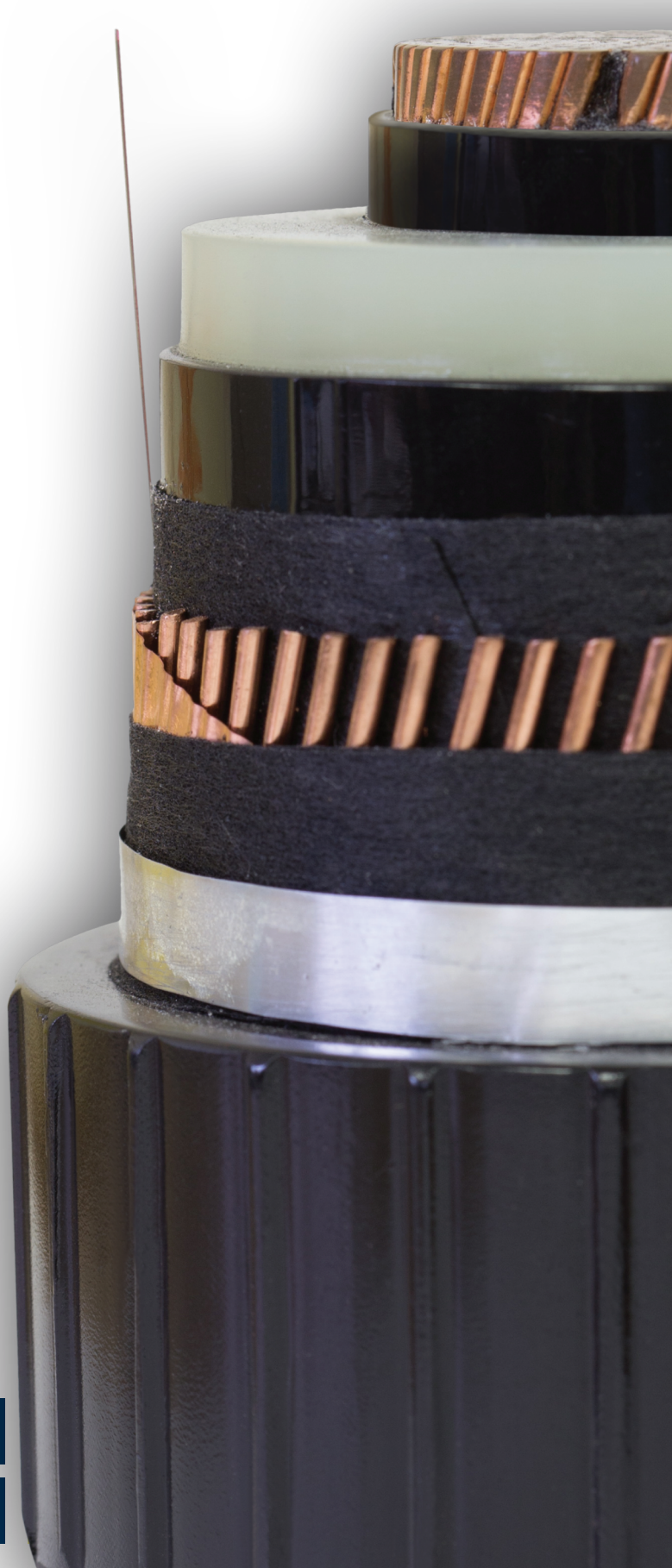
ESTRALIN HVC

XLPE CABLES
AND CABLE SYSTEMS
66-220 KV



MODERN SOLUTIONS FOR
POWER CABLES/ESTRALIN HVC

Cables 66-220 kV are widely used for electric energy transmission and distribution especially in large cities and at production plants, where electric energy consumption and load density levels are particularly high. Although basic requirements of cables (i.e. reliability, functionality, low maintenance costs) are obvious, failing in one of these requirements can cause remarkable financial losses as well as interruption of the service being provided.

Unlike cables with paper or oil-filled insulation which have reliability issues as well as high maintenance needs, medium and high voltage XLPE power cables provides very long service life and provide continuous electric power to consumer during their service life without any maintenance needs.

Design, modern production technologies and perfect materials with better electric and mechanical properties makes XLPE cables service life longest among other types of cables.

XLPE cables transfer capability is substantially higher than paper or oil-filled insulated cables. According to international standards, XLPE cables are designed for continuous service with conductor temperature of 90°C and it is still active under emergency conditions even at higher temperatures while oil-filled or paper insulated cables can withstand conductor temperature only up to 70°C which significantly decreases their transfer capability.

XLPE cables are environmentally safe. Absence of liquid inclusions ensures maintaining clean environment, which permits usage at any environmentally demanding projects and service-free maintenance of cable lines.

Due to its single core design, cable laying and installation of accessories, even in the most extreme conditions, are easier. XLPE cables with polyethylene sheath can be laid even temperatures as low as -20°C.

XLPE cable production technology was first introduced in the 1970s. The cross-links are a space lattice constructed using formation of longitudinal and transversal ties between macromolecules of polymer. With its physical and electrical properties, cross-linked polymer suits ideally for insulation of medium, high and extra-high voltage cables.

During production of XLPE cables, as any inclusions to the insulation will reduce life expectancy of the cable, special attention has to be paid regarding the purity and quality of insulation materials. In order to reach the ultimate target of producing reliable cable with a long trouble free operation time, special measures has to be taken by providing high quality raw material from a reliable supplier and treating them in special "clean rooms" in order to avoid contamination of insulating material.

High adhesion between semiconducive screens and insulation is a critical point. Applying insulation and semiconductive screens with triple extrusion technology followed by simultaneous cross linking of all three layers ensures high adhesion.

Based on obvious advantages of enhanced design and modern production technology, XLPE cables proved their universal application in developed countries and cause remarkable, continuous decrease of usage of oil and paper filled insulated cables day by day.

Estralin HVC – High Voltage cable production pioneer in Russia

The ultimate target of the «Estralin High Voltage Cables» (Estralin HVC) plant is introduction of innovative technologies in the field of power cable production. Providing high quality production and services, we help our customers to increase their competitiveness as well as reduce the adverse impact upon environment.

Estralin HVC gives utmost importance to Research & Development of new technologies in order to provide high quality, competitive final product. Using best materials from leading global manufacturers for insulation (peroxide-cross-linked polyethylenes, triingostable (TSPE) and copolymer (CCPE) polyethylenes), high skilled personnel are key for us to perfect production which complies International and Russian Standards which put us on par with Western European Manufacturers.

Starting from choosing the right cables and accessories according to project and customer requirements until commissioning of complete cable line, Estralin has continuous control over the project in order to guarantee full satisfaction of final client.

