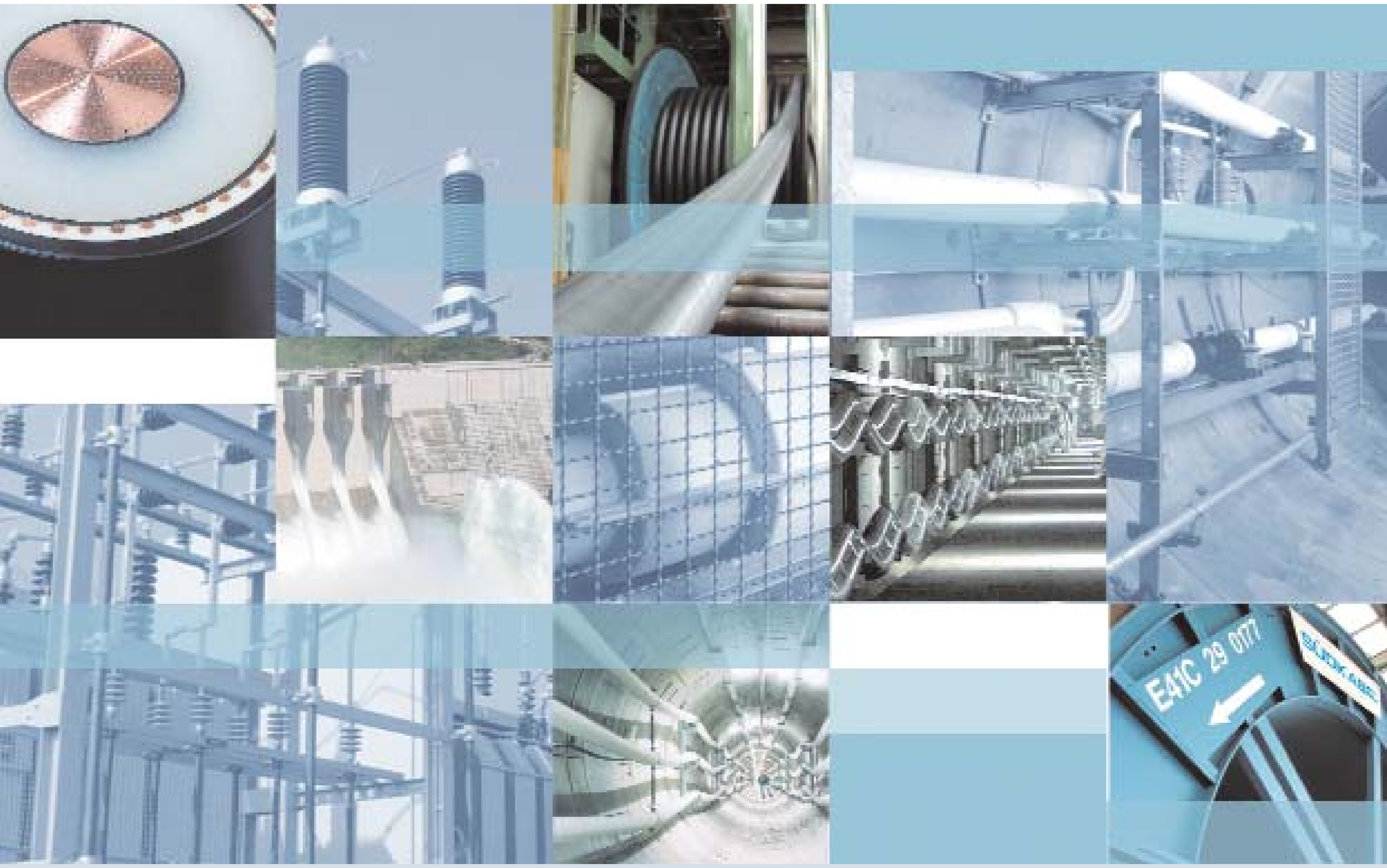
XLPE Power Cable Systems for High and Extra-High Voltages



Kabelsysteme, Kabel und Garnituren
Cable Systems, Cables and Accessories

SÜDKABEL

XLPE Cable Systems for High and Extra-High Voltages

Contents

Südkabel – a brief history

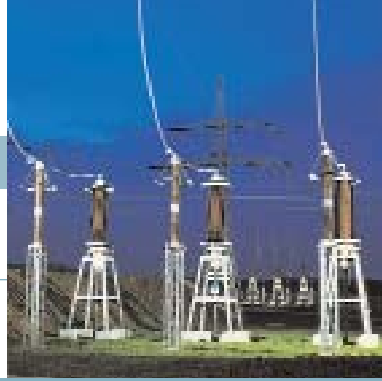
Südkabel's first cable factory was initially founded at Mannheim in 1898 as Süddeutsche Kabelwerke (Südkabel). In 1970, Südkabel merged with Rheinische Kabel- und Drahtwerke GmbH (Rheinkabel), Cologne, and from that date onwards the company operated under the name of Kabel- und Lackdrahtfabriken GmbH (Kabel+Draht).

