 1 to 5 µs	52 / 72.5	250 / 325	69	350	440	72.5 / 100	325 / 450
- Half peak value: 40 to 60 us	123 / 145	550 / 650	115	550	690	245 / 425	1050 / 1425
- 10 positive and 10 negative voltage impulses	170	750	138	650	815	525	1550
- Conductor temperature	Tc = 100 - 105°C		Tc = T_E(105 - 130°C)			Tc = 95°C	
7. Power frequency voltage test	At 2.5 Uo for 15 minutes, and at room temperature					Test required see standards	

5.5.2 - STANDARDS REQUIREMENTS (cont.) - TYPE TESTS ON CABLE COMPONENTS (optional tests)

Tests item in accordance with IEC 840	Tests conditions	IEC Publication 840	AEIC CS7-93 and EdF standards
1. Check of cable construction	See special tests 2.1 and 2.2 (without resistance measurement)		
2. Resistivity of semi-conducting layers			
- conductor screen	IEC 811-1-2, IEC 840, and	≤ 1000 Ω.m } at 90 ± 2ºC	Similar tests are specified in:
- core screen	ageing at 100 ± 2˚C-7 x 24 h	≤ 500 Ω.m }	
3. Ageing test on complete cable	Same as §2 above	- insulation: IEC 840 - table IV	- the US standards
Compatibility of materials		- non-metallic sheath: table V	• AEIC CS7-93
		- semi-conducting layers: see §2 above	• ICEA S-66-524
			• NEMAWC7
			• NEMAWC 5
4. Test on XLPE insulation			
4.1 Mechanical properties	IEC 811-1-1, 811-1-2, 840	IEC 840 - table IV	- the EDF standards
4.2 Hot set test	IEC 811-2-1, IEC 840 - table VI	IEC 840 - table VI	• HN 33-S-52 and
4.3 Shrinkage test	IEC 811-1-3, IEC 840 - table VI	IEC 840 - table VI	• HN 33-S-53
5. Test on PVC sheaths			
5.1 Mechanical properties	IEC 811-1-1, 811-1-2, 840	IEC 840 - table V	
5.2 Loss of mass	IEC 811-3-2, IEC 840 - table VIII	IEC 840 - table VIII	
5.3 Pressure test at high temperature	IEC 811-3-1, IEC 840 - table V	IEC 840 - table V	
5.4 Test at low temperature	IEC 811-1-4, IEC 840 - table VIII	IEC 840-1-4 Clause 8	
5.5 Heat shock test	IEC 811-3-1, IEC 840 - table VIII	IEC 840-3-1 sub-clause 9.2	
6. Carbon black content on PE sheath	IEC 811-4-1 clause 11	IEC 840 - table VII	
7. Other tests when applicable			
7.1 Test under fire conditions	IEC 332-1	IEC 332-1	
7.2 Water penetration test	IEC 840 Amendment 1	IEC 840 Amendment 1	

5.5.2 - STANDARDS REQUIREMENTS (cont.) - ELECTRICAL TESTS AFTER INSTALLATION

Tests item in accordance with IEC 840	**IEC Publication 840** 36 kV < Um ≤ 170 kV	**AEIC CS7-93 Standard** 69 kV ≤ U ≤ 138 kV	**HN 33-S-52 and HN 33-S-53 Standards** 36 kV ≤ Um ≤ 525 kV
1. Test on the XLPE insulation		Test not required on the insulation and the non-mettalic sheath	Test under consideration
1.1 Test condition for new installation.....	After completed installation of the cable and its accessories		
1.2 d.c. voltage test	at 3. Uo - duration: 15 min.		
Remark: The international Experts of working group 21-09 of CIGRE tend to proscribe this d.c. test, and other test methods are under the consideration		Testing of the completed cable system after installation is subject to mutual agreement between the Purchaser and the Manufacturer	
1.3 a.c. voltage test ..... (by agreement between the Purchaser and the Contractor)	at power frequency: - at $\sqrt{\ }$ Uo - duration: 5 min. or - at Uo - duration: 24 h	Tests methods, tests levels and duration of tests should be discussed with and approved by the Manufacturer prior to testing	
2. Test on non-metallic sheaths			
2.1 Test condition	If required for the particular contract or order		After completed installation of the cable and its accessories
2.2 d.c. voltage test	in accordance with IEC 229: 4 kV per millimeter of specified thick-ness of the sheath, with a maximum value of 10kV duratin: 1 minute.		at 20 kV - duration: 15 min.

HIGH VOLTAGE CABLES
FROM 38/66 (72.5) KV TO 130/225 (245) KV

CONTENTS

1 NOTICE

As this catalogue is not intended to cover all of **LIBAN CABLES SAL** possibilities in High Voltage cables manufacturing, the hereafter listing of the types of cables is not restrictive but only indicative of the main and most current types we manufacture.

On the other hand, our specification sheets are inspired mainly from :

- Iternational Commision Specification (IEC 840).
- Association of Edison Illuminating Companies (AEIC CS7-93).
- Electricité de France Standards (HN 33-S-52) and (HN 33-S-53).
- Electricité du Liban current specification.

Whereas, in fact, some High Voltage cables may require special conception, fully within the capabilities of LIBAN CABLES SAL, ISO 9001 certified, precisely because in position to conceive / tailor your special needs.

That is why, while consulting this catalogue, it is important to take into account that any combination or change of the constructional details mentioned in this catalogue remain feasible, on base of special conception / development, matching any special or different specifications.

Finally, and within our policy of constant improvement, we reserve the right to alter any part of the information contained in this publication without incurring any obligation.
In all cases this brochure being only indicative, and unless expressly agreed upon, it cannot be considered by any mean as contractual document.

2 INTRODUCTION

Devoted to the manufacturing of electric and telecom cables, Liban Cables is the first and largest supplier in Lebanon and a leader in the Middle-East region.

Liban Cables was founded in 1968 by a group of Lebanese industrialists backed up by the technical assistance of two international leading firms :

- Les Cables de Lyon - France (became ALCATELafterwards)
- Phelps Dodge - U.S.A.

Staffed with qualified engineers and highly skilled technicians, our plant is located in Nahr-Ibrahim at 30 Km from Beirut, where cables are designed and manufactured according to all international specifications : IEC, AIEC, VDE, UTE, BS and others on customer request.

Early after its foundation, Liban Cables has become the major supplier of the Lebanese market in both the public and private sectors. The product range of Liban Cables covers all electric cables up to 245 KV, communication cables (copper and optical fiber) in addition to a wide variety of special cables manufactured on customer request.

High quality cables, continuous developments of the production range, direct and fast shipments have contributed in rendering Liban Cables an important exporter for many countries on the three limitrophe continents (Asia, Europe & Africa). Liban Cables products are particularly appreciated by administrations and international contractors operating in the region and seeking reliable and direct supplies of power and communication cables.

3 QUALITY

Step by step, from raw material to final product, quality constitutes a major concern to Liban Cables.

Raw material are continuously and repetitively tested from trial orders till the last batch received afterwards.

In addition to the final tests carried out on finished products, work in process is already tested within two simultaneous procedures :

- A built in quality control system carried out by the production itself at any step of work in process.
- A parallel and contradictory procedure is also carried out on the same stages and products by independent inspectors reporting to the quality control service.

End users and/or third part inspection authorities are also constantly commissioning the finished products and assessing the strict conformity to ordered specifications.

In fact, our ISO 9001 certification stated in Feb 1997 by the International Certification Network (EQNET) is certified by the French Association for Quality Assurance (AFAQ), the well known rigourous and independant accredited European assessor. This certification, under reference AFAQ Nº QUAL / 1997 / 7034, confirms the soundness and the performance of the Quality System we apply for the Design, the Development, the Manufacturing and the Marketing & Sales of all our products.

4 RECOMMENDED ORDERING PARAMETERS

Based on your specific context of usage, we remain ready to design the exactly suitable system (Cable & Accessories), on base of worldwide proven standards, as well as on base of special conception / development, carried out in cooperation with our Technical Assistance pourveyor, Alcatel Cable France.

5.1 - TABLES OFCONSTRUCTIONAL DATA, ELECTRICAL CHARACTERISTICS AND CURRENT RATINGS

General presentation

The following tables are given as a guide to engineers involved in the study of network links, admissible current ratings as well as defining and selection of cable types.
The tables are not the definitive list of Liban Cables range but a simple solution guide to the most common cables used. Should a problem be unresolved by the tables then a case study could be carried out by Liban Cables, on base of specific request to reach the most appropriate tailored conception. In this event, please contact: **Liban Cables**

Two screen options for cables in the High Voltage 66 KV to 225 KV range are given, for copper or aluminium conductors:

1 - Lead sheath screen
2 - Copper or aluminium wire screen

Laying and Earthing conditions

We have retained only these most common configurations (see chapter 5.2 for other laying conditions):

• **Laying**	**Trefoil formation**		**Flat formation**	
	Buried cables	Cables in air	Buried cables	Cables in air
• Laying depth	d = 1.3 m		d = 1.3 m	
• Thermal conditions				
- Case N˚1*	ρ_T = 1.0˚C.m/W T = 20˚C	T = 30˚C	ρ_T = 1.0˚C.m/W T = 20˚C	T = 30˚C
- Case N˚2*	ρ_T = 1.2˚C.m/W T = 30˚C	T = 50˚C	ρ_T = 1.2˚C.m/W T = 30˚C	T = 50˚C
• Axial distance	Close formation		2 x outer diameter	
• Earthing method				
- S < 630 mm2	continuous earthing (with circulating currents in the metallic screen)		at one point only or perfect cross-bonding (without circulating current in the metallic screen)	
- S ≥ 630 mm2	at one point only or perfect cross-bonding (without circulating current in the metallic screen)			

*ρ_T: Soil thermal resistivity - T: Soil or air temperature.

Admissible current ratings

Admissible current ratings given in the following pages are against the conditions given in the above table, for one circuit in operation with a load factor of 100%, in accordance with IEC Publication 60287.

5.2 - CORRECTING FACTORS FOR OTHER LAYING CONDITIONS

In the tables of the hereafter chapters 6.1 and 6.2, we have considered a single circuit composed of 3 cables under continuous operation and with the following laying conditions:

	Buried cables Depth of burial: d = 1.3 m		**Cables in air**	
	Trefoil formation	Flat formation	Trefoil formation	Flat formation
- Case N°1*	ρ_T = 1.0 and T = 20°C*		Air temperature = 30°C	
- Case N°2*	ρ_T = 1.2 and T = 30°C*		Air temperature = 50°C	

*ρ_T: Soil thermal resistivity, in °C.m/W - T: Soil temperature, in °C.

When for a particular project, one or more parameters of laying are different from those in the above mentioned table, the correcting factors given hereafter permit estimation of the current rating under the laying conditions of the project.

1. CASE OFBURIED CABLES

The corrected current rating Ic is imperatively the one given in the tables for the case N°1 multiplied by the correcting factors of:

- Depth of burial (Kd), if $d \neq 1.3$ meter
- Soil thermal resistivity (Kr), if $\rho_T \neq 1.0$°C.m/W
- Soil temperature (Kt), if $T \neq 20$°C
- Proximity effect (Kn), if the number of circuits: n > 1

Example: Calculation of the corrected current rating for a 1 x 630 mm^2 copper 76/132 (145) KVcable, lead sheathed, laid in trefoil formation, with:

- d = 1.50 m
- ρ_T = 1.2°C.m/W
- T = 30°C
- n = 2 with axial spacing between circuits: s = 400 mm

The table of continuous current ratings gives for ρ_T = 1.0 and T = 20°C: I = 865 A and the tables of correcting factors give:

- For d = 1.50 m : Kd = 0.98
- For ρ_T = 1.2°C.m/W : Kr = 0.93
- For T = 30°C : Kt = 0.92
- For n = 2 and s = 400 mm : Kn = 0.79

The corrected current rating is: Ic = 865 x 0.98 x 0.93 x 0.92 x 0.79 = **573 A approx.**

2. CASE OF CABLES IN AIR

The corrected current rating Ic is **imperatively the one given in the tables for the case N˚1** (Air temperature = 30˚C) multiplied by the correcting factor of the air temperature (Ka) if T ≠ 30˚C.
There is no proximity effect in this method of laying when the axial distance between adjacent cables of 2 circuits side by side is superior to twice the external diameter of the cable.