In order to maintain complying to international quality standards, systematic approach has been introduced at the factory. Environmental aspects are very important for Estralin HVC and all necessary measures are being taken accordingly.

Estralin HVC's successes in development, introduction of quality assurance and environmental management systems have been recognized by the largest independent European certification Company, TUV CERT: the Plant was awarded certificates of conformity with regulatory requirements of ISO 9001 : 2008, ISO 14001 : 2004.

Core production of Estralin HVC is 66-220 kV XLPE cables.

According to their design, all cables technological data and service characteristics comply the international standard requirements:IEC 60840 (66-150 kV cables), and IEC 62067 (220 kV cables), as well as with the GOST R certification, including those with regard to fire safety.

Our company offers:

- medium and high voltage cables
- technical support at all stages of cooperation.









Markings

Conductor material	**Without designation**	Copper conductor
	A	Aluminum conductor
	RM	Round conductor
	RMS	Segmented conductor
Insulation material	2X	XLPE insulation
Screen	S	Copper wire and copper tape screen
	SA	Aluminium wire and aluminium tape screen
	(F)	Watertight screen from swelling tape which provides longitudinal water sealing
	(FL)	Watertight screen from swelling tape which provides radial water sealing and laminated polymer
Armouring	AWA	Wires armouring from galvanized steel
Sheath	K	Lead sheath
	Y	PVC sheath
	2Y	XLPE sheath
	H	Halogen free flame retardant sheath
	LWL (following screen designation)	Optic fibers in steel tubing inserted into copper

Example[1]:

A2XS(FL)Y-A-LWL 1x1600RMS/185 64/110 kV

- A2X — Aluminum conductor
- S(FL) — XLPE insulation
- Y — Dual water sealed, flame retardant PVC outer sheath of category «A»
- LWL — Integrated optical fiber
- 1x — Conductor quantity
- 1600RMS — Longitudinal segmented conductor
- /185 — Screen cross-section
- 64/110 kV — Nominal voltage

[1] Cable design and markings can be changed when new decisions are implemented.

Comparative characteristics	XLPE cable	High pressure oil-filled cable
Continuous permissible temperature, °C	90	85
Permissible heating in emergency, °C	105	90
Ultimate permissible temperature under short-circuit current flow, °C	250	200
Density of 1-sec. short-circuit current, A/mm² — copper conductor — aluminum conductor	 144 93	 101 67
Relative permittivity ε at 20°C	2,5	3,3
Dielectric loss ratio, tg δ at 20°C	0,001	0,004

Main advantages of XLPE cables are the following:

- high cable transmission capacity due to increased conductor permissible temperature;
- high current of thermal resistance during short-circuit that is of a special importance when a cross-section has been chosen on the basis of short-circuit nominal current only;
- low weight, smaller diameter and bending radius, which facilitates laying in both cable structures and underground along complicated routes;
- strong insulation provides enormous advantages at the laying over a sloping, hilly or rough territory, i.e. along the routes with considerable level difference due to absence of mass dulling effect;
- absence of liquids (oils) under pressure, and consequently, no need for costly refilling equipment, that means the considerable saving in operational costs, simplification of installation equipment, reducing time and cost of cable laying, as well as installation;
- the possibility of fast repair in emergency situation;
- absence of leakages and, therefore, no risks of environmental pollution in case of damage.

Design

XLPE insulated 66-220 kV cables consist of a round or segment copper or aluminum conductor, semiconductive core layer, XLPE insulation, semiconductive insulation layer, semiconductive tape, copper wire screen and copper tape screen, semiconductive tape, outer XLPE-sheath or PVC-compound.

Extruded screen made of semiconductive material, insulation and semiconductive insulation screen is laid over the conductor. Insulation thickness depends on conductor diameter.

The metal screen consists of copper wires and a copper tape laid above them. The screen cross-section is selected from short-circuit (SC) currents flow condition.

To ensure longitudinal sealing with "F"-index, a layer of waterproofing material should be used. Upon contact with water, the layer swells and makes a lateral barrier, thus preventing spreading of moisture in case of outer sheath failure.

"FL"-index has a sheath made of aluminum polyethylene tape welded together with XLPE- or PVC-sheath. This design allows to have an effective diffusion barrier, which prevents penetration of water vapor, whereas the outer sheath made of black PE serves as the mechanical protection.

Cables with reinforced XLPE-sheath and longitudinal ribs designed for sheath damage control, are used during cable laying.

On the Customer request, a 66-220 kV cable may be manufactured with optical fiber which is used for temperature measurement through the full length of the cable and for signals transmission.

Design

In addition, to ensure the sealing, lead sheath may be used. When this occurs, the cable will have the “K”-index. The lead sheath do not only ensure the sealing but also can replace, partially or in full, the screen transmitting short-circuit currents.

To ensure the additional mechanical protection the aluminum-alloy wire armor with “AWA”-index can be used.

Cables with reinforced XLPE-sheath and longitudinal ribs designed for sheath damage control, are used during cable laying.

On the Customer request, a 66-220 kV cable may be manufactured with optical fiber which is used for temperature measurement through the full length of the cable and for signals transmission.

XLPE 66 kV cable specification

Conductor cross-section (S)	mm^2	185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm^2	150	150	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	11,5	11,0	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	63,6	64,9	66,2	67,8	69,4	72,4	75,6	79,5	83,7	89,3	93,2	96,4	102,4
Weight approx.														
Al conductor	kg/m	4,4	4,6	4,8	5,0	5,2	5,7	6,2	6,9	7,7	8,7	9,5	10,2	11,6
Cu conductor		5,5	6,1	6,6	7,2	7,7	8,8	10,2	11,9	14,0	16,1	18,2	20,2	24,1
Min. bending radius (15D)	m	0,954	0,974	0,993	1,017	1,041	1,086	1,134	1,193	1,256	1,340	1,398	1,446	1,536
Maximum pulling force														
Al (30 S)	kN	5,55	7,20	9,00	10,5	12,0	15,0	18,9	24,0	30,0	36,0	42,0	48,0	60,0
Cu (50 S)		9,25	12,00	15,00	17,5	20,00	25,0	31,5	40,0	50,0	60,0	70,0	80,0	100,0
DC resistance														
Cu conductor	Ω/km	0,1640	0,1250	0,1000	0,0890	0,0778	0,0605	0,0460	0,0367	0,0291	0,0247	0,0212	0,0186	0,0149
Al conductor		0,0991	0,0754	0,0601	0,0543	0,0470	0,0366	0,0280	0,0221	0,0176	0,0151	0,0129	0,0113	0,0090
Inductance between conductors	$\frac{mH}{km}$	0,4627	0,4439	0,4289	0,4209	0,4057	0,39	0,3781	0,363	0,351	0,339	0,334	0,330	0,317
Inductance between conductor and screen	$\frac{mH}{km}$	0,228	0,206	0,187	0,178	0,170	0,183	0,181	0,132	0,121	0,114	0,106	0,101	0,092
Capacitance (per phase)	uF/km	0,167	0,188	0,210	0,221	0,232	0,252	0,274	0,300	0,328	0,366	0,392	0,413	0,453