Kabel + Draht was for more than 15 years a wholly owned subsidiary of Brown, Boveri & Cie. (BBC) and after the merger between Asea and BBC to create the ABB Group in 1988, the company's name was changed to ABB Kabel und Draht GmbH.

As from 1997, the power cable operations were handled under the name of ABB Energiekabel GmbH in Mannheim.

Effective 1 January 2004, the company together with all its cable and accessory manufacturing operations in Mannheim, Germany, was taken over by the German Wilms Group - owner of a number of independent companies and cable factories - and from this date onwards it has been trading as Südkabel GmbH.






A Pioneer with Can-do

Capabilities Honed over Decades

Professional expertise at the highest voltage level

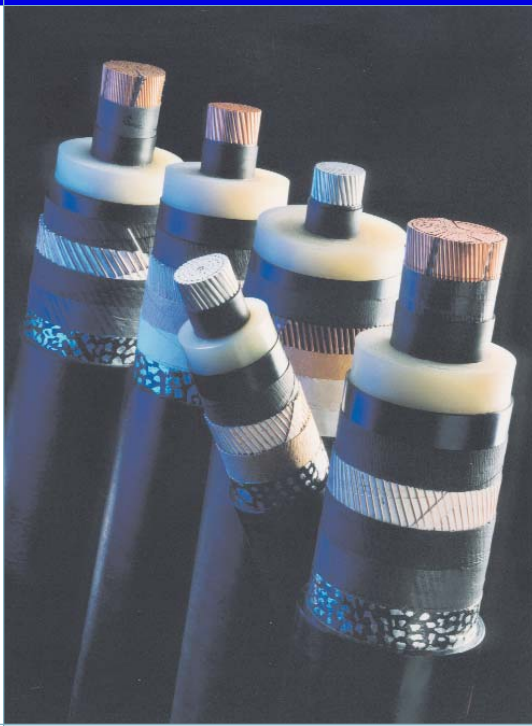
Südkabel is a respected partner for power utilities and the electrical engineering industry the whole world over.
For safe, reliable power transmission and distribution, it offers complete system packages coupled with state-of-the-art production processes, comprehensive service support and a maximum of quality assurance.

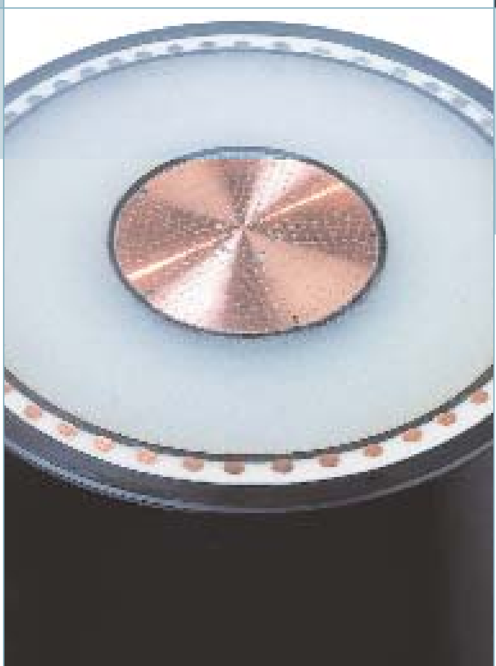
On national and international markets alike, this long-established company, drawing on more than a century of experience in cable production, is acknowledged as a top-ranking vendor of cable systems; its can-do expertise is incorporated in up-to-the-future products whose efficacy has been validated in actual operation.

Südkabel – for pathbreaking XLPE technology

Südkabel has set numerous milestones in the field of power transmission cables.
Its pioneering achievements are particularly evident in the field of XLPE technology: it was back in the 1960s that the first solid-dielectric medium-voltage cables were installed in Germany.

Since then, the cable specialists have maintained their path breaking status worldwide - by planning and building the first 123 kV XLPE cable systems in Germany in the early 1970s, Germany's first XLPE insulated 245 kV cable system, the first 420 kV XLPE cable system in the European transmission network, and not least by manufacturing and installing their first 550 kV XLPE cable system in China.