Example: Calculation of the corrected current rating for a 1 x 630 mm^2 copper 76/132 (145) KVcable, lead sheathed, laid in flat formation, with:

- Air temperature T = 40˚C

The table of continuous current ratings gives for T = 30˚C : I = 1225 A
and the tables of correcting factors give:

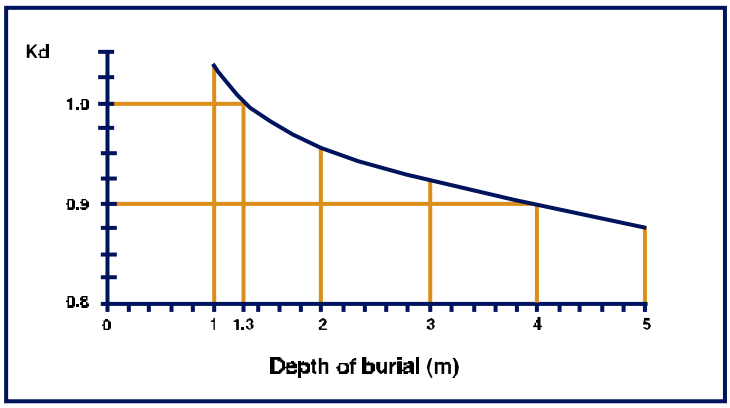
- For T = 40˚C : Ka = 0.90

The corrected current rating is: Ic = 1225 x 0.90 = **1103 A approx.**

5.2 - CORRECTING FACTORS FOR OTHER LAYING CONDITIONS (cont.)

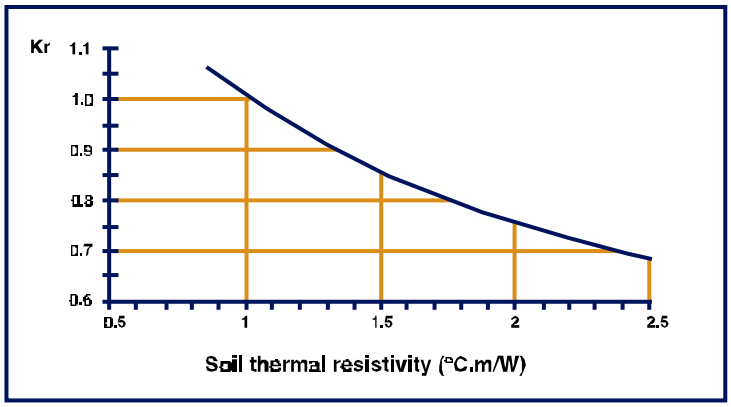
Depth of burial (Kd)

Edpth of burial (m)	Rating Factor
1.0	1.03
1.3	1.00
1.5	0.98
2.0	0.95
2.5	0.93
3.0	0.91
3.5	0.90
4.0	0.89
4.5	0.88
5.0	0.87



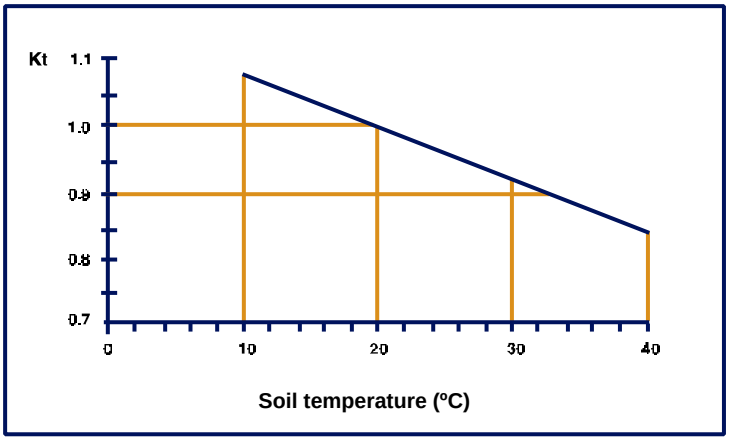
Soil thermal resistivity (Kr)

Soil thermal resistivity (˚C.m/W)	Rating Factor
0.85	1.06
1.0	1.00
1.2	0.93
1.5	0.86
2.0	0.76
2.5	0.69



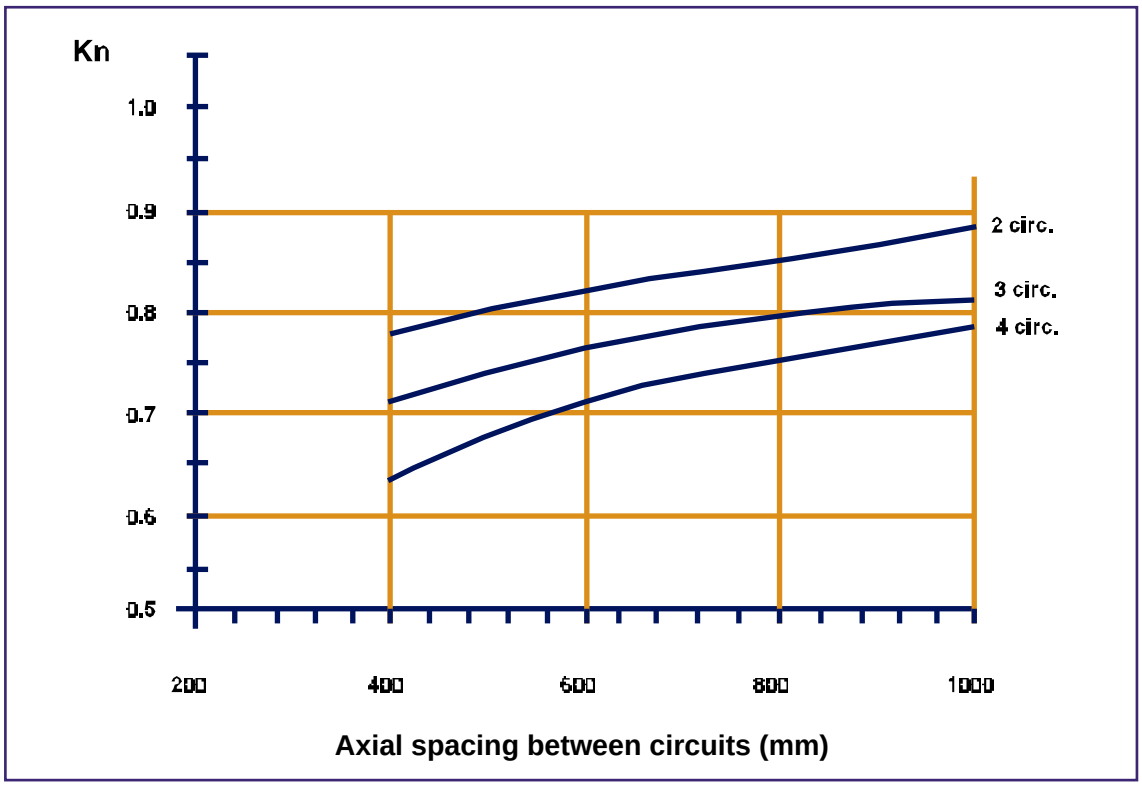
Soil temperature (Kt)

Soil temperature (˚C)	Rating factor
10	1.07
20	1.00
30	0.92
40	0.84



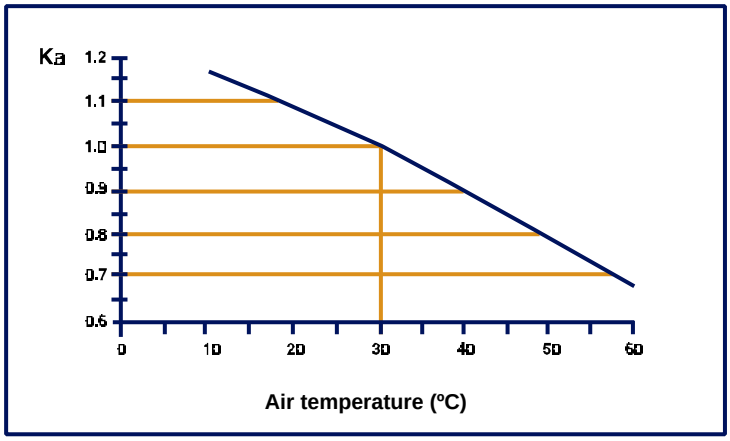
Proximity effect (Kn)

Axial spacing between circuits (mm)	Numberof circuits			
	1	2	3	4
400	1.00	0.79	0.71	0.65
600	1.00	0.85	0.76	0.72
800	1.00	0.88	0.79	0.75
1000	1.00	0.89	0.81	0.79



Airtemperature (Ka)

Soil temperature (˚C)	Rating factor
10	1.17
20	1.09
30	1.00
40	0.90
50	0.80
60	0.68



5.3 - SHORT-CIRCUIT CURRENT RATINGS

The following pages show the method for the calculation of short-circuit current ratings in the conductor and in the metallic screen, in accordance with IEC 949.

The short-circuit current ratings are given for:

1. Conductor	copper or aluminium
2. Metallic screen	in lead alloy
	in copper wires or flat wires
	in aluminium wires

Each case is accompanied by an example of calculation with a cable presented in the preceding pages.

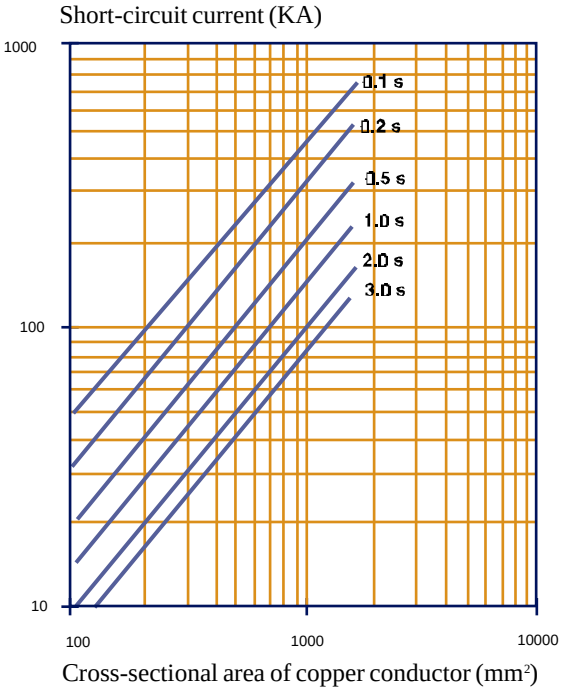
Method of calculation

The calculation method takes into account an adiabatic heating.

- For the conductor	The obtained values are near the reality because the loss of heat in the insulation is insignifiant.
- For the metallic screen	The simplified method given in the following pages does not take into account the loss of heat in the external environment. Thereby the obtained values are on the low side but give an approximative value between 5% and 10% under the value of the admissible short-circuit current.