XLPE 66 kV cable specification with lead sheath

Conductor cross-section (S)	mm²	185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm²	150	150	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	11,5	11,0	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5
Thickness of lead sheah	mm	2,2	2,2	2,2	2,2	2,2	2,2	2,4	2,4	2,6	2,6	2,7	2,7	2,8
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	67,6	68,9	70,2	71,8	73,4	76,4	80,0	83,9	88,5	94,1	98,2	101,4	107,6
Weight approx. Al conductor Cu conductor	kg/m	 8,6 9,7	 8,9 10,4	 9,2 11,1	 9,5 11,7	 9,9 12,4	 10,6 13,7	 11,9 15,8	 12,9 17,9	 14,6 20,8	 16,1 23,5	 17,5 26,2	 18,5 28,5	 20,9 33,4
Min. bending radius (20D)	m	1,352	1,378	1,404	1,436	1,468	1,528	1,600	1,678	1,770	1,882	1,964	2,028	2,152
Maximum pulling force Al (30 S) Cu (50 S)	kN	 5,55 9,25	 7,20 12,00	 9,00 15,00	 10,5 17,5	 12,0 20,00	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0
DC resistance Cu conductor Al conductor	Ω/km	 0,1640 0,0991	 0,1250 0,0754	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,0470	 0,0605 0,0366	 0,0460 0,0280	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,0090
Inductance between conductors	mH/km	0,479	0,456	0,436	0,425	0,416	0,400	0,386	0,371	0,358	0,348	0,339	0,332	0,321
Inductance between conductor and screen	mH/km	0,232	0,210	0,191	0,182	0,173	0,160	0,148	0,135	0,124	0,117	0,109	0,104	0,095
Capacitance (per phase)	uF/km	0,167	0,188	0,210	0,221	0,232	0,252	0,274	0,300	0,328	0,366	0,392	0,413	0,453

Permissible continuous current-capacity during cable laying for XLPE cables 66 kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in ground;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases –cable diameter;
- cable laying depth – 1,5 m;
- soil maximum temperature +15°C;
- soil thermal resistance– 1,2 K·m/W;
- conductor temperature - +90°C;
- circuits quantity– 1;
- load factor (LF) – 0,1 и 0,8.

Table 1.1. Continious current-carrying capacity during cable laying in ground

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A														
	Cu LF=0,8	489	568	642	682	734	834	945	1058	1164	1365	1474	1558	1664
	Cu LF=1,0	438	506	571	605	650	737	832	927	1016	1186	1276	1345	1430
	Al LF=0,8	380	442	500	534	576	659	754	856	959	1093	1187	1268	1395
	Al LF=1,0	340	394	445	474	510	582	664	750	837	950	1028	1095	1199
Continuous current-capacity, A														
	Cu LF=0,8	511	595	674	716	771	880	1001	1128	1251	1337	1423	1496	1620
	Cu LF=1,0	456	528	597	634	682	776	883	990	1095	1168	1242	1303	1408
	Al LF=0,8	397	462	524	560	603	692	793	903	1017	1103	1186	1259	1383
	Al LF=1,0	354	411	464	496	533	610	698	793	891	964	1035	1097	1202

Table 1.2. Single point earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A														
	Cu LF =0,8	460	524	582	613	651	722	794	865	927	1024	1075	1113	1162
	Cu LF =1,0	410	466	516	541	574	634	695	752	803	881	922	952	989
	Al LF =0,8	366	420	470	499	533	599	671	743	813	892	947	991	1058
	Al LF =1,0	327	374	417	442	471	527	588	648	706	770	814	849	902
Continuous current-capacity, A														
	Cu LF =0,8	448	501	547	570	599	649	706	752	791	840	868	891	916
	Cu LF =1,0	396	441	479	499	523	564	612	649	681	721	743	762	781
	Al LF =0,8	365	414	457	481	509	561	614	666	713	758	790	815	853
	Al LF =1,0	324	365	402	423	446	490	534	577	615	652	679	699	729

Permissible continuous current-capacity during cable laying in air for XLPE cables 66 kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in the air;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases –cable diameter;
- conductor temperature - +90°C;
- ambient temperature - +25°C;
- protection from solar radiation.

Table 1.3. Single point earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A	Cu	563	661	756	809	876	1009	1156	1312	1464	1741	1901	2027	2200
	Al	438	514	589	633	687	797	922	1061	1205	1391	1528	1646	1840
Continuous current-capacity, A	Cu	626	737	849	909	987	1142	1319	1511	1703	1994	2191	2350	2576
	Al	486	573	659	711	772	898	1043	1208	1382	1580	1742	1883	2120

Table 1.4. Both ends earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A	Cu	536	620	698	741	795	895	1001	1109	1209	1362	1450	1518	1612
	Al	425	494	560	599	645	737	837	944	1050	1173	1262	1335	1453
Continuous current-capacity, A	Cu	550	625	689	724	765	839	913	984	1049	1132	1182	1220	1276
	Al	448	515	575	611	650	726	805	884	959	1037	1092	1137	1207

XLPE 110 kV cable specification

Conductor cross-section (S)	mm^2	185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm^2	150	150	150	150	150	150	150	150	150	150	150	150	150
Thickness of insulation	mm	16,0	16,0	16,0	16,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	71,7	74,0	76,5	77,9	77,5	80,5	83,7	88,6	92,8	97,8	102,6	104,9	112,9
Weight approx. **Al conductor** **Cu conductor**	kg/m	5,5 6,6	5,8 7,3	6,2 8,1	6,4 8,6	6,5 8,9	7,0 10,1	7,6 11,6	8,4 13,5	9,3 15,7	10,6 18,0	11,5 20,2	12,2 22,1	13,8 26,2
Minimal bending radius (15·D)	m	1,071	1,110	1,148	1,169	1,163	1,208	1,256	1,329	1,392	1,469	1,539	1,574	1,694
Maximum pulling force **Al (30·S)** **Cu (50·S)**	kN	5,55 9,25	7,20 12,00	9,00 15,00	10,5 17,5	12,0 20,00	15,0 25,0	18,9 31,5	24,0 40,0	30,0 50,0	36,0 60,0	42,0 70,0	48,0 80,0	60,0 100,0
DC resistance **Al** **Cu**	Om/ km	0,1640 0,0991	0,1250 0,0754	0,1000 0,0601	0,0890 0,0543	0,0778 0,0470	0,0605 0,0366	0,0460 0,0280	0,0367 0,0221	0,0291 0,0176	0,0247 0,0151	0,0212 0,0129	0,0186 0,0113	0,0149 0,0090
Inductance between conductors 	mH/ km	0,494	0,473	0,455	0,444	0,429	0,412	0,397	0,382	0,368	0,356	0,347	0,339	0,328
Inductance between conductors and screen	mH/ km	0,261	0,242	0,225	0,215	0,206	0,185	0,172	0,158	0,145	0,136	0,128	0,122	0,111
Capacitance (per phase)	uF/ km	0,135	0,146	0,157	0,164	0,179	0,194	0,209	0,228	0,248	0,274	0,293	0,308	0,336