XLPE – The Insulating Material

for High and Extra-High Voltage Cables

The raw material used for the insulation is low-density polyethylene (LDPE). By virtue of its homopolar character, polyethylene has a low relative permittivity, a very low power loss factor and very high dielectric strength.

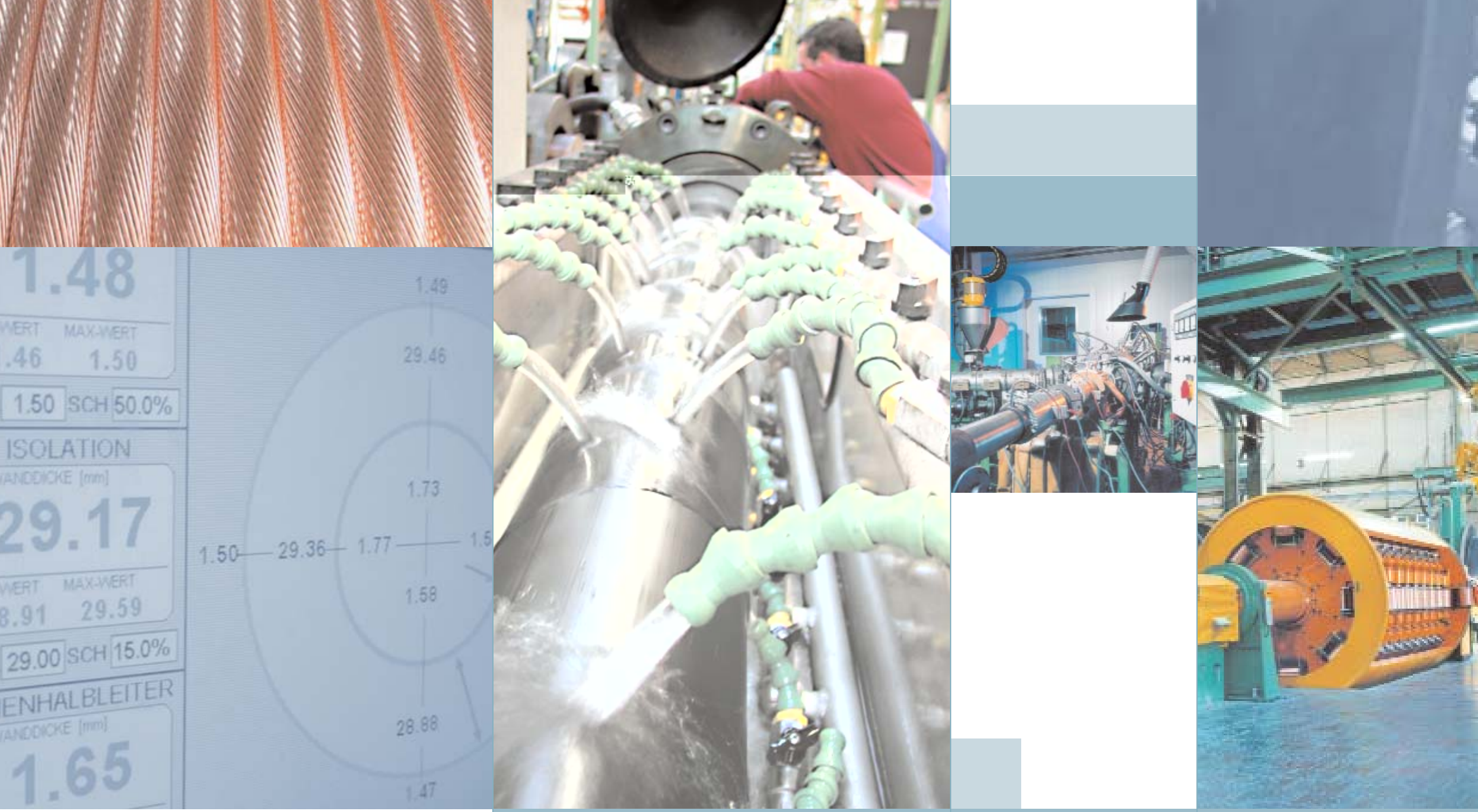
The cross-linking process provides improved mechanical characteristics while not affecting the dielectric properties at all.

Besides the excellent electrical properties, the mechanical characteristics remain also very good even at high temperatures.

Even at high short-circuit temperatures, XLPE retains good dimensional stability and in this crucial point it is definitely superior to thermoplastic PE.

Thanks to XLPE's high thermal stability, thermal ageing plays practically no role at all, provided the permissible operating conditions are complied with.

Results from extensive long-term studies show, that with the technologies available nowadays the material can be relied upon to cope with very high operating field strengths.