5.3 - SHORT-CIRCUIT CURRENT RATINGS (cont.)
COPPER CONDUCTOR

GENERAL



The following formula in accordance with IEC 949 takes into account an adiabatic heating, i.e. without loss of heat in the insulation.

$$I = 226 \frac{S}{\sqrt{t}} \sqrt{\ln \frac{234 + \theta_f}{234 + \theta_i}}$$

or

$$J = \frac{I}{S} = \frac{1}{\sqrt{t}} \left[226 \sqrt{\ln \frac{234 + \theta}{234 + \theta}} \right] = \frac{1}{\sqrt{t}} \times 143.2$$

I : permissible short circuit current (A).
S : cross-sectional area of the conductor (mm^2).
t : short circuit duration time (s).
θ_f: final temperature (250°C)
θ_i: initial temperature (90°C)
J : permissible current density (A/mm^2)

Fort = 1s: J = Jo = 143.2 A/mm²

$$\text{For } t \neq 1s : \; J = \frac{j_0}{\sqrt{t}}$$

Practical application

Example: a 630 mm^2 copper conductor will carry:

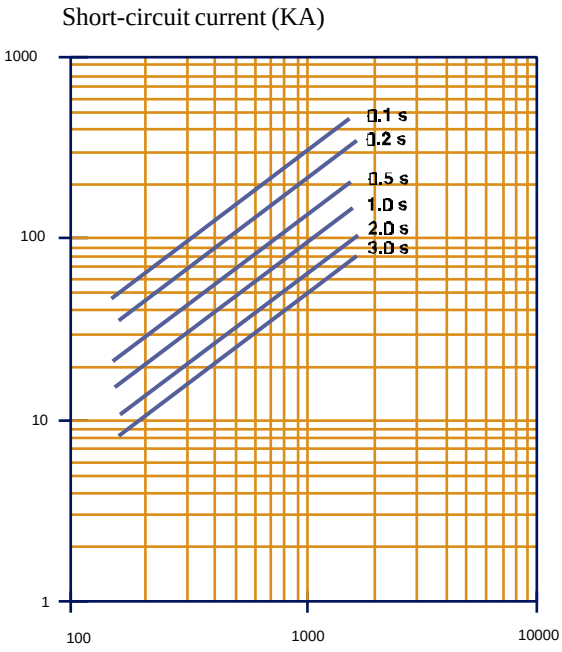
a) For 1 second: $I_o = J_o \times S = 143.2 \times 630$ = 90216 Amperes, i.e. 90.2 KA

b) For 0.5 second: $I = \frac{j_0}{\sqrt{t}} \times S = \frac{I_0}{\sqrt{t}} = \frac{90216}{\sqrt{0.5}}$ = 127585 Amperes, i.e. 127.6 KA

C) For 2 seconds: $I = \frac{j_0}{\sqrt{t}} \times S = \frac{I_0}{\sqrt{t}} = \frac{90216}{\sqrt{2}}$ = 63792 Amperes, i.e. 63.8 KA

5.3 - SHORT-CIRCUIT CURRENT RATINGS (cont.) ALUMINIUM CONDUCTOR

GENERAL



The following formula in accordance with IEC 949 takes into account an adiabatic heating, i.e. without loss of heat in the insulation.

$$I = 148 \frac{S}{\sqrt{t}} \sqrt{\ln \frac{228 + \theta_f}{228 + \theta_i}}$$

or

$$J = \frac{I}{S} = \frac{1}{\sqrt{t}} \left[148 \sqrt{\ln \frac{228 + \theta_f}{228 + \theta_i}} \right] = \frac{1}{\sqrt{t}} \times 94.5$$

I : permissible short circuit current (A).
S : cross-sectional area of the conductor (mm^2).
t : short circuit duration time (s).
θ_f: final temperature (250°C)
θ_i: initial temperature (90°C)
J : permissible current density (A/mm^2)

For t = 1s: J = Jo = 94.5 A/mm^2

$$\text{For } t \neq 1s: \; J = \frac{j_0}{\sqrt{t}}$$

Practical application

Example: a 630 mm^2 aluminium conductor will carry:

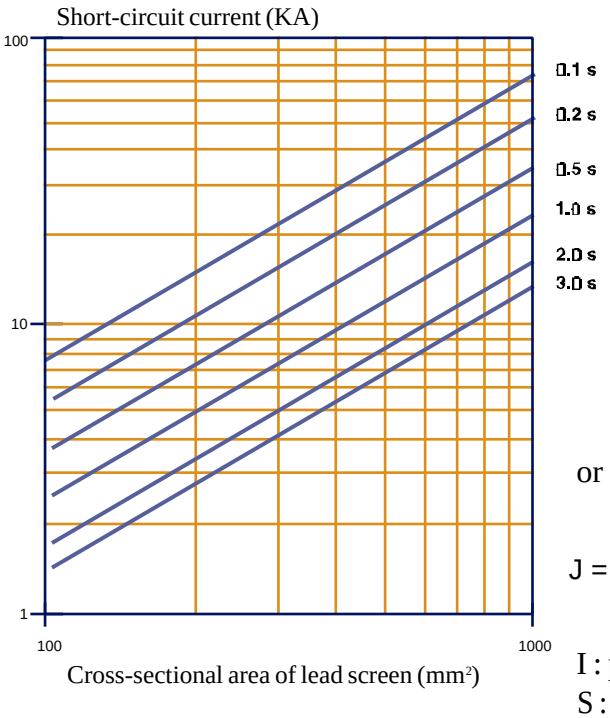
a) For 1 second: $I_o = J_o \times S = 94.5 \times 630$ = 59535 Amperes, i.e. 59.5 KA

b) For 0.5 second: $I = \frac{j_0}{\sqrt{t}} \times S = \frac{I_0}{\sqrt{t}} = \frac{59535}{\sqrt{0.5}}$ = 84195 Amperes, i.e. 84.2 KA

C) For 2 seconds: $I = \frac{j_0}{\sqrt{t}} \times S = \frac{I_0}{\sqrt{t}} = \frac{59535}{\sqrt{2}}$ = 42097 Amperes, i.e. 42.1 KA

5.3 - SHORT-CIRCUITCURRENTRATING S (cont.) LEAD METALLIC SCREEN

GENERAL



The following formula in accordance with IEC 949 takes into account an adiabatic heating i.e. without loss of heat in the insulation but equally in the external environment. Thereby the more important the short-circuit duration is, the more pessimistic the calculated values.

$$I = 41 \frac{S}{\sqrt{t}} \sqrt{1 \, n \frac{230 + \theta_f}{230 + \theta_i}}$$

or

$$J = \frac{I}{S} = \frac{1}{\sqrt{t}} \left[41 \sqrt{L \, n \frac{230 + \theta_f}{230 + \theta_i}} \right] = \frac{1}{\sqrt{t}} \times 24.3$$

I : permissible short circuit current (A).
S : cross-sectional area of the conductor (mm^2).
t : short circuit duration time (s).
θ_f: final temperature (210˚C)
θ_i: initial temperature (80˚C)
J : permissible current density (A/mm^2)

For t = 1s: J = Jo = 24,3 A/mm²

$$\text{For } t \neq 1s : \; J = \frac{j_0}{\sqrt{t}}$$

Practical application

Example: a 300 mm^2 aluminium conductor 64/110 (123) KV cable has, according to the dimensional table a lead screen of 400 mm2. This screen will carry:

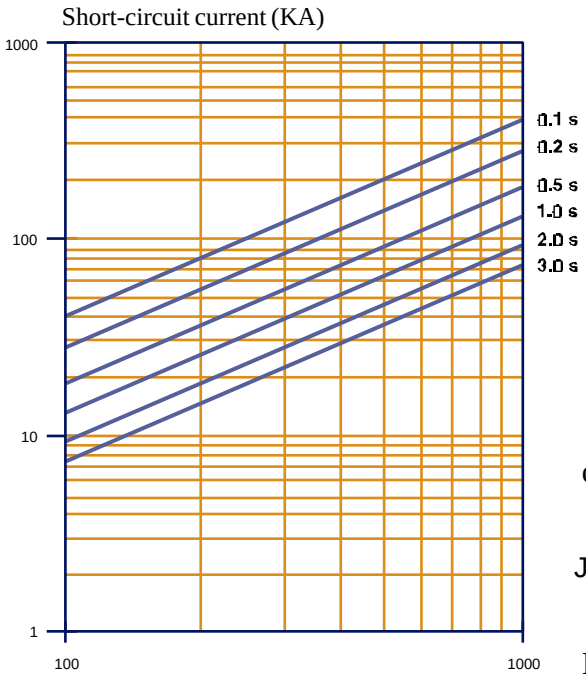
a) For 1 second: $Io = Jo \times S = 24.3 \times 400$ = 9720 Amperes, i.e. 9.7 KA

b) For 0.5 second: $I = \frac{j_0}{\sqrt{t}} \times S = \frac{I_0}{\sqrt{t}} = \frac{9720}{\sqrt{0.5}}$ = 13746 Amperes, i.e. 13.7 KA

C) For 2 seconds: $I = \frac{j_0}{\sqrt{t}} \times S = \frac{I_0}{\sqrt{t}} = \frac{9720}{\sqrt{2}}$ = 6873 Amperes, i.e. 6.9 KA

5.3 - SHORT-CIRCUIT CURRENT RATINGS (cont.)
COPPER METALLIC SCREEN

GENERAL



The following formula in accordance with IEC 949 takes into account an adiabatic heating, i.e. without loss of heat in the insulation but equally in the external environment. Thereby the more important the short-circuit duration is, the more pessimistic the calculated values.

$$I = 226 \frac{S}{\sqrt{t}} \sqrt{L\,n \frac{234 + \theta_f}{234 + \theta_i}}$$

or

$$J = \frac{I}{S} = \frac{1}{\sqrt{t}} \left[226 \sqrt{L\,n \frac{234 + \theta_f}{234 + \theta_i}} \right] = \frac{1}{\sqrt{t}} \times 133.0$$

I : permissible short circuit current (A).
S : cross-sectional area of the conductor (mm^2).
t : short circuit duration time (s).
θ_f: final temperature (210°C)
θ_i: initial temperature (80°C)
J : permissible current density (A/mm^2)

For t = 1s: J = Jo = 133.0 A/mm^2

$$\text{For } t \neq 1s: \; J = \frac{j_0}{\sqrt{t}}$$

Practical application

Example: a 300 mm^2 Copper conductor 64/110 (123) KV cable has, according to the dimensional table a copper screen of 140 mm^2. This screen will carry:

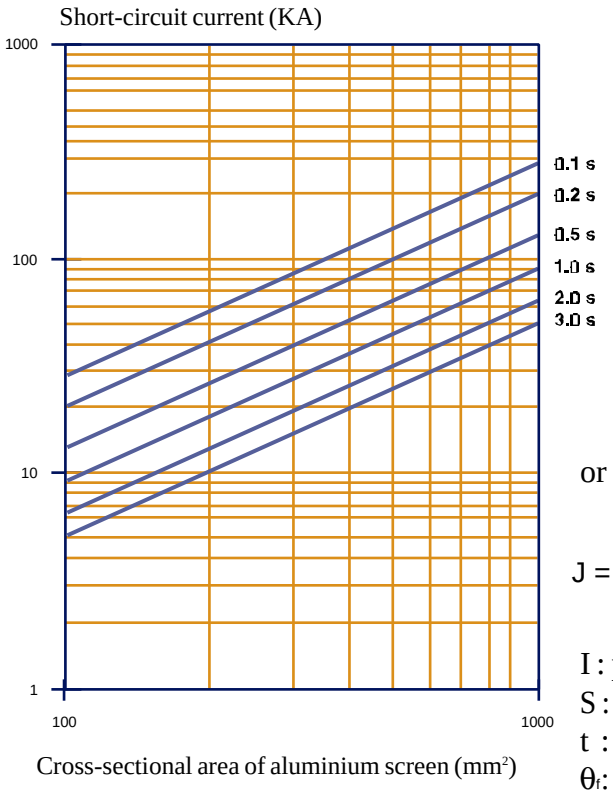
a) For 1 second: $Io = Jo \times S = 133.0 \times 140 = 18620$ Amperes, i.e. 18.6 KA

b) For 0.5 second: $I = \frac{j_0}{\sqrt{t}} \times S = \frac{I_0}{\sqrt{t}} = \frac{18620}{\sqrt{0.5}} = 26332$ Amperes, i.e. 26.3 KA

C) For 2 seconds: $I = \frac{j_0}{\sqrt{t}} \times S = \frac{I_0}{\sqrt{t}} = \frac{18620}{\sqrt{2}} = 13166$ Amperes, i.e. 13.2 KA

5.3 - SHORT-CIRCUIT CURRENT RATINGS (cont.)
ALUMINIUM METALLIC SCREEN

GENERAL



The following formula in accordance with IEC 949 takes into account an adiabatic heating, i.e. without loss of heat in the insulation but equally in the external environment. Thereby the more important the short-circuit duration is, the more pessimistic the calculated values.

$$I = 148 \frac{S}{\sqrt{t}} \sqrt{L\,n \frac{228 + \theta_f}{228 + \theta_i}}$$

or

$$J = \frac{I}{S} = \frac{1}{\sqrt{t}} \left[148 \sqrt{L\,n \frac{228 + \theta_f}{228 + \theta_i}} \right] = \frac{1}{\sqrt{t}} \times 87.8$$

I : permissible short circuit current (A).
S : cross-sectional area of the conductor (mm^2).
t : short circuit duration time (s).
θ_f: final temperature (210˚C)
θ_i: initial temperature (80˚C)
J : permissible current density (A/mm^2)

For t = 1s: J = Jo = 87.8 A/mm^2

$$\text{For } t \neq 1s : J = \frac{j_0}{\sqrt{t}}$$

Practical application

Example: a 300 mm^2 aluminium conductor 64/110 (123) KV cable has, according to the dimensional table an aluminium screen of 140 mm^2. This screen will carry:

a) For 1 second: $Io = Jo \times S = 87.8 \times 140$ = 12292 Amperes, i.e. 12.3 KA

b) For 0.5 second: $I = \frac{j_0}{\sqrt{t}} \times S = \frac{I_0}{\sqrt{t}} = \frac{12292}{\sqrt{0.5}}$ = 17383 Amperes, i.e. 17.4 KA

C) For 2 seconds: $I = \frac{j_0}{\sqrt{t}} \times S = \frac{I_0}{\sqrt{t}} = \frac{12292}{\sqrt{2}}$ = 8692 Amperes, i.e. 8.7 KA

5.4 - DELIVERY AND LAYING

Delivery

All versions of cables given in this catalogue have standard delivery lengths of about 500 meters.
However, it is possible to increase the delivery lengths as long as the unloading equipment (hoists, etc...) at the arrival are competent, and if the forwarding conditions allow it.