XLPE 110 kV cable specification with lead sheath

Conductor cross-section (S)	mm^2	185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm^2	150	150	150	150	150	150	150	150	150	150	150	150	150
Thickness of insulation	mm	16,0	16,0	16,0	16,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0
Thickness of lead sheah	mm	2,2	2,2	2,2	2,2	2,2	2,2	2,4	2,4	2,6	2,6	2,7	2,7	2,8
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	76,6	78,9	81,2	82,8	82,4	85,4	89,0	92,9	97,5	103,1	107,2	110,4	116,6
Weight approx. **Al conductor** **Cu conductor**	kg/m	 10,1 11,2	 10,6 12,1	 11,1 13,0	 11,5 13,7	 11,5 14,0	 12,2 15,3	 13,6 17,5	 14,7 19,7	 16,5 22,7	 18,0 25,5	 19,6 28,3	 20,7 30,6	 23,1 25,6
Minimal bending radius (20·D)	m	1,532	1,578	1,624	1,656	1,648	1,708	1,780	1,858	1,950	2,062	2,144	2,208	2,332
Maximum pulling force **Al (30·S)** **Cu (50·S)**	κN	 5,55 9,25	 7,20 12,00	 9,00 15,00	 10,5 17,5	 12,0 20,00	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0
DC resistance **Al** **Cu**	Om/ km	 0,1640 0,0991	 0,1250 0,0754	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,0470	 0,0605 0,0366	 0,0460 0,0280	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,0090
Inductance between conductors 	mH/ km	0,504	0,483	0,465	0,454	0,439	0,422	0,407	0,391	0,378	0,366	0,356	0,349	0,337
Inductance between conductors and screen	mH/ km	0,265	0,245	0,228	0,218	0,203	0,188	0,175	0,161	0,148	0,139	0,131	0,124	0,114
Capacitance (per phase)	uF/ km	0,135	0,146	0,157	0,164	0,179	0,194	0,209	0,228	0,248	0,274	0,293	0,308	0,336

XLPE 132 kV cable specification

Conductor cross-section (S)	mm^2	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm^2	150	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	18,5	17,5	17,5	16,5	16,0	16,0	16,0	16,0	16,0	16,0	16,0	16,0
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	79,0	79,3	80,9	80,5	82,5	85,7	89,6	93,8	99,4	103,3	106,5	112,5
Weight approx. **Al conductor** **Cu conductor**	kg/m	 6,0 7,5	 6,1 8,0	 6,4 8,6	 6,4 8,9	 6,8 9,9	 7,4 11,4	 8,2 13,2	 9,0 15,3	 10,1 17,6	 10,9 19,6	 11,7 21,7	 13,3 25,7
Min. bending radius (15D)	m	1,185	1,190	1,214	1,208	1,238	1,286	1,344	1,407	1,491	1,550	1,598	1,688
Maximum pulling force **Al (30 S)** **Cu (50 S)**	kN	 7,20 12,00	 9,00 15,00	 10,5 17,5	 12,0 20,00	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0
DC resistance **Cu conductor** **Al conductor**	Ω/km	 0,1250 0,0754	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,0470	 0,0605 0,0366	 0,0460 0,0280	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,0090
Inductance between conductors	mH/km	0,483	0,460	0,449	0,434	0,415	0,400	0,384	0,370	0,359	0,349	0,341	0,330
Inductance between conductor and screen	mH/km	0,255	0,232	0,222	0,207	0,189	0,175	0,161	0,149	0,139	0,131	0,124	0,114
Capacitance (per phase)	uF/km	0,133	0,148	0,154	0,168	0,185	0,199	0,217	0,236	0,261	0,278	0,292	0,319

XLPE 132 kV cable specification with lead sheath

Conductor cross-section (S)	mm^2	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm^2	150	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	18,5	17,5	17,5	16,5	16,0	16,0	16,0	16,0	16,0	16,0	16,0	16,0
Thickness of lead sheah	mm	2,2	2,2	2,2	2,2	2,2	2,4	2,4	2,6	2,6	2,7	2,7	2,8
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	83,9	84,2	85,8	85,4	87,4	91,0	94,9	99,5	105,1	109,2	112,4	118,6
Weight approx. **Al conductor** **Cu conductor**	kg/m	 11,5 13,0	 11,7 13,5	 12,0 14,2	 12,1 14,5	 12,6 15,7	 14,0 17,9	 15,1 20,1	 16,9 23,2	 18,5 26,0	 20,0 28,8	 21,1 31,1	 23,6 36,1
Min. bending radius (20D)	m	1,678	1,684	1,716	1,708	1,748	1,820	1,898	1,990	2,102	2,184	2,248	2,378
Maximum pulling force **Al (30 S)** **Cu (50 S)**	kN	 7,20 12,00	 9,00 15,00	 10,5 17,5	 12,0 20,00	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0
DC resistance **Cu conductor** **Al conductor**	Ω/km	 0,1250 0,0754	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,0470	 0,0605 0,0366	 0,0460 0,0280	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,0090
Inductance between conductors	mH/km	0,495	0,472	0,461	0,446	0,427	0,412	0,396	0,382	0,370	0,360	0,352	0,340
Inductance between conductor and screen	mH/km	0,261	0,238	0,227	0,212	0,194	0,180	0,166	0,153	0,144	0,135	0,129	0,118
Capacitance (per phase)	uF/km	0,133	0,148	0,154	0,168	0,185	0,199	0,217	0,236	0,261	0,278	0,292	0,319