The Design of High Voltage XLPE Cables

The conductor

In high voltage XLPE cables, round, compacted, stranded conductors made of copper or aluminium are used. In order to reduce the skin effect, a segmented conductor design is provided in the case of conductor cross-sectional areas of >1000 sq.mm.

The insulation

For optimised manufacture of the XLPE insulation and the field-limiting inner and outer semi-conductive layers, the cable core is extruded in a triple extrusion head, thus ensuring the smooth interfacing between insulation and semi-conductive layers required for high operating field strength.

The subsequent continuous cross-linking and cooling operation is performed in a tube connected directly to the triple head.
The "dry" cross-linking process and the high pressure inside the tube assure a homogeneous insulation structure for the cable core, without any voids.

The screen

A layer of conductive tapes is applied over the extruded outer semi-conductive layer. The copper-wire screen itself consists of shield wires arranged in a helical configuration and one or more counter-helixes made of copper tapes.
The geometrical cross-section of the copper screen is chosen to suit the short-circuit requirements in each individual application.

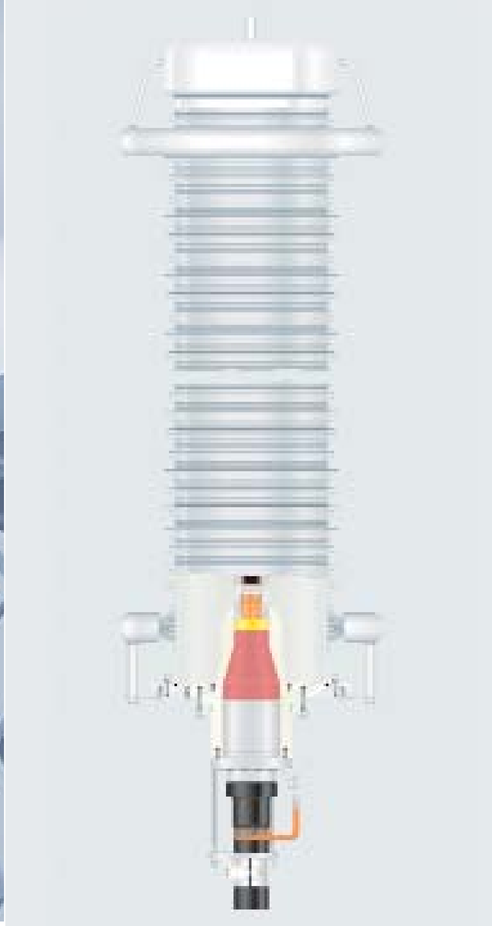
The screen area is in longitudinally watertight design, either filled with a swellable powder or with a swellable substrate provided by inserting textile or nonwoven tapes.
These substances will swell up substantially if they come into contact with water, e.g. following damage to the outer sheath, thus forming a barrier to water in the longitudinal direction.

The outer sheath

To ensure reliable protection against mechanical effects from outside, the high and extra-high voltage XLPE cables are given an outer sheath made of high-density polyethylene (HDPE), which possesses excellent mechanical properties.

With a transversely watertight cable design, protection is provided by a laminated sheath, comprising a longitudinally applied coated aluminium tape, firmly welded to the polyethylene sheath extruded over it.
While the polyethylene provides mechanical protection for the cable, the aluminium tape prevents radial water-vapour diffusion and thus any penetration of moisture into the cable.
As an optional extra, additional flame-retardant and/or semi-conductive layers can be extruded together with the PE outer sheath.

Besides the cable construction described above, other cable designs can also be offered, e.g. with a lead sheath.



Outdoor termination

For our extra-high voltage cables with insulation made of cross-linked polyethylene, all commonly used cable accessories are available: outdoor terminations, transformer and SF_6 GIS terminations, and joints. Accessories for XLPE-insulated high and extra-high voltage cables necessitate seamlessly customised compatibility, so Südkabel develops and manufactures these accessories in-house.

The entire range of accessories is matched to the cables with optimum precision - thus providing a maximum of safety under all operating conditions in our customers' power transmission networks.

Outdoor terminations

The outdoor terminations are installed with a porcelain or a composite insulator.

The length of the insulator's creepage path is specified to suit the requirements of the particular application concerned. It is usually mounted on a steel support construction using additional post-insulators, providing the necessary potential isolation between the termination's base plate and the earthed supporting structure during sheath testing.