Laying

Bending radius

The following table gives the minium bending radius for the cables given in this catalogue, in three situations. The bending radius are calculated according to the English ESI Standard 09-02.

On drum	During pulling	Afterlaying
R = 12.5 x D	Direct or in air: R = 30 x D In ducts: R = 35 x D	With former: R = 15 x D Without former: R = 20 x D

with D: External diameter of the cable.

Permissible mechanical force on the conductor

The maximum pulling force on the conductor is given by the following formula:

Max. pulling force = K x S **in daN**

Where S: Cross-sectional area of the conductor (mm^2)
K: Maximum stress (daN / mm^2)

with K: 6 daN/mm2 for copper conductor
K: 5 daN / mm2 for aluminium conductor

Maximum sidewall pressure

The maximum sidewall pressure is given by the following formula:

$$\text{Max. sidewall pressure} = \frac{\text{max. pulling force}}{\text{bending radius (direct orin air)}} \quad \text{in daN/m}$$

5.5 - DESIGN, MANUFACTURING AND TESTING OF XLPE INSULATED CABLES

5.5.1 - DESIGN AND MANUFACTURING

Stranding

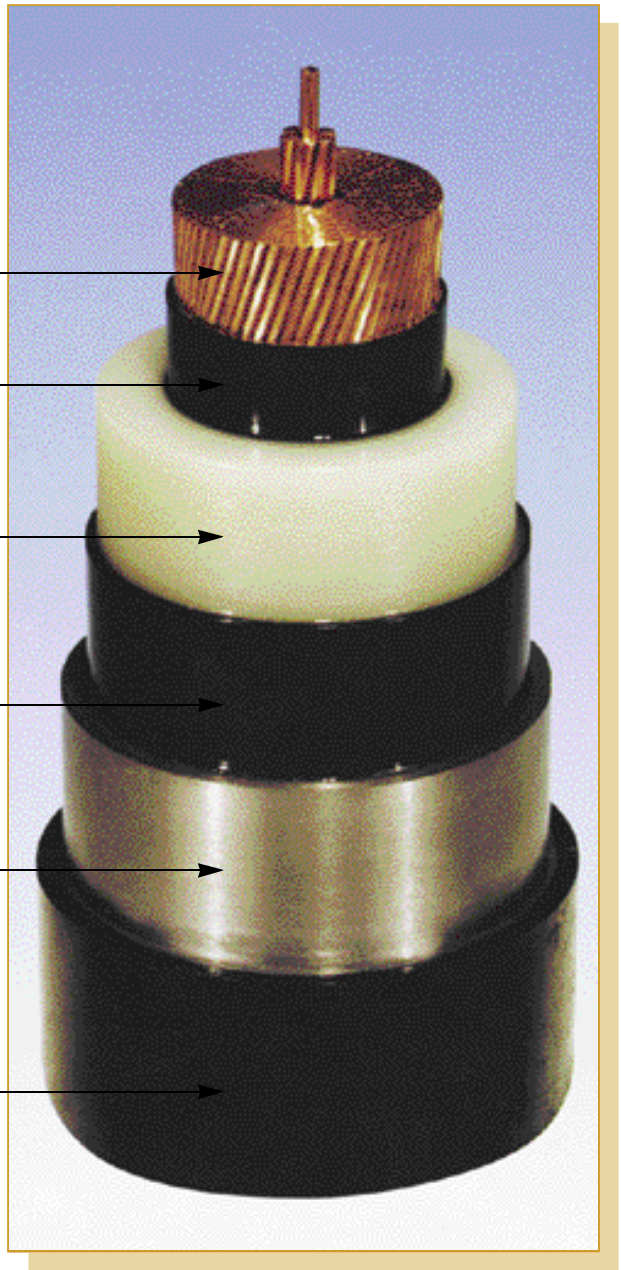
Insulation

Dry curing process,
Triple head extrusion

Screening

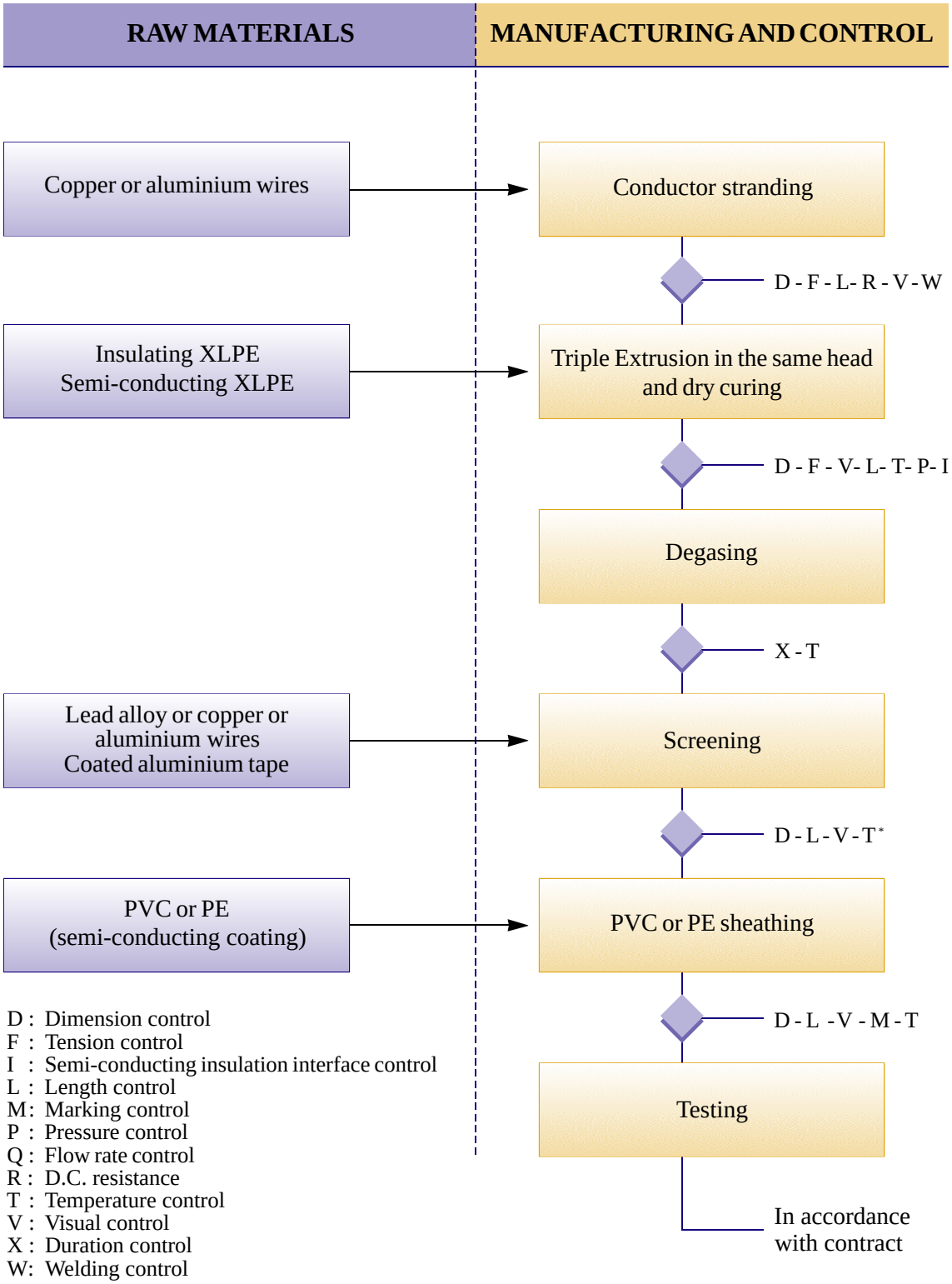
Lead sheath or metallic wires

Sheathing



	ROLE	COMPOSITION
CONDUCTOR (Cross-section: S)	• To carry current: - in normal operation. - in emergency operation. - in short-circuit operation. • To withstand pulling stresses during cable laying.	**Stranded Copperoraluminium wires.**
CONDUCTOR SCREEN	• To prevent concentration of electric field at particular points on the conductor. • To ensure close contact with the insulation.	**Extruded semi-conducting XLPE.**
INSULATION	To withstand during the designed cable service life different stresses and the following voltages: - rated voltage in normal operation. - lightning overvoltage. - switching overvoltage.	**Extruded insulating XLPE** The internal and external semi-conducting layers and the insulation are extruded in the same head at the same time, followed by a **dry curing** process.
INSULATION SCREEN	• To ensure close contact with the insulation. • To prevent concentrations of electric field at particular points.	**Extruded semi-conducting XLPE.**
METALLIC SHIELD	To provide: - an electrical screening (no electric field outside). - radial waterproofing. - an active conductor for the capacitive and homopolar short-circuit current. - a contribution for mechanical protection.	**Extruded lead alloy** or **Copperoraluminium wires** With outside a coated aluminium tape laid lengthwise and overlapped.
OUTER PROTECTIVE SHEATH	To insulate the metallic screen from the surrounding medium in order to protect it against corrosion	**Extruded insulating PVC orPE** With possibly a semi-conducting coating sheet to allow dielectric tests on sheath in plant and on site.