XLPE 150 kV cable specification

Conductor cross-section (S)	mm^2	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm^2	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	18,5	18,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	81,3	82,9	82,5	85,5	88,7	92,6	96,8	102,4	106,3	109,5	115,5
Weight approx. **Al conductor** **Cu conductor**	kg/m	 6,4 8,2	 6,6 8,8	 6,7 9,2	 7,2 10,3	 7,8 11,7	 8,6 13,5	 9,4 15,7	 10,5 18,0	 11,4 20,1	 12,2 22,1	 13,7 26,2
Min. bending radius (15D)	m	1,220	1,244	1,238	1,283	1,331	1,389	1,452	1,536	1,595	1,643	1,733
Maximum pulling force **Al (30 S)** **Cu (50 S)**	kN	 9,00 15,00	 10,5 17,5	 12,0 20,0	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100
DC resistance **Al conductor** **Cu conductor**	Ω/km	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,047	 0,0605 0,0366	 0,464 0,028	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,009
Inductance between conductors 	mH/km	0,465	0,454	0,439	0,422	0,407	0,391	0,376	0,365	0,354	0,347	0,335
Inductance between conductor and screen	mH/km	0,238	0,228	0,213	0,197	0,184	0,169	0,156	0,146	0,137	0,131	0,120
Capacitance (per phase)	uF/km	0,142	0,149	0,161	0,174	0,187	0,203	0,221	0,243	0,259	0,272	0,297

XLPE 150 kV cable specification with lead sheath

Conductor cross-section (S)	mm^2	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm^2	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	18,5	18,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5
Thickness of lead sheah	mm	2,2	2,2	2,2	2,2	2,4	2,4	2,6	2,6	2,7	2,7	2,8
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	86,2	87,7	87,4	90,4	94,0	97,9	102,5	108,1	112,2	115,4	121,6
Weight approx. **Al conductor** **Cu conductor**	kg/m	 12,0 13,9	 12,4 14,6	 12,4 14,9	 13,2 16,3	 14,6 18,6	 15,7 20,7	 17,6 23,8	 19,2 26,7	 20,8 29,5	 21,9 31,8	 24,4 36,9
Min. bending radius (20D)	m	1,724	1,754	1,748	1,808	1,880	1,958	2,050	2,162	2,244	2,308	2,432
Maximum pulling force **Al (30 S)** **Cu (50 S)**	kN	 9,00 15,00	 10,5 17,5	 12,0 20,0	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100
DC resistance **Al conductor** **Cu conductor**	Ω/km	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,047	 0,0605 0,0366	 0,464 0,028	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,009
Inductance between conductors 	mH/ km	0,477	0,465	0,450	0,433	0,418	0,402	0,388	0,375	0,365	0,358	0,345
Inductance between conductor and screen	mH/ km	0,243	0,233	0,218	0,202	0,188	0,174	0,161	0,151	0,142	0,135	0,124
Capacitance (per phase)	uF/ km	0,142	0,149	0,161	0,174	0,187	0,203	0,221	0,243	0,259	0,272	0,297

Permissible continuous current-capacity during cable laying for XLPE cables 110-150 kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in ground;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases –cable diameter;
- cable laying depth – 1,5 m;
- soil maximum temperature +15°C;
- soil thermal resistance– 1,2 K·m/W;
- conductor temperature - +90°C;
- circuits quantity– 1;
- load factor (LF) – 0,1 и 0,8.

Table 1.5. Continious current-carrying capacity during cable laying in ground

Conductor cross-section (S), mm²			185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A	Cu	LF =0,8	490	569	644	684	736	837	949	1064	1173	1369	1479	1565	1669
		LF =1,0	438	507	572	606	652	739	835	932	1023	1189	1280	1350	1437
	Al	LF =0,8	380	442	501	535	577	661	756	859	964	1095	1189	1271	1396
		LF =1,0	341	395	445	475	511	584	665	753	841	951	1030	1097	1202
Continuous current-capacity, A	Cu	LF =0,8	510	592	671	714	769	878	1000	1128	1253	1444	1567	1661	1794
		LF =1,0	456	529	598	634	683	777	883	994	1100	1266	1371	1450	1562
	Al	LF =0,8	396	460	522	558	601	690	792	902	1017	1146	1247	1332	1478
		LF =1,0	354	411	465	496	534	611	699	794	893	1004	1091	1164	1287

Table 1.6. Single point earthing currents

Conductor cross-section (S), mm²			185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A	Cu	LF =0,8	463	529	589	621	660	732	807	879	944	1038	1091	1130	1181
		LF =1,0	413	470	521	548	581	641	704	763	816	892	933	964	1001
	Al	LF =0,8	368	423	474	504	538	605	678	752	824	902	957	1003	1071
		LF =1,0	328	376	420	445	475	532	593	655	714	777	822	858	911
Continuous current-capacity, A	Cu	LF =0,8	451	505	552	576	605	656	706	752	791	840	868	891	916
		LF =1,0	398	445	485	505	529	571	612	649	681	721	743	762	781
	Al	LF =0,8	366	415	460	484	513	565	620	672	720	767	800	827	864
		LF =1,0	325	368	405	426	450	494	539	583	622	660	687	710	739

Permissible continuous current-capacity during cable laying in air for XLPE cables 110-150 kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in the air;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases–cable diameter;
- conductor temperature - +90°C;
- ambient temperature - +25°C;
- protection from solar radiation.

Table 1.7. Single point earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A	Cu	563	660	754	806	874	1006	1153	1310	1462	1729	1888	2013	2185
	Al	437	513	587	631	684	794	918	1056	1200	1380	1515	1632	1824
Continuous current-capacity, A	Cu	618	727	833	892	968	1123	1296	1483	1671	1953	2145	2300	2519
	Al	480	565	647	697	756	882	1025	1185	1356	1548	1705	1842	2072

Table 1.8. Both ends earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A	Cu	540	625	706	749	804	905	1015	1125	1229	1383	1474	1543	1639
	Al	426	497	563	603	649	741	843	952	1060	1183	1274	1348	1468
Continuous current-capacity, A	Cu	552	628	696	732	776	852	929	1004	1072	1158	1210	1249	1306
	Al	447	514	576	612	653	731	812	894	972	1053	1110	1157	1229