SF$_6$-GIS termination

Transformer termination

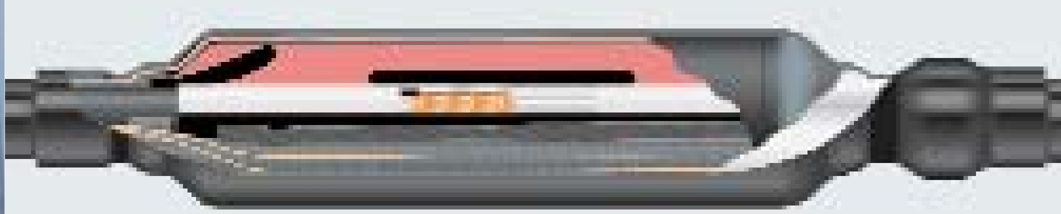
SF$_6$ GIS terminations

The terminations for SF$_6$-gas-insulated switchgears are installed with an epoxy resin insulator, including an integrated insulating clearance for potential isolation between the switchgear housing and the cable screen/sheath.
The interface dimensions conform to IEC TS 60859 or are agreed between the switchgear and cable system suppliers for the particular application concerned.
Both conventional terminations with a fluid filling in the insulator and plug-in "dry" terminations are available.

The advantage of the plug-in terminations is that the insulator socket can be installed in advance at the switchgear manufacturer's plant, thus obviating the need for additional work with SF$_6$ gas for cable installation on site.
The version with plug-in terminations also enables a cable test to be performed before the plug-in operation, using appropriate test adapters.

Transformer terminations

The transformer terminations feature an insulator made of epoxy resin, with an integrated insulating clearance for potential isolation between the transformer housing and the cable screen/sheath.
The interface dimensions conform to DIN EN 50299 and IEC TS 60859, or are agreed between the transformer and cable suppliers concerned in the particular case involved.
As with the switchgear terminations, both conventional fluid-filled and "dry" plug-in terminations are available for use in transformers.
Using the plug-in terminations in transformers offers comparable advantages to those obtained with the switchgear.



Straight joint

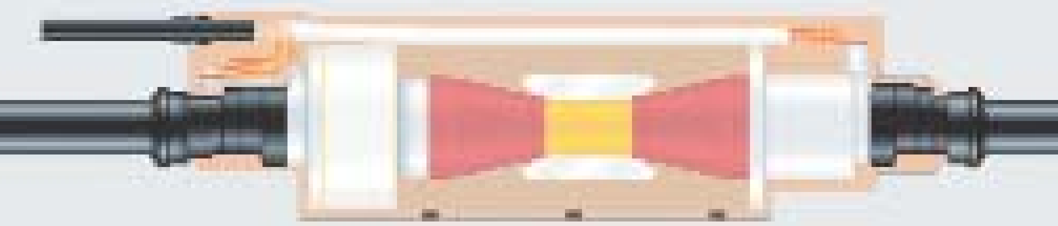
Joints

Südkabel offers an extensive program of joints for high and extra-high voltage XLPE cables.
The joints are completely maintenance-free, since they contain no gaseous or liquid constituents ("solid joints").

Both straight-through joints with through connections of the screen and sectionalising joints with potential isolation of the screen on each side of the joint are used.
For better quality assurance of the manufacturing and installation procedures, prefabricated and pretested joints are the preferred solution.

The sectionalising joints are suitable for cross-bonding the screens or for single-sided screen earthing of the individual laying sections.
In 1993, Südkabel was the first company to provide prefabricated, pretested joints in the extra-high voltage levels of 245 kV to 420 kV as well.

This tripartite joint type has more than proved its outstanding reliability in several projects on the 420 kV voltage level.



Cross-bonding joint

Cable Systems

Südkabel possesses decades of experience in designing, laying and installing high and extra-high voltage cable systems.

We design them

We design and build the cable systems to suit our customers' individual requirements.
In challenging projects, our experience and know-how may be invaluable, particularly in the early stages.
It may be in finding the most cost-efficient solution, developing customised designs, optimising the maximum transmittable power, specifying an efficient cooling system, suggesting the correct embedding material or the use of appropriate earthing procedures, e.g. single-point screen grounding or cross-bonding.

We assist you in designing the optimum route, factoring in the health, safety and environmental regulations involved.