5.5.3 - MANUFACTURING AND CONTROLFLOWCHART



D : Dimension control
F : Tension control
I : Semi-conducting insulation interface control
L : Length control
M: Marking control
P : Pressure control
Q : Flow rate control
R : D.C. resistance
T : Temperature control
V : Visual control
X : Duration control
W: Welding control

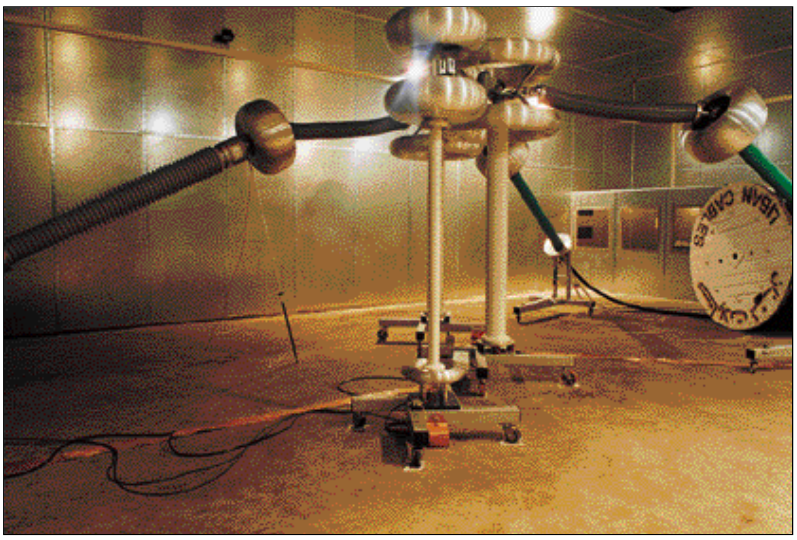
* for lead alloy sheathing only

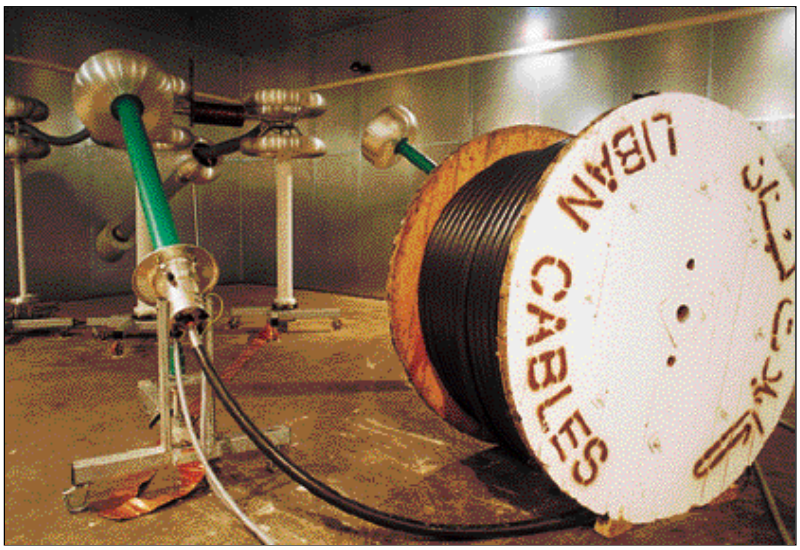
5.6 - HVROUTINE TEST LABORATORY

All the power cables manufactured in the power Department of LIBAN CABLES are systematically tested in this laboratory.

Test equipement:

- AC resonant system 350,5000 KUA, 50 Hz
- Partial discharge measurement equipment

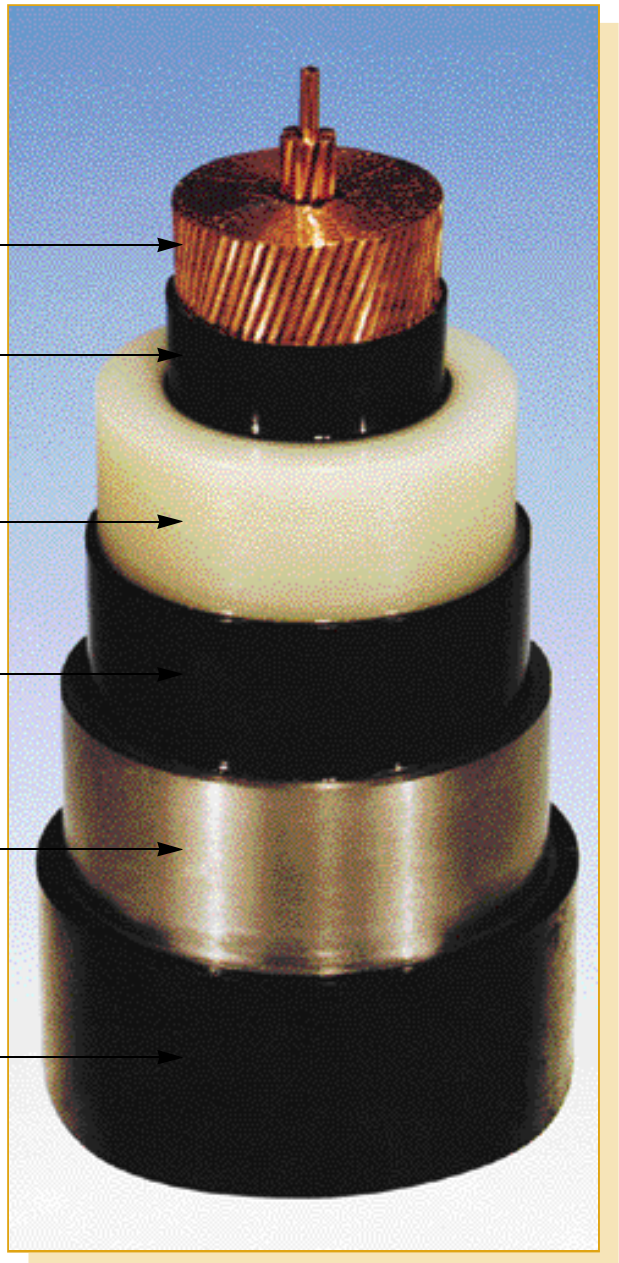




Routine tests and some other tests are carried out in this laboratory.
The Faraday cage and its High Voltage transformer provide clearance sufficient for testing reels of cable up to 350 KV.

6.1 - COPPER AND ALUMINIUM CONDUCTOR LEAD SHEATH SCREEN (66 - 225 KV)

COMPACTROUND STRANDED COPPER OR ALUMINIUM



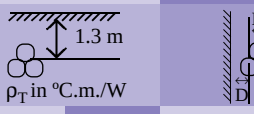
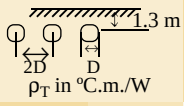
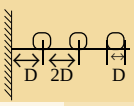
36 / 63 TO 40 / 69 (72.5) KVXLPE CABLES
COPPER CONDUCTOR

Lead sheath screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Thickness of lead sheath	Thickness of Jacket	Outside diameter of cable	Lead sectional area	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm	mm	Approx. mm	mm²	Approx. kg/m	Ω/km	µF/km
150 R	R: compact Round stranded	14.2	1.0	10.0	1.0	2.0	2.9	54	300	7	0.1240	0.17
185R		15.9	1.0	10.0	1.0	2.0	2.9	54	300	7	0.0991	0.18
240R		18.4	1.0	10.0	1.0	2.0	2.9	54	300	7	0.0754	0.21
300R		20.5	1.0	10.0	1.0	2.0	3.0	60	335	9	0.0601	0.22
400R		23.2	1.0	10.0	1.0	2.0	3.0	60	335	9	0.0470	0.25
500R		26.4	1.0	10.0	1.0	2.0	3.2	66	370	11	0.0366	0.25
630R		30.3	1.0	10.0	1.0	2.0	3.3	71	405	13	0.0283	0.26
800R		34.7	1.0	10.0	1.0	2.0	3.4	77	440	16	0.0221	0.28
1000R		39.1	1.0	10.0	1.0	2.0	3.4	77	445	17	0.0176	0.35

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
Induced current in the metallic screen		 ρ_T in °C.m./W				Induced current in the metallic screen		 ρ_T in °C.m./W			
	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C		mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	150 R	400	345	460	365	without circulating current	150 R	420	365	525	420
	185 R	480	390	525	415		185 R	510	410	600	480
	240 R	520	450	615	490		240 R	555	475	710	570
	300 R	585	505	705	560		300 R	625	540	810	645
	400 R	660	570	810	640		400 R	715	615	945	755
	500 R	745	640	925	735		500 R	815	700	1090	870
without circulating current	630 R	870	750	1100	870		630 R	930	800	1260	1005
	800 R	975	840	1250	990		800 R	1050	900	1445	1155
	1000 R	1070	920	1395	1105		1000 R	1165	1000	1645	1310

Lead sheath screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Thickness of lead sheath	Thickness of Jacket	Outside diameter of cable	Lead sectional area	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm	mm	Approx. mm	mm²	Approx. kg/m	Ω/km	µF/km
150 R	R: compact Round stranded	14.2	1.0	10.0	1.0	2.0	2.9	54	300	6	0.2060	0.17
185R		16.2	1.0	10.0	1.0	2.0	2.9	54	300	6	0.1640	0.19
240R		18.4	1.0	10.0	1.0	2.0	2.9	54	300	6	0.1250	0.22
300R		21.0	1.0	10.0	1.0	2.0	3.0	60	335	7	0.1000	0.22
400R		23.3	1.0	10.0	1.0	2.0	3.0	60	335	7	0.0778	0.25
500R		26.4	1.0	10.0	1.0	2.0	3.2	66	370	8	0.0605	0.25
630R		30.3	1.0	10.0	1.0	2.0	3.3	71	405	9	0.0469	0.26
800R		34.7	1.0	10.0	1.0	2.0	3.4	76	440	11	0.0367	0.28
1000R		38.8	1.0	10.0	1.0	2.0	3.4	77	445	11	0.0291	0.35
1200 R		41.7	1.0	10.0	1.0	2.0	3.6	82	475	12	0.0247	0.35

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
Induced current in the metallic screen	mm²	1.3 m, ρT in °C.m./W		D, D		Induced current in the metallic screen	mm²	1.3 m, 2D, D, ρT in °C.m./W		D, 2D, D	
		ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C			ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	150 R	310	270	360	285	without circulating current	150 R	325	280	405	325
	185 R	350	305	410	325		185 R	370	320	470	375
	240 R	405	350	480	380		240 R	430	370	555	440
	300 R	460	395	555	440		300 R	485	420	635	505
	400 R	525	450	640	505		400 R	560	480	740	590
	500 R	595	515	740	585		500 R	640	550	855	680
without circulating current	630 R	695	600	875	695		630 R	735	630	1000	795
	800 R	790	680	1010	800		800 R	835	720	1155	920
	1000 R	880	755	1150	910		1000 R	945	810	1335	1060
	1200 R	945	815	1250	990		1200 R	1020	875	1450	1155

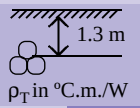
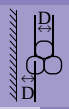
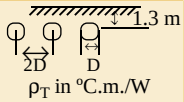
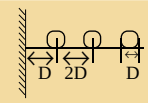
64 / 110 (123) KVXLPE CABLES
COPPER CONDUCTOR

Lead sheath screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Thickness of lead sheath	Thickness of Jacket	Outside diameter of cable	Lead sectional area	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm	mm	Approx. mm	mm²	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	16.0	1.0	2.0	3.2	65	370	9	0.0754	0.16
300 R		20.5	1.0	16.0	1.0	2.0	3.3	70	400	10	0.0601	0.16
400 R		23.2	1.0	16.0	1.0	2.0	3.3	71	400	11	0.0470	0.18
500 R		26.4	1.0	16.0	1.0	2.0	3.4	76	435	13	0.0366	0.19
630 R		30.3	1.0	16.0	1.0	2.0	3.5	77	440	14	0.0283	0.23
800 R		34.7	1.0	16.0	1.0	2.1	3.6	86	520	18	0.0221	0.23
1000 R		39.1	1.0	16.0	1.0	2.2	3.8	91	575	21	0.0176	0.24

Continuous current ratings (load factor= 100%) for one circuit in operation (Amperes)

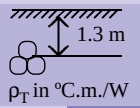
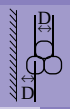
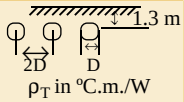
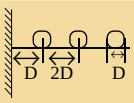
Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 ρT in °C.m./W						 ρT in °C.m./W			
Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	515	445	615	490	without circulating current	240 R	550	475	700	560
	300 R	580	500	700	560		300 R	620	535	795	635
	400 R	655	565	805	640		400 R	710	610	925	740
	500 R	740	640	925	735		500 R	810	700	1065	850
without circulating current	630 R	870	750	1095	870		630 R	925	795	1235	990
	800 R	970	835	1245	990		800 R	1040	900	1420	1135
	1000 R	1065	920	1390	1105		1000 R	1155	995	1595	1275

Lead sheath screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Thickness of lead sheath	Thickness of Jacket	Outside diameter of cable	Lead sectional area	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm	mm	Approx. mm	mm²	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	16.0	1.0	2.0	3.2	65	370	8	0.1250	0.16
300 R		21.0	1.0	16.0	1.0	2.0	3.3	70	400	9	0.1000	0.17
400 R		23.3	1.0	16.0	1.0	2.0	3.3	71	400	9	0.0778	0.19