XLPE 220 kV cable specification

Conductor cross-section (S)	mm^2	400	500	630	800	1000	1200	1400	1600	2000	2500
Screen cross-section	mm^2	265	265	265	265	265	265	265	265	265	265
Insulation thickness	mm	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	94,3	97,3	100,5	105,4	109,6	114,5	119,3	121,6	127,6	134,5
Weight approx. **Al conductor** **Cu conductor**	kg/m	9,6 12,1	10,2 13,3	10,9 14,9	11,9 17,0	12,8 19,2	14,1 21,5	15,1 23,8	15,9 25,8	17,6 30,0	19,7 35,2
Min. bending radius (20D)	m	1,884	1,946	2,010	2,108	2,192	2,290	2,386	2,432	2,552	2,690
Maximum pulling force **Al (30 S)** **Cu (50 S)**	kN	12,0 20,0	15,0 25,0	18,9 31,5	24,0 40,0	30,0 50,0	36,0 60,0	42,0 70,0	48,0 80,0	60,0 100,0	75,0 125,0
DC resistance **Al conductor** **Cu conductor**	Ω/km	0,0778 0,047	0,0605 0,0366	0,464 0,028	0,0367 0,0221	0,0291 0,0176	0,0247 0,0151	0,0212 0,0129	0,0186 0,0113	0,0149 0,009	0,0119 0,0072
Inductance between conductors	mH/km	0,468	0,450	0,434	0,416	0,401	0,386	0,375	0,367	0,354	0,341
Inductance between conductor and screen	mH/km	0,246	0,230	0,214	0,199	0,184	0,171	0,161	0,154	0,142	0,130
Capacitance (per phase)	uF/km	0,138	0,148	0,158	0,171	0,184	0,199	0,211	0,221	0,240	0,261

XLPE 220 kV cable specification with lead sheath

Conductor cross-section (S)	mm^2	400	500	630	800	1000	1200	1400	1600	2000	2500
Screen cross-section	mm^2	265	265	265	265	265	265	265	265	265	265
Insulation thickness	mm	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0
Thickness of lead sheah	mm	2,2	2,2	2,4	2,4	2,6	2,6	2,7	2,7	2,8	3,0
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	98,4	101,4	105,0	108,9	113,5	119,1	123,2	126,4	132,6	139,9
Weight approx. **Al conductor** **Cu conductor**	kg/m	 15,7 18,2	 16,5 19,6	 18,0 22,0	 19,2 24,2	 21,2 27,5	 22,9 30,4	 24,6 33,3	 25,8 35,7	 28,4 40,9	 32,1 47,6
Min. bending radius (20D)	m	1,968	2,028	2,100	2,178	2,270	2,382	2,464	2,528	2,652	2,798
Maximum pulling force **Al (30 S)** **Cu (50 S)**	kN	 12,0 20,0	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0	 75,0 125,0
DC resistance **Al conductor** **Cu conductor**	Ω/km	 0,0778 0,047	 0,0605 0,0366	 0,464 0,028	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,009	 0,0119 0,0072
Inductance between conductors	mH/km	0,474	0,456	0,441	0,423	0,408	0,395	0,384	0,376	0,362	0,350
Inductance between conductor and screen	mH/km	0,247	0,230	0,215	0,199	0,185	0,174	0,164	0,156	0,144	0,133
Capacitance (per phase)	uF/km	0,138	0,148	0,158	0,171	0,184	0,199	0,211	0,221	0,240	0,261

Permissible continuous current-capacity during cable laying for XLPE cables 220 kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in ground;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases –cable diameter;
- cable laying depth – 1,5 m;
- soil maximum temperature +15°C;
- soil thermal resistance– 1,2 K·m/W;
- conductor temperature - +90°C;
- circuits quantity– 1;
- load factor (LF) – 0,1 и 0,8.

Table 1.9. Continious current -carrying capacity during cable laying in ground

Conductor cross-section (S), mm²		400	500	630	800	1000	1200	1400	1600	2000	2500
Continuous current-capacity, A Cu	LF =0,8	731	832	944	1060	1169	1356	1465	1550	1658	1718
	LF =1,0	645	732	827	924	1015	1172	1261	1330	1415	1457
Al	LF =0,8	573	657	751	853	958	1084	1177	1258	1384	1488
	LF =1,0	506	577	658	744	832	937	1014	1079	1182	1263
Continuous current-capacity, A Cu	LF =0,8	759	866	986	1112	1235	1421	1542	1638	1764	1837
	LF =1,0	675	768	873	982	1087	1247	1350	1431	1536	1595
Al	LF =0,8	593	680	780	889	1002	1128	1227	1313	1453	1570
	LF =1,0	528	604	690	784	882	990	1074	1148	1266	1363

Table 1.10. Single point earthing currents

Conductor cross-section (S), mm²		400	500	630	800	1000	1200	1400	1600	2000	2500
Continuous current-capacity, A Cu	LF =0,8	647	716	787	855	914	995	1042	1077	1121	1151
	LF =1,0	566	623	681	735	782	846	882	908	940	959
Al	LF =0,8	530	595	664	735	802	871	922	963	1024	1073
	LF =1,0	464	519	577	634	689	743	783	814	861	897
Continuous current-capacity, A Cu	LF =0,8	615	670	723	772	814	866	896	918	947	967
	LF =1,0	538	583	627	666	700	741	765	782	804	819
Al	LF =0,8	517	572	629	685	736	785	820	848	889	921
	LF =1,0	454	501	548	594	635	675	703	724	757	782

Permissible continuous current-capacity during cable laying in air for XLPE cables kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in the air;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases –cable diameter;
- conductor temperature - +90°C;
- ambient temperature - +25°C;
- protection from solar radiation.

Table 1.11. Single point earthing currents

Conductor cross-section (S), mm²		400	500	630	800	1000	1200	1400	1600	2000	2500
Continuous current-capacity, A	Cu	863	992	1138	1292	1443	1695	1850	1973	2141	2250
	Al	676	782	904	1039	1181	1352	1483	1596	1782	1944
Continuous current-capacity, A	Cu	942	1087	1253	1433	1613	1883	2066	2214	2423	2565
	Al	736	854	990	1144	1307	1492	1641	1773	1992	2187

Table 1.12. Both ends earthing currents

Conductor cross-section (S), mm²		400	500	630	800	1000	1200	1400	1600	2000	2500
Continuous current-capacity, A	Cu	791	891	997	1104	1203	1343	1428	1493	1581	1646
	Al	640	730	828	933	1037	1151	1236	1307	1418	1513
Continuous current-capacity, A	Cu	798	886	975	1061	1140	1237	1298	1344	1408	1460
	Al	661	746	835	927	1015	1104	1171	1224	1307	1379

Correction factors for XLPE cables 66 – 220 kV

Correction factors for different temperatures												
Temperature °C	- 5	0	5	10	15	20	25	30	35	40	45	50
in the ground	1,13	1,1	1,06	1,03	1,0	0,97	0,93	0,89	0,86	0,82	0,77	0,73
in the air	1,21	1,18	1,14	1,11	1,07	1,04	1,0	0,96	0,92	0,88	0,83	0,78

Correction factors for different thermal resistivities of soil						
Thermal resistivity of soil, K·m/W	0,8	1,0	1,2	1,5	2,0	2,5
Correction factor	1,13	1,05	1,0	0,93	0,85	0,8