We lay them

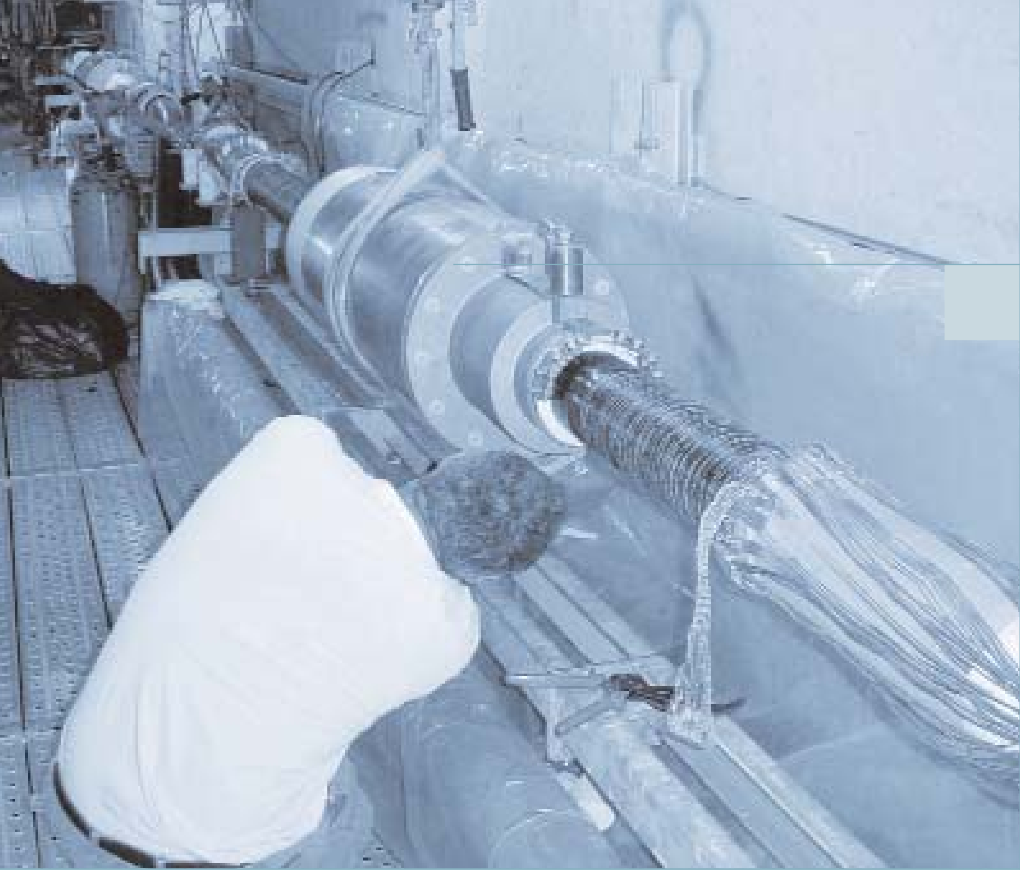
Laying cables of the highest voltage levels requires the use of special laying methods and equipment, plus meticulous preparation.
We calculate the cable pull for each individual case, and minimise the tensile forces involved by using state-of-the-art cable pulling equipment.
The length of the individual laying sections will depend on a multitude of factors, such as the laying conditions in the cable route, the maximum delivery length, restrictions on transportation by land or sea, and the design of the protection against transient over-voltages, using cross-bonding or single-point grounding of the cable screens.
While laying lengths of approx. 500 to 600 m are usually planned, in special cases lengths of well above 1000 m are possible.

We install them

Our accessories are installed by our specially trained fitters, with many years of experience behind them.
An intensive training program for all relevant electrical and mechanical jobs involved, plus annual refresher courses, are all part of the job for our fitters.

We commission them

Before a cable system we have installed is commissioned, it is usually tested in accordance with the relevant test specifications for XLPE high and extra-high voltage cable systems.
These include DC voltage tests on the cable sheath and/or AC voltage tests on the main insulation.
For extra-high voltage systems, particularly, they may be supplemented by partial discharge tests on the accessories installed.






Project Management

On request, Südkabel offers a complete project management package for the installation of XLPE high and extra-high voltage cable systems.

Our detailed project planning package includes:

- calculating current carrying capacities
- selecting accessories
- transportation to site
- laying the cables
- installing the accessories
- final inspection and testing

In addition, our spectrum of products and services can be extended to include complete site coordination, with planning and execution of the requisite civil engineering work.

Our Quality Philosophy

Südkabel's trademark is quality.

Our goal is to supply products and services in the highest possible quality, at the time agreed, and conforming to the contractually specified conditions.

A high standard of quality is maintained and continuously improved through the challenge of satisfying our customers' ever-more-stringent requirements.

A free and frank dialogue with our staff, the public and government agencies is high on our list of corporate priorities.

We regard it as an important part of our job to continuously monitor all our production steps and products for eco-compatibility, and to improve them wherever possible.

On request, we provide our customers and the public with all information regarding the eco-relevance of the products we manufacture.

Instructions on correct handling and eco-friendly disposal can be supplied with every product if so desired.