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

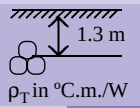
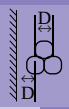
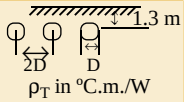
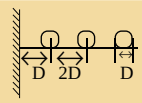
Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 ρ_T in °C.m./W						 ρ_T in °C.m./W			
Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	405	350	480	385	without circulating current	240 R	425	370	540	435
	300 R	455	395	550	440		300 R	485	420	620	495
	400 R	520	450	635	505		400 R	555	480	720	575

Lead sheath screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Thickness of lead sheath	Thickness of Jacket	Outside diameter of cable	Lead sectional area	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm	mm	Approx. mm	mm²	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	18.0	1.0	2.0	3.3	71	400	10	0.0754	0.15
300 R		20.5	1.0	18.0	1.0	2.0	3.4	76	435	12	0.0601	0.15
400 R		23.2	1.0	18.0	1.0	2.0	3.4	77	440	12	0.0470	0.16
500 R		26.4	1.0	18.0	1.0	2.0	3.5	81	465	14	0.0366	0.17
630 R		30.3	1.0	18.0	1.0	2.1	3.6	86	520	16	0.0283	0.19
800 R		34.7	1.0	18.0	1.0	2.2	3.8	91	575	19	0.0221	0.20
1000 R		39.1	1.0	18.0	1.0	2.4	4.0	95	655	22	0.0176	0.23

Continuous current ratings (load factor= 100%) for one circuit in operation (Amperes)

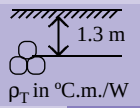
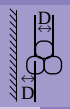
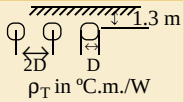
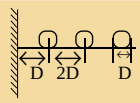
Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 ρ_T in °C.m./W						 ρ_T in °C.m./W			
Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	515	445	615	490	without circulating current	240 R	540	475	690	555
	300 R	580	500	765	560		300 R	620	535	855	630
	400 R	655	565	805	640		400 R	705	610	915	730
	500 R	735	635	920	730		500 R	805	695	1055	845
without circulating current	630 R	865	750	1090	870		630 R	920	795	1225	980
	800 R	970	835	1245	990		800 R	1040	895	1405	1120
	1000 R	1065	915	1385	1100		1000 R	1155	995	1580	1265

Lead sheath screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Thickness of lead sheath	Thickness of Jacket	Outside diameter of cable	Lead sectional area	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm	mm	Approx. mm	mm²	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	18.0	1.0	2.0	3.3	71	400	9	0.1250	0.15
300 R		21.0	1.0	18.0	1.0	2.0	3.3	74	420	9	0.1000	0.16
400 R		23.3	1.0	18.0	1.0	2.0	3.3	76	435	10	0.0778	0.17

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 ρ_T in °C.m./W						 ρ_T in °C.m./W			
Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	405	350	480	385	without circulating current	240 R	425	370	540	430
	300 R	455	395	550	440		300 R	480	415	620	495
	400 R	520	450	635	505		400 R	550	480	715	570

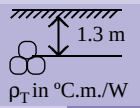
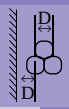
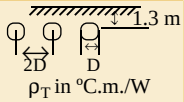
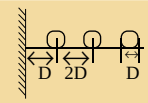
87 / 150 (170) KVXLPE CABLES
COPPER CONDUCTOR

Lead sheath screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Thickness of lead sheath	Thickness of Jacket	Outside diameter of cable	Lead sectional area	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm	mm	Approx. mm	mm²	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	20.0	1.0	2.0	3.4	76	435	11	0.0754	0.13
300 R		20.5	1.0	20.0	1.0	2.0	3.5	81	465	12	0.0601	0.14
400 R		23.2	1.0	20.0	1.0	2.0	3.5	81	465	13	0.0470	0.15
500 R		26.4	1.0	20.0	1.0	2.1	3.6	85	515	15	0.0366	0.16
630 R		30.3	1.0	20.0	1.0	2.2	3.8	91	575	17	0.0283	0.17
800 R		34.7	1.0	20.0	1.0	2.4	4.0	95	655	20	0.0221	0.19
1000 R		39.1	1.0	20.0	1.0	2.5	4.0	99	715	23	0.0176	0.21

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 ρT in °C.m./W						 ρT in °C.m./W			
Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	515	445	615	490	without circulating current	240 R	545	475	685	550
	300 R	575	500	700	555		300 R	615	535	780	625
	400 R	605	565	805	640		400 R	650	610	905	725
	500 R	735	635	920	730		500 R	805	695	1050	840
without circulating current	630 R	865	745	1090	865		630 R	920	795	1215	970
	800 R	965	835	1240	985		800 R	1040	895	1395	1115
	1000 R	1060	915	1385	1100		1000 R	1150	995	1570	1255

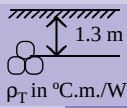
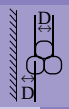
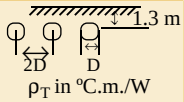
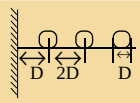
87 / 150 (170) KVXLPE CABLES
ALUMINIUM CONDUCTOR

Lead sheath screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Thickness of lead sheath	Thickness of Jacket	Outside diameter of cable	Lead sectional area	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm	mm	Approx. mm	mm²	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	20.0	1.0	2.0	3.3	76	435	9	0.1250	0.13
300 R		21.0	1.0	20.0	1.0	2.0	3.5	81	465	10	0.1000	0.14
400 R		23.3	1.0	20.0	1.0	2.0	3.3	81	465	11	0.0778	0.15

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

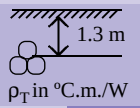
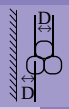
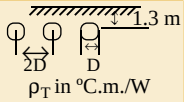
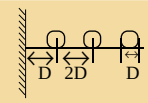
Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
Induced current in the metallic screen	mm²	 ρ_T in °C.m./W				Induced current in the metallic screen	mm²	 ρ_T in °C.m./W			
		ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C			ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	405	350	480	385	without circulating current	240 R	425	370	535	425
	300 R	455	395	550	440		300 R	480	415	610	490
	400 R	515	445	635	505		400 R	550	475	710	570

Lead sheath screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Thickness of lead sheath	Thickness of Jacket	Outside diameter of cable	Lead sectional area	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm	mm	Approx. mm	mm²	Approx. kg/m	Ω/km	µF/km
400 R	R: compact Round stranded	23.2	1.0	23.0	1.0	2.4	3.7	90	620	16	0.0470	0.14
500 R		26.4	1.0	23.0	1.0	2.4	3.7	91	625	17	0.0366	0.15
630 R		30.3	1.0	23.0	1.0	2.5	3.9	99	710	20	0.0283	0.16
800 R		34.7	1.0	23.0	1.0	2.5	3.9	99	715	22	0.0221	0.18
1000 R		39.1	1.0	23.0	1.0	2.7	4.1	108	840	26	0.0176	0.18

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

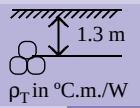
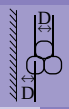
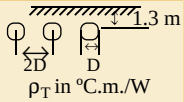
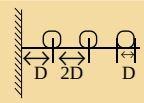
Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 ρ_T in °C.m./W						 ρ_T in °C.m./W			
Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	400 R	645	555	795	635	without circulating current	400 R	700	610	895	715
	500 R	725	625	910	725		500 R	800	695	1040	830
without circulating current	630 R	860	740	1080	860		630 R	915	790	1195	955
	800 R	965	830	1235	980		800 R	1035	890	1380	1105
	1000 R	1055	910	1375	1090		1000 R	1145	990	1540	1230

Lead sheath screen

Constructional data (nominal)

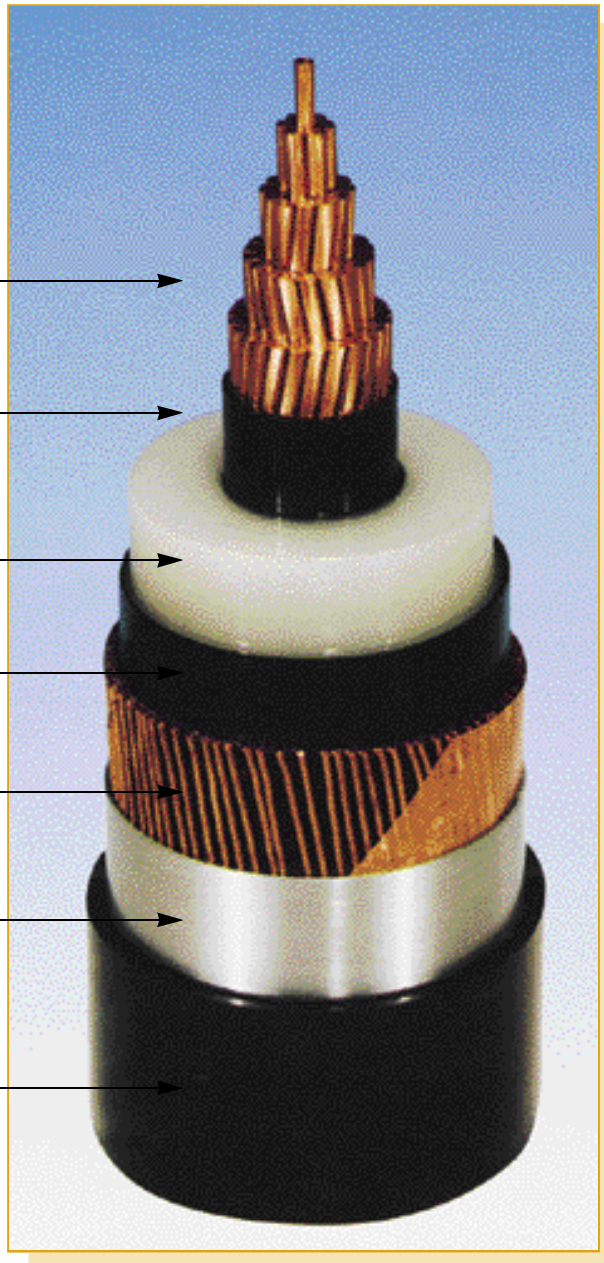
Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Thickness of lead sheath	Thickness of Jacket	Outside diameter of cable	Lead sectional area	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm	mm	Approx. mm	mm²	Approx. kg/m	Ω/km	µF/km
400 R	R: compact Round stranded	23.3	1.0	23.0	1.0	2.4	3.7	91	625	14	0.0778	0.14
500 R		26.4	1.0	23.0	1.0	2.4	3.7	91	625	14	0.0605	0.15
630 R		30.3	1.0	23.0	1.0	2.5	3.9	99	710	16	0.0469	0.16
800 R		34.7	1.0	23.0	1.0	2.6	4.1	103	775	18	0.0367	0.17
1000 R		38.8	1.0	23.0	1.0	2.7	4.3	108	840	20	0.0291	0.18
1200 R		41.7	1.0	23.0	1.0	2.7	4.3	108	840	20	0.0247	0.20

Continuous current ratings (load factor= 100%) for one circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
											
Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	400 R	510	440	630	500	without circulating current	400 R	550	475	700	560
	500 R	580	500	725	580		500 R	630	545	815	655
without circulating current	630 R	685	590	860	685		630 R	720	625	945	755
	800 R	775	665	990	785		800 R	820	710	1095	875
	1000 R	865	745	1120	890		1000 R	925	800	1245	995
	1200 R	930	800	1220	970		1200 R	1000	865	1365	1090

6.2 - COPPER AND ALUMINIUM CONDUCTOR WIRE SCREEN (66 - 225 KV)

COMPACTROUND STRANDED COPPER OR ALUMINIUM



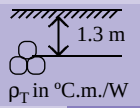
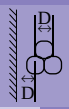
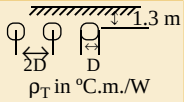
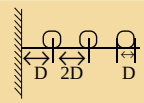
36 / 63 TO 40 / 69 (72.5) KVXLPE CABLES
COPPER CONDUCTOR