Correction factors for different instalation dephts										
Cable laying depth, m	1	1,5	1,8	2,0	2,2	2,5	3,0	4,0	5,0	10,0
Correction factor	1,05	1,0	0,98	0,96	0,95	0,93	0,91	0,88	0,86	0,8

Correction factors of cable laying in pipes			
Laying conditions	Cable laid in pipes partially	Cable laid in separate pipes	Cable laid in one pipe
Correction factor	0,94	0,9	0,9

Correction factors for numbers of cables						
Distance between CL, mm	**Number of parallel CL**					
	2	3	4	5	6	7
500	0,86	0,76	0,72	0,68	0,65	0,63
700	0,87	0,79	0,75	0,72	0,7	0,68
900	0,89	0,81	0,78	0,75	0,73	0,72
1000	0,9	0,82	0,79	0,76	0,75	0,74
1500	0,92	0,86	0,84	0,82	0,81	0,8
2000	0,94	0,9	0,88	0,87	0,86	0,85
2500	0,95	0,92	0,9	0,89	0,89	0,88
3000	0,96	0,93	0,92	0,91	0,91	0,91
3500	0,97	0,94	0,94	0,93	0,93	0,93
4000	0,97	0,95	0,95	0,94	0,94	0,94
4500	0,98	0,96	0,96	0,95	0,95	0,95
5000	0,98	0,97	0,96	0,96	0,96	0,95
5500	0,98	0,97	0,97	0,96	0,96	0,96
6000	0,98	0,97	0,97	0,96	0,96	0,96

Example of calculating of current capacity for 66 – 220 kV cables

Cable line 110 kV

- conductor material - copper;
- conductor cross-section - 800 mm^2;
- installation type – in ground;
- type of installation – close trefoil;
- laying depth – 3 m;
- number of circuits - 2;
- distance between parallel circuits -1.5 m;
- cable screens earthing –both ends;
- ambient temperature +30°C;
- load factor-1;
- thermal resistivity of native soil – 2.0 K•m/W.

According to tables, current capacity for standard cable laying conditions (cable with a copper conductor with cross-section 800 mm^2 with both-ends earthing and a load factor 1.0) is 816 A.

Correction factor:

Correction factor for different instalation dephts K1=0,91;
Correction factor for numbers of cables K2= 0,92;
Correction factor for different temperatures K3=0,86;
Correction factor for different thermal resistivities of soil K4=0,85.

Permissible continuous current (ACC) for the above conditions can be calculated by:

Iper.=Ist·K1·K2·K3·K4 =816·0,91·0,92·0,86·0,85≈499 A.*

* * The exact value of the permissible continuous current is determined after calculation of IEC 60287 method.

Formulas for auxiliary calculations

1. Dynamic forces in case of short-circuit

$$F = \frac{0.2}{s} \cdot I_{max}^2 \ [N/m]$$

where I_{max} – 2.5·I_{SC} [кA];
I_{SC} – short-circuit current [кA];
s – distance between cable axes [m];
F – maximum force [N/m].

2. Electrical stresses

$$E_{max} = \frac{U_0}{r_1 \cdot \ln(\frac{r_e}{r_i})} \ [kV/mm] \qquad E_{min} = \frac{U_0}{r_e \cdot \ln(\frac{r_e}{r_i})} \ [kV/mm]$$

where: r_e – outer insulation radius [mm];
r_i – inner insulation radius [mm];
U_0 – nominal voltage[kV];
E_{max} – electrical stress at conductor screen [kV/mm];
E_{min} – electrical stress at insulation screen [kV/mm].

3. Dielectric losses

$$W = 2 \cdot \pi \cdot f \cdot U_0^2 \cdot C \cdot tan(\delta) \ [W/km]$$

where: f – frequency [Hz];
U_0 – nominal voltage [kV];
C – capacity [mkF/km];
$tan(\delta)$ – tan of dielectric losses.

4. Induction and inductive resistance

$$L = 2 \cdot \ln(\frac{k \cdot b}{r_0}) \cdot 10^{-1} \ [mGn/kg]$$

where: k=1 trefoil formation, k=1.26 flat formation;
b – distance between axes [mm];
r_0 – average radius of the conductor [mm].

$$X = \frac{2 \cdot \pi \cdot f \cdot L}{1000} \ [Ohm/km]$$

where : f – frequency [Hz];
L – inductance [mGn/km];
X – inductance resistance [Ohm/km].

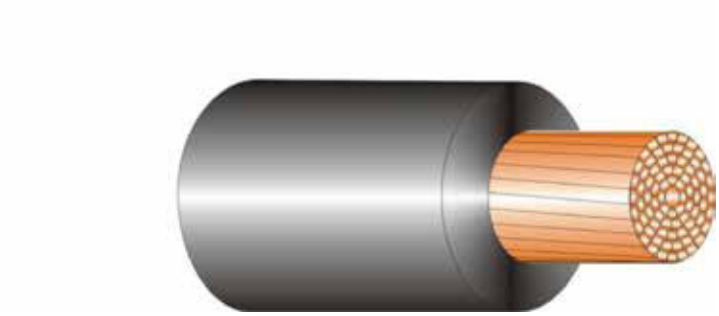
5. Maximum one-second short-circuit current

$$I_s = \frac{I_{sc}}{\sqrt{t_{sc}}} \ [кA]$$

where: I_s – maximum one-second SC current [кA];
I_{SC} – short-circuit current [кA];
t_{SC} – duration of the short-circuit current [s].

Earthing/cross-bonding cable

Earthing/cross-bonding cables are designed for transposition and screen earthing of XLPE cables. They can also be used as an additional earthing cable which is used as the connecting earthing points of cable screens when the cable line is earthed single-sided. The additional earthing cable can be used when it comes to single-sided erthing to keep down induced voltage occur in short-circuit fault.