The good thermal properties of cross-linked polyethylene permit a continuous conductor temperature of 90 °C.
In the event of a short-circuit, the conductors can briefly withstand a temperature of up to 250 °C.
The cross-sectional area of the conductor is determined in dependence on the transmission capacity specified.
The short-circuit data of the network involved must of course be taken into account. For defining the cross-sectional area of the metallic screen, the single-phase short-circuit current is normally the determining factor.

The maximum permissible conductor temperature and heat transfer to the surroundings limits the maximum transmission capacity.

This means the following conditions have to be factored in:

- installation underground, in air or in water
- ambient temperatures
- thermal conductivity of the surroundings
- soil drying out
- cables laid in parallel or with direct or indirect cooling of the cable system involved

High heat losses in the screen due to induced screen currents can be avoided when using single-point screen grounding or the cross-bonding procedure.
Due to the low permittivity and the low power loss factor of XLPE, the dielectric losses of XLPE cables dependent on the operating voltage are very small.

The cable dimensions indicated in following tables are average values and may for technical reasons vary without affecting the functional efficiency of the cable.

cross-section of conductor	diameter of conductor	insulation thickness*)	diameter of core	cross-section of screen	sheath thickness	diameter of cable	weight with Al-conductor
mm^2	mm	mm	mm	mm^2	mm	mm	kg/m
nominal voltage 60 kV							
95	11.2	9.0	33.0	35	2.5	42	1.8
120	12.6	9.0	34.4	35	2.5	44	1.9
150	14.0	9.0	35.8	35	2.5	45	2.0
185	15.8	9.0	37.6	35	2.6	47	2.2
240	18.0	9.0	39.8	35	2.6	49	2.5
300	20.2	9.0	42.0	35	3.0	52	2.8
400	23.2	9.0	45.0	35	3.0	55	3.2
500	26.2	9.0	48.0	35	3.0	58	3.6
630	30.6	9.0	52.8	35	3.0	63	4.2
800	34.8	9.0	57.0	35	3.4	68	4.9
1000	39.3	9.0	61.5	35	3.4	73	5.7
1200	43.3	9.0	68.5	35	3.8	81	6.9
1400	46.7	9.0	71.9	35	3.8	84	7.6
1600	50.3	9.0	75.5	35	3.8	88	8.4
2000	56.6	9.0	81.8	35	4.0	94	9.8
nominal voltage 110 kV							
150	14.0	15.0	47.8	35	3.0	58	3.0
185	15.8	15.0	49.6	35	3.0	60	3.2
240	18.0	15.0	51.8	35	3.0	62	3.5
300	20.2	15.0	54.0	35	3.4	65	3.9
400	23.2	15.0	57.0	35	3.4	68	4.3
500	26.2	15.0	60.0	35	3.4	71	4.8
630	30.6	15.0	64.8	35	3.8	77	5.6
800	34.8	15.0	69.0	35	3.8	81	6.3
1000	39.3	15.0	73.5	35	3.8	86	7.2
1200	43.3	15.0	80.5	50	4.0	93	8.6
1400	46.7	15.0	83.9	50	4.0	97	9.4
1600	50.3	15.0	87.5	50	4.0	100	10.2
2000	56.6	15.0	93.8	50	4.0	107	11.8
2500	63.3	15,0	100.5	50	4.0	113	13.5

**) Verified by technical experience lower values for the insulation thickness may be offered*

60 kV (U_{max} = 72,5 kV) and 110 kV (U_{max} = 123 kV)