Copperwire screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Diameter and number of copper wires	Thickness of Alu coated tape	Thickness of Jacket	Outside diameter of cable	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm x N	mm	mm	Approx. mm	Approx. kg/m	Ω/km	µF/km
185 R	R: compact Round stranded	15.9	1.0	10.0	1.0	1.5X80	0.2	2.9	59	5	0.0991	0.18
240 R		18.4	1.0	10.0	1.0	1.5X80	0.2	2.9	60	5	0.0754	0.21
300 R		20.5	1.0	10.0	1.0	1.5X80	0.2	3.0	65	6	0.0601	0.22
400 R		23.2	1.0	10.0	1.0	1.5X80	0.2	3.0	65	7	0.0470	0.25
500 R		26.4	1.0	10.0	1.0	1.5X80	0.2	3.1	71	8	0.0366	0.25
630 R		30.3	1.0	10.0	1.0	1.5X80	0.2	3.3	76	10	0.0283	0.26
800 R		34.7	1.0	10.0	1.0	1.5X80	0.2	3.4	82	12	0.0221	0.28
1000 R		39.1	1.0	10.0	1.0	1.5X80	0.2	3.4	83	14	0.0176	0.35

Continuous current ratings (load factor= 100%) for one circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial 		In air 		Earthing conditions	Nominal sectional area	Direct burial 		In air 	
Induced current in the metallic screen	mm²	ρT in °C.m./W ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρT in °C.m./W ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	185 R	420	365	510	405	without circulating current	185 R	480	415	605	485
	240 R	475	410	595	470		240 R	555	480	720	575
	300 R	530	455	670	530		300 R	625	540	820	655
	400 R	600	515	755	595		400 R	715	615	955	760
	500 R	660	570	855	675		500 R	815	700	1100	875
without circulating current	630 R	840	725	1085	860		630 R	925	795	1270	1010
	800 R	920	790	1205	955		800 R	1030	885	1415	1130
	1000 R	1015	875	1365	1075		1000 R	1155	990	1645	1310

36 / 63 TO 40 / 69 (72.5) KVXLPE CABLES
ALUMINIUM CONDUCTOR

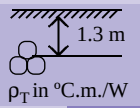
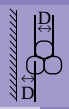
Aluminium wire screen

Constructional data (nominal)

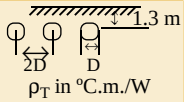
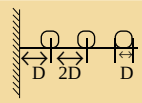
Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Diameter and numberof aluminium wires	Thickness of Alu PE tape	Thickness of Jacket	Outside diameter of cable	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm x N	mm	mm	Approx. mm	Approx. kg/m	Ω/km	µF/km
150 R	R: compact Round stranded	14.2	1.0	10.0	1.0	1.5X80	0.2	2.9	55	4	0.2060	0.17
185 R		16.2	1.0	10.0	1.0	1.5X80	0.2	2.9	55	4	0.1640	0.19
240 R		18.4	1.0	10.0	1.0	1.5X80	0.2	2.9	56	4	0.1250	0.22
300 R		21.0	1.0	10.0	1.0	1.5X80	0.2	3.0	61	4	0.1000	0.22
400 R		23.3	1.0	10.0	1.0	1.5X80	0.2	3.0	61	5	0.0778	0.25
500 R		26.4	1.0	10.0	1.0	1.5X80	0.2	3.2	67	5	0.0605	0.25
630 R		30.3	1.0	10.0	1.0	1.5X80	0.2	3.3	72	6	0.0469	0.26
800 R		34.7	1.0	10.0	1.0	1.5X80	0.2	3.4	78	7	0.0367	0.28
1000 R		38.8	1.0	10.0	1.0	1.5X80	0.2	3.4	78	8	0.0291	0.35
1200 R		41.7	1.0	10.0	1.0	1.5X80	0.2	3.6	83	9	0.0247	0.35

Continuous current ratings (load factor= 100%) for one circuit in operation (Amperes)

Laying conditions: Trefoil formation

Earthing conditions	Nominal sectional area	Direct burial		In air	
Induced current in the metallic screen		 ρ_T in °C.m./W			
	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	150 R	300	260	360	285
	185 R	340	295	410	325
	240 R	395	340	480	380
	300 R	440	380	545	435
	400 R	495	425	615	485
	500 R	565	485	720	570
without circulating current	630 R	685	590	880	695
	800 R	775	665	1015	800
	1000 R	865	740	1150	910

Laying conditions: Flat formation

Earthing conditions	Nominal sectional area	Direct burial		In air	
Induced current in the metallic screen		 ρ_T in °C.m./W			
	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
without circulating current	150 R	325	285	410	330
	185 R	370	325	475	380
	340 R	430	370	560	445
	300 R	490	420	645	510
	400 R	555	480	730	585
	500 R	640	550	865	690
	630 R	735	635	1010	805
	800 R	840	720	1170	935
	1000 R	945	810	1350	1075

64 / 110 (123) KVXLPE CABLES
COPPER CONDUCTOR

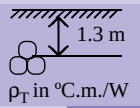
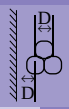
Copper wire screen

Constructional data (nominal)

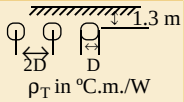
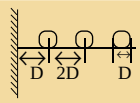
Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Diameter and number of copper wires	Thickness of Alu coated tape	Thickness of Jacket	Outside diameter of cable	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm x N	mm	mm	Approx. mm	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	16.0	1.0	1.5X80	0.2	3.2	66	6	0.0754	0.16
300 R		20.5	1.0	16.0	1.0	1.5X80	0.2	3.2	71	7	0.0601	0.16
400 R		23.2	1.0	16.0	1.0	1.5X80	0.2	3.2	72	8	0.0470	0.18
500 R		26.4	1.0	16.0	1.0	1.5X80	0.2	3.3	77	9	0.0366	0.19
630 R		30.3	1.0	16.0	1.0	1.5X80	0.2	3.4	78	11	0.0283	0.23
800 R		34.7	1.0	16.0	1.0	1.5X80	0.2	3.6	86	13	0.0221	0.23
1000 R		39.1	1.0	16.0	1.0	1.5X80	0.2	3.8	91	16	0.0176	0.24

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

Laying conditions: Trefoil formation

Earthing conditions Induced current in the metallic screen	Nominal sectional area mm²	Direct burial  ρ_T in °C.m./W		In air 	
		ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	485	420	600	475
	300 R	535	465	675	535
	400 R	600	515	765	605
	500 R	665	570	865	685
without circulating current	630 R	840	720	1085	860
	800 R	930	800	1225	975
	1000 R	1015	875	1365	1080

Laying conditions: Flat formation

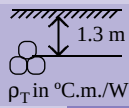
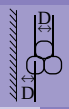
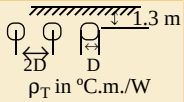
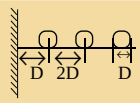
Earthing conditions Induced current in the metallic screen	Nominal sectional area mm²	Direct burial  ρ_T in °C.m./W		In air 	
		ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
without circulating current	240 R	550	475	705	565
	300 R	620	540	805	645
	400 R	710	615	935	745
	500 R	810	700	1075	860
	630 R	920	795	1255	1000
	800 R	1040	895	1425	1035
	1000 R	1150	990	1600	1275

Aluminium wire screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Diameter and numberof aluminium wires	Thickness of Alu PE tape	Thickness of Jacket	Outside diameter of cable	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm x N	mm	mm	Approx. mm	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	16.0	1.0	1.5X80	0.2	3.2	66	5	0.1250	0.16
300 R		21.0	1.0	16.0	1.0	1.5X80	0.2	3.3	72	6	0.1000	0.17
400 R		23.3	1.0	16.0	1.0	1.5X80	0.2	3.3	72	6	0.0778	0.19

Continuous current ratings (load factor= 100%) for one circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 ρT in °C.m./W						 ρT in °C.m./W			
Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	390	340	480	380	without circulating current	240 R	430	370	550	440
	300 R	440	380	550	435		300 R	485	420	630	505
	400 R	500	430	630	500		400 R	555	480	730	585

76 / 132 (145) KVXLPE CABLES
COPPER CONDUCTOR

Copper wire screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Diameter and number of copper wires	Thickness of Alu coated tape	Thickness of Jacket	Outside diameter of cable	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm x N	mm	mm	Approx. mm	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	18.0	1.0	1.5X80	0.2	3.4	72	7	0.0754	0.15
300 R		20.5	1.0	18.0	1.0	1.5X80	0.2	3.4	77	8	0.0601	0.15
400 R		23.2	1.0	18.0	1.0	1.5X80	0.2	3.4	78	9	0.0470	0.16
500 R		26.4	1.0	18.0	1.0	1.5X80	0.2	3.5	82	10	0.0366	0.17
630 R		30.3	1.0	18.0	1.0	1.5X80	0.2	3.6	87	12	0.0283	0.19
800 R		34.7	1.0	18.0	1.0	1.5X80	0.2	3.8	92	14	0.0221	0.20
1000 R		39.1	1.0	18.0	1.0	1.5X80	0.2	4.0	95	16	0.0176	0.23

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

Laying conditions: Trefoil formation

Earthing conditions Induced current in the metallic screen	Nominal sectional area mm²	Direct burial (1.3 m, ρ_T in °C.m./W) ρ_T= 1.0 T=20°C	Direct burial ρ_T= 1.2 T=30°C	In air T=30°C	In air T=50°C
with circulating currents	240 R	485	420	600	475
	300 R	550	475	690	545
	400 R	595	515	765	605
	500 R	660	570	865	685
without circulating current	630 R	835	720	1080	860
	800 R	930	800	1225	975
	1000 R	1015	875	1365	1080

Laying conditions: Flat formation

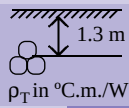
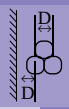
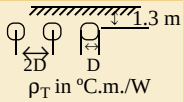
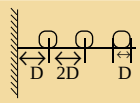
Earthing conditions Induced current in the metallic screen	Nominal sectional area mm²	Direct burial (1.3 m, 2D, D, ρ_T in °C.m./W) ρ_T= 1.0 T=20°C	Direct burial ρ_T= 1.2 T=30°C	In air (D, 2D, D) T=30°C	In air T=50°C
without circulating current	240 R	550	475	700	560
	300 R	620	540	795	640
	400 R	710	615	925	740
	500 R	805	700	1065	850
	630 R	920	795	1230	985
	800 R	1035	895	1310	1125
	1000 R	1145	990	1585	1270

Aluminium wire screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Diameter and numberof aluminium wires	Thickness of Alu PE tape	Thickness of Jacket	Outside diameter of cable	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm x N	mm	mm	Approx. mm	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	18.0	1.0	1.5X80	0.2	3.3	72	5	0.1250	0.15
300 R		21.0	1.0	18.0	1.0	1.5X80	0.2	3.4	75	6	0.1000	0.16
400 R		23.3	1.0	18.0	1.0	1.5X80	0.2	3.4	77	6	0.0778	0.17

Continuous current ratings (load factor= 100%) for one circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 ρT in °C.m./W						 ρT in °C.m./W			
Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	390	340	480	380	without circulating current	240 R	430	370	545	435
	300 R	440	380	545	435		300 R	485	420	625	500
	400 R	495	430	630	500		400 R	555	480	725	580

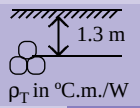
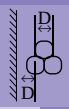
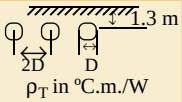
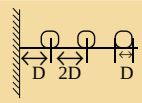
87 / 150 (170) KVXLPE CABLES
COPPER CONDUCTOR

Copper wire screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Diameter and number of copper wires	Thickness of Alu coated tape	Thickness of Jacket	Outside diameter of cable	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm x N	mm	mm	Approx. mm	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	20.0	1.0	1.5X80	0.2	3.4	77	8	0.0754	0.13
300 R		20.5	1.0	20.0	1.0	1.5X80	0.2	3.5	82	9	0.0601	0.14
400 R		23.2	1.0	20.0	1.0	1.5X80	0.2	3.5	82	9	0.0470	0.15
500 R		26.4	1.0	20.0	1.0	1.5X80	0.2	3.6	86	11	0.0366	0.16
630 R		30.3	1.0	20.0	1.0	1.5X80	0.2	3.8	91	13	0.0283	0.17
800 R		34.7	1.0	20.0	1.0	1.5X80	0.2	4.0	95	15	0.0221	0.19
1000 R		39.1	1.0	20.0	1.0	1.5X80	0.2	4.0	99	17	0.0176	0.21