Technical specification of earthing/cross-bonding cable

Conductor cross-section (S)	mm^2	240	400
Cable sheath thickness	mm	3,5	3,5
Cable diameter (D)	mm	25,1	30,6
Weight	kg/km	2414	3911
Min banding radius(10·D)	m	0,251	0,306
Conductor resistance against DC, at 20 °C, Cu	Om/km	0,754	0,0470

Permissible short-circuit currents for earthing/cross-bonding cables

Conductor heating temperature:

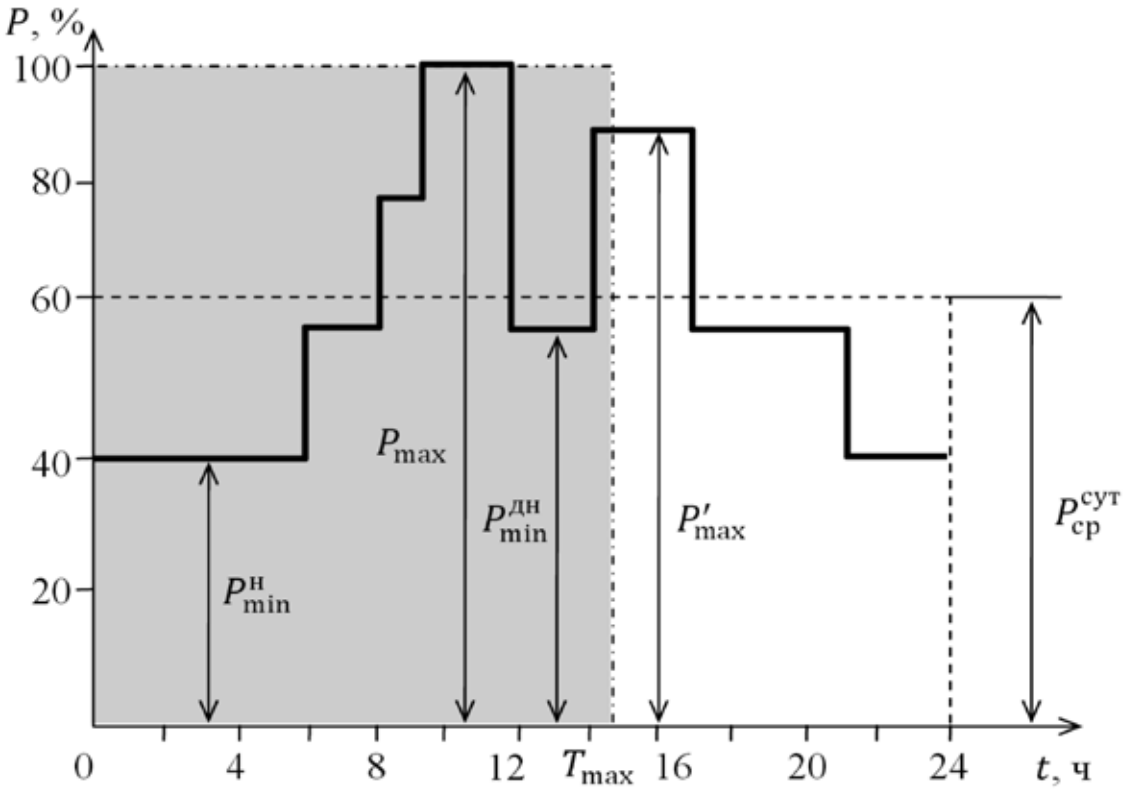
-before short-circuit 40°C
-after short-circuit 80°C

Permissible one-second SC current		
Cable cross-section, mm^2	240	400
Short circuit current, кA	35,3	58,7

Load factor

Load factor % - average energy load to the maximum peak load during a period. Most clearly, the load factor can be determined from the schedule of CL load.

Example of the CL load schedule



From the CL load schedule you can see that the load factor is equal to 0.6. The exact value of the load factor may be determined in the Regional Dispatching Office of the power system. The load factor can be calculated from the daily load schedule :

$$K_н = \frac{\sum_{i=1}^{n}(P_i \cdot t_i)}{24}$$

where: t_i – the period of i-time duration
P_i (%) – the ratio of power in the i-th time interval to the maximum power.

Short-circuit currents

Short-circuit current for all types of cables is calculated on the basis of the following conditions:

conductor temperature:

-before short-circuit 90°C
-after short-circuit 250°C

copper and alloy screen temperature:

-before short-circuit 70°C
-after short-circuit 350°C

Lead sheath temperature:

--before short-circuit 70°C
--after short-circuit 180°C

XLPE cable can be overloaded with temperatures up to 105°C. Emergency overloads do not considerably affect cable service life. The total duration of the overload mode should be no more than 100 hours per year and not more than 1000 hours for the service life. One-second long permissible short-circuit currents along the conductor and through the screen should not exceed the figures presented in the Tables.

Permissible one-cecond short-circuit current in the conductor												
Conductor cross-section, mm²	185	240	300	350	400	500	630	800	1000	1200	1600	2000
Cu conductor	26,5	34,3	42,9	50,1	57,2	71,5	90,1	114,4	14	172,8	230	288
Al conductor	17,5	22,7	28,2	33,1	37,6	47	59,2	75,2	93,1	114,3	152	190

Permissible one-cecond short-circuit current in the screen														
Copper screen cross-section, mm²	35	50	70	95	120	150	185	210	240	265	280	290	300	310
Lead sheath cross-section, mm²	249	383	551	769	968	1199	1493	1732	1963	2197	2288	2385	2458	2562
Short-circuit current, кА	6,8	9,8	13,6	17,7	22,9	28,2	34,7	40,0	45,2	50,4	52,4	54,7	56,3	58,6

Permissible one-cecond short-circuit current in the screen														
Alloy screen cross-section, mm²	35	50	70	95	120	150	185	210	240	265	280	290	300	310
Short-circuit current, кА	4,4	6,4	9,2	12,2	15,6	19,0	23,4	26,9	30,4	34,0	35,02	36,8	37,8	39,4

In the case of short-circuit, apart from the heating, the dynamic forces between cable phases have to be taken into consideration; their values can be significant. These values are important for cable clamps.

Cable laying conditions and testing after high voltage cable laying

During XLPE 66-220 kV cable laying the bending radius should be not less than 20xD, where D — outside cable diameter. When cables accessories installation is carried out with the use of a special template the preheating, minimal bending radius should be at least 15xD.

During cable laying use a cable sleeve or pulling eye, pulling force should not exceed the following figures:

$F=Sx50$ N/ mm^2 — for copper conductor,
$F=Sx30$ N/ mm^2 — for aluminum conductor

where S — conductor area of the cross-section, mm^2.

Ambient temperature during cable laying should not be lower than -5°C. If cable is preheated the cable laying can be carried out at the following temperatures:

-15°C – for cables with PVC-plasticate sheath;
-20°C – for cables with polyethylene sheath.

After cable line installation and commissioning, each phase of the cable and its accessories should be tested by increased AC voltage of 128 kV during one hour with frequency of 20 to 300 Hz. As agreed between manufacturing company and customer, it is permitted to conduct testing by nominal working AC voltage of 64 kV during 24 hours without load, instead of the test by increased AC voltage. The test by increased DC is feasible, but not recommended, and only as agreed between manufacturing company and customer.

Cable sheath has to be tested by DC of 10 kV, applied between a metallic screen and earthing for one minute.

During cable laying of Estralin HVC production the requirements of «Maintenance of XLPE cable laying 110-500 kV, №TD-16-01P» should be met.

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