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 ρ_T in °C.m./W						 ρ_T in °C.m./W			
Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	480	420	600	475	without circulating current	240 R	550	475	695	555
	300 R	535	465	675	540		300 R	620	535	790	635
	400 R	595	515	765	610		400 R	705	610	915	735
	500 R	660	575	865	690		500 R	805	695	1055	845
without circulating current	630 R	835	720	1080	860		630 R	920	795	1220	975
	800 R	930	800	1225	975		800 R	1035	895	1400	1120
	1000 R	1015	875	1360	1080		1000 R	1145	985	1575	1335

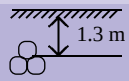
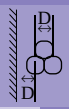
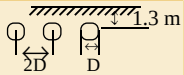
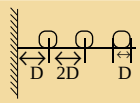
87 / 150 (170) KVXLPE CABLES
ALUMINIUM CONDUCTOR

Aluminium wire screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Diameter and numberof aluminium wires	Thickness of Alu PE tape	Thickness of Jacket	Outside diameter of cable	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm x N	mm	mm	Approx. mm	Approx. kg/m	Ω/km	µF/km
240 R	R: compact Round stranded	18.4	1.0	20.0	1.0	1.5X80	0.2	3.3	77	6	0.1250	0.13
300 R		21.0	1.0	20.0	1.0	1.5X80	0.2	3.5	82	7	0.1000	0.14
400 R		23.3	1.0	20.0	1.0	1.5X80	0.2	3.5	82	7	0.0778	0.15

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 ρT in °C.m./W						 ρT in °C.m./W			
Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	240 R	390	340	480	380	without circulating current	240 R	425	370	540	435
	300 R	440	380	545	435		300 R	485	420	620	495
	400 R	495	430	625	500		400 R	555	480	720	575

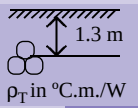
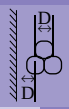
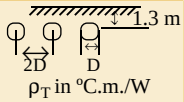
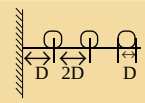
130 / 225 (245) KVXLPE CABLES
COPPER CONDUCTOR

Copper wire screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Diameter and number of copper wires	Thickness of Alu coated tape	Thickness of Jacket	Outside diameter of cable	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm x N	mm	mm	Approx. mm	Approx. kg/m	Ω/km	µF/km
400 R	R: compact Round stranded	23.2	1.0	23.0	1.0	1.5X80	0.2	3.8	91	11	0.0470	0.14
500 R		26.4	1.0	23.0	1.0	1.5X80	0.2	3.8	91	12	0.0366	0.15
630 R		30.3	1.0	23.0	1.0	1.5X80	0.2	4.0	99	14	0.0283	0.16
800 R		34.7	1.0	23.0	1.0	1.5X80	0.2	4.0	99	15	0.0221	0.18
1000 R		39.1	1.0	23.0	1.0	1.5X80	0.2	4.2	108	19	0.0176	0.18

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

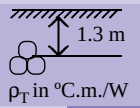
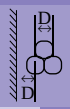
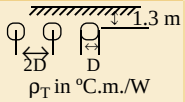
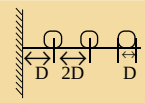
Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
											
Induced current in the metallic screen	mm²	ρ_T in °C.m./W ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρ_T in °C.m./W ρ_T= 1.0 T=20°C	ρ_T= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	400 R	595	515	770	610	without circulating current	400 R	705	610	905	725
	500 R	660	570	870	690		500 R	805	695	1050	840
without circulating current	630 R	880	720	1075	855		630 R	915	795	1205	965
	800 R	925	800	1220	970		800 R	1035	890	1390	1110
	1000 R	1015	875	1355	1080		1000 R	1145	990	1550	1240

Aluminium wire screen

Constructional data (nominal)

Conductor			Thickness of Conductor screen	Thickness of insulation	Thickness of insulation screen	Diameter and numberof aluminium wires	Thickness of Alu PE tape	Thickness of Jacket	Outside diameter of cable	Weight of cable	DC conductor resistance at 20°C	Electro-static capacitance
Nominal sectional area mm²	Shape	Diameter mm	Approx. mm	Approx. mm	Approx. mm	mm x N	mm	mm	Approx. mm	Approx. kg/m	Ω/km	µF/km
400 R	R: compact Round stranded	23.3	1.0	23.0	1.0	1.5X80	0.2	3.8	91	8	0.0778	0.14
500 R		26.4	1.0	23.0	1.0	1.5X80	0.2	3.8	91	9	0.0605	0.15
630 R		30.3	1.0	23.0	1.0	1.5X80	0.2	4.0	99	10	0.0469	0.16
800 R		34.7	1.0	23.0	1.0	1.5X80	0.2	4.1	104	11	0.0367	0.17
1000 R		38.8	1.0	23.0	1.0	1.5X80	0.2	4.2	108	12	0.0291	0.18
1200 R		41.7	1.0	23.0	1.0	1.5X80	0.2	4.2	108	13	0.0247	0.20

Continuous current ratings (load factor= 100%) forone circuit in operation (Amperes)

Laying conditions: Trefoil formation						Laying conditions: Flat formation					
Earthing conditions	Nominal sectional area	Direct burial		In air		Earthing conditions	Nominal sectional area	Direct burial		In air	
		 1.3 m ρT in °C.m./W		 D D				 1.3 m 2D D ρT in °C.m./W		 D 2D D	
Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C	Induced current in the metallic screen	mm²	ρT= 1.0 T=20°C	ρT= 1.2 T=30°C	T=30°C	T=50°C
with circulating currents	400 R	495	430	625	500		400 R	555	480	710	570
	500 R	560	485	720	570		500 R	635	550	825	665
without circulating currents	630 R	675	585	865	690	without circulating current	630 R	730	630	960	770
	800 R	765	660	995	795		800 R	830	720	1110	890
	1000 R	855	740	1130	900		1000 R	935	805	1265	1010
	1200 R	920	795	1230	980		1200 R	1010	875	1390	1110

7.1 - FORMULAE

Ohms law	$U = RI$
Joules law	$W = RI^2t$
Resistance of a line (feed and return)	$R = \frac{2L}{xS}$
DC Power	$P_{(W)} = UI$
Single phase Power	$P_{(W)} = UI \cos \varphi$
Three phase Power	$P_{(W)} = \sqrt{3}\, UI \cos \varphi$
DC Current	$I = \frac{P_{(W)}}{U}$
AC Single core current	$I = \frac{P_{(VA)}}{U} = \frac{P_{(W)}}{U \cos \varphi}$
AC Three phase current	$I = \frac{P_{(VA)}}{U\sqrt{3}} = \frac{P_{(W)}}{U\sqrt{3} \cos \varphi}$
Efficiency	$e = \frac{P \text{ output}}{P \text{ input}}$

U = Rated Voltage in V (volts) (between phase in three phase system).
I = Current in A (Amperes).
R = Resistance in (ohms).
W = Energy in Ws (Watt second).
t = Time in s (second)
L = Length of cable in m (meter).
x = Conductivity (56 for copper and 34 for Aluminium).
S = Cross sectional area in mm^2.
P = Power in W (Watt) or VA (VoltAmpere).
Cos φ = Power factor.
e = Efficiency.
Δu = Voltage drop sending to receiving end of line in V (Volts).

Voltage drop

Nature of the current	Voltage drop Δu (v)	Size mm^2
Single phase AC/DC systems	If current known $\Delta u = \frac{2\,LI}{x\,S}$	$S = \frac{2\,LI}{x\,\Delta u}$
	If power known $\Delta u = \frac{2\,L\,P_{(W)}}{x\,S\,U}$	$S = \frac{2\,L\,P_{(W)}}{x\,\Delta u\,U}$
Three phase system	If current known $\Delta u = \frac{1.73\,LI \cos \varphi}{x\,S}$	$S = \frac{1.73\,LI \cos \varphi}{x\,\Delta u}$
	If power known $\Delta u = \frac{L\,P_{(W)}}{x\,S\,U}$	$S = \frac{L\,P_{(W)}}{x\,\Delta u\,U}$

7.2 - CONVERSION FACTORS AND UNITS

Length : The SI unit for length is the m

1m = 10^2 cm = 10^3 mm = 10^{-3} Km
1m = 39.37 in = 3.28 ft = 1.0936 Yd = 0.6214 x 10^{-3} miles
1 in = 0.0254 m = 0.0833 ft = 0.0277 Yd = 0.0158 x 10^{-3} miles
1 ft = 0.03048 m = 12 in = 0.333 Yd = 0.189 x 10^{-3} miles
1 Yd = 0.9144 m = 36 in = 3 ft = 0.568 x 10^{-3} miles
1 mile = 1609 m = 63360 in = 5280 ft = 1760 Yd

m = meters, in = inches, ft = feet, Yd = Yards

Weight : The SI unit for weight is the Kg

1 Kg = 10^3 g = 10^{-3} T (metric ton)
1 Kg = 2.20462 lb = 35.27 oz
1 oz = 28.349 x 10^{-3} Kg = 0.0625 lb

Kg = Kilogrammes, lb = pounds, oz = ounces

Volume : The SI unit for volume is the m^3

1 m^3 = 10 dm^3 = 10^6 cm^3 = 109 mm^3
1 m^3 = 1000 L= 35.315 ft^3 = 219.97 I.gal = 264.17 U.S. gal
IL= 0.001 m^3 = 0.0353 ft^3 = 0.21997 I.gal = 0.26417 U.S. gal
1 ft^3 = 28.317 x 10^{-3} m^3 = 28.317 L= 6.2288 I. gal = 7.479 U.S. gal
1 I.gal = 4.546 x 10^{-3} m^3 = 4.546 L= 0.1605 ft^3 = 1.2009 U.S. gal
1 U.S. gal = 3.7854 x 10^{-3} m^3 = 3.785 L= 0.1366 ft^3 = 0.8327 I. gal

1 = liters, ft = feet, I.gal = Imperial gallon, U.S.gal = United States gallon

Force : The SI unit for force is the N

1N = 0.10197 Kgf = 0.2248 Lbf
1Kgf = 9.80665 N = 2.2046 Lbf
1Lbf = 4.4482 N = 0.4536 Kgf

N = Newton, Kgf = Kilogram force, Lbf = pound force

Power : The SI unit for power is the W

1W= 0.102 Kgm / s = 1.359 x 10^{-3} HP= 3.412 BTU / h
1 Kgm / s = 9.81 W = 0.0133 HP= 33.47 BTU / h
1HP= 735.5 W = 75 Kgm / s = 2510 Btu / h
1BTu = 0.2931 W = 0.0298 Kgm / s = 0.393 x 10^{-3} HP

w = watt, Kgm / s = Kilogramme meter per second,
HP= Metric Horse power, BTU / h = British thermal unit per hour

Pressure : The SI unit for pressure is the pa = 1 N/m^2

1 $N/m^2 = 10^{-5}$ $Kgf / cm^2 = 10^{-5}$ bar

1$Kgf / cm^2 = 10^5$ N / m^2 = 1 bar

Pa = Pascal, Nm^2 = Newton per square meter

Kgf / cm^2 = Kilogramme force per square centimeter

Work : The SI unit for work is the J

1 J = 1Ws (Wattsecond) = 1 Nm (Newton-meter)

1 J = 0.2778 x 10^{-6} Kwh = 0.239 x 10^{-3} Kcal

1 Kwh = 3.6 x 10^6 J = 859.8 Kcal

1 Kcal = 4186.8 J = 1.163 x 10^{-3} Kwh

J = Joules, Kwh = Kilowatt hour, Kcal = Kilocalories

Temperature :The SI unit for Temperature is the Kelvin (K)

Temperature in ^{O} C = Temperature in ^{O}K - 273 = 5/9 (Temperature in ^{O}F - 32)

Temperature in ^{O} K = Temperature in ^{O} C + 273

^{O} C = degree celcius, ^{O}K = degree Kelvin, ^{O}F = degree Fahrenheit