weight with Cu-conductor	conductor resistance Al, 20°C	conductor resistance Cu, 20°C	capaci-tance	charging current/phase at 50 Hz	charging power/system at 50 Hz	inductance o oo	inductance ooo	max. field-strength at cond. at U_0	surge impedance	reduction factor
kg/m	Ω/km	Ω/km	µF/km	A/km	MVA/km	mH/km	mH/km	kV/mm	Ω	
2.3	0.320	0.193	0.15	1.6	0.17	0.47	0.72	6.1	34.4	0.50
2.7	0.253	0.153	0.16	1.7	0.18	0.46	0.70	5.9	32.1	0.50
3.0	0.206	0.124	0.17	1.8	0.19	0.44	0.68	5.8	30.1	0.50
3.4	0.164	0.0991	0.18	2.0	0.21	0.43	0.65	5.6	27.9	0.50
4.0	0.125	0.0754	0.20	2.1	0.23	0.41	0.63	5.4	25.6	0.50
4.6	0.100	0.0601	0.21	2.4	0.24	0.40	0.60	5.3	23.7	0.50
5.7	0.0778	0.0470	0.24	2.6	0.27	0.38	0.57	5.1	21.5	0.45
6.7	0.0605	0.0366	0.26	2.8	0.29	0.37	0.55	5.0	19.6	0.45
8.1	0.0469	0.0283	0.29	3.2	0.33	0.35	0.52	4.8	17.3	0.45
9.9	0.0367	0.0221	0.32	3.5	0.36	0.34	0.49	4.7	15.7	0.45
12.0	0.0291	0.0176	0.35	3.9	0.41	0.33	0.47	4.6	14.3	0.45
14.4	0.0247	0.0151	0.40	4.3	0.45	0.33	0.45	4.5	12.8	0.40
16.3	0.0212	0.0129	0.42	4.6	0.48	0.33	0.43	4.5	12.0	0.40
18.4	0.0186	0.0113	0.45	4.9	0.51	0.32	0.42	4.5	11.3	0.40
22.2	0.0149	0.0090	0.49	5.3	0.55	0.31	0.40	4.4	10.3	0.40
3.9	0.206	0.124	0.12	2.4	0.46	0.49	0.68	7.6	42.1	0.45
4.4	0.164	0.0991	0.13	2.6	0.50	0.48	0.65	7.3	39.4	0.45
5.0	0.125	0.0754	0.14	2.8	0.53	0.46	0.63	7.0	36.5	0.45
5.7	0.100	0.0601	0.15	3.0	0.57	0.44	0.60	6.7	34.0	0.45
6.8	0.0778	0.0470	0.16	3.2	0.61	0.42	0.57	6.4	31.2	0.45
7.9	0.0605	0.0366	0.18	3.5	0.67	0.41	0.55	6.2	28.8	0.45
9.5	0.0469	0.0283	0.20	3.9	0.74	0.39	0.52	6.0	25.7	0.40
11.3	0.0367	0.0221	0.22	4.3	0.82	0.38	0.49	5.8	23.5	0.40
13.5	0.0291	0.0176	0.23	4.7	0.90	0.37	0.47	5.6	21.5	0.40
16.0	0.0247	0.0151	0.26	5.2	0.99	0.36	0.49	5.5	19.4	0.35
18.2	0.0212	0.0129	0.27	5.5	1.05	0.36	0.48	5.4	18.4	0.35
20.1	0.0186	0.0113	0.29	5.8	1.11	0.35	0.46	5.3	17.4	0.30
24.2	0.0149	0.0090	0.32	6.3	1.20	0.34	0.44	5.2	15.9	0.30
29.1	0.0120	0.0072	0.35	6.9	1.31	0.33	0.42	5.1	14.6	0.30

cross-section of conductor mm²	diameter of conductor mm	insulation thickness*) mm	diameter of core mm	cross-section of screen mm²	sheath thickness mm	diameter of cable mm	weight with Al-conductor kg/m
nominal voltage 132 kV							
240	18.0	16.0	53.8	95	3.4	66	4.4
300	20.2	16.0	56.0	95	3.4	68	4.7
400	23.2	16.0	59.0	95	3.4	71	5.2
500	26.2	16.0	62.0	95	3.4	74	5.7
630	30.6	16.0	66.8	95	3.8	80	6.5
800	34.8	16.0	71.0	95	3.8	84	7.2
1000	39.3	16.0	75.5	95	4.0	89	8.2
1200	43.3	16.0	82.5	95	4.0	96	9.4
1400	46.7	16.0	85.9	95	4.0	100	10.3
1600	50.3	16.0	89.5	95	4.0	103	11.0
2000	56.6	16.0	95.8	95	4.0	109	12.5
2500	63.3	16.0	102.5	95	4.0	116	14.4
nominal voltage 150 kV							
240	18.0	18.0	57.8	95	3.4	70	4.8
300	20.2	18.0	60.0	95	3.4	72	5.1
400	23.2	18.0	63.0	95	3.4	75	5.6
500	26.2	18.0	66.0	95	3.8	79	6.2
630	30.6	18.0	70.8	95	3.8	84	7.0
800	34.8	18.0	75.0	95	4.0	89	7.9
1000	39.3	18.0	79.5	95	4.0	93	8.7
1200	43.3	18.0	86.5	95	4.0	100	10.0
1400	46.7	18.0	89.9	95	4.0	104	10.9
1600	50.3	18.0	93.5	95	4.0	107	11.6
2000	56.6	18.0	99.8	95	4.0	113	13.2
2500	63.3	18.0	106.5	95	4.0	120	15.1
nominal voltage 220 kV							
400	23.2	21.6	70.2	150	3.8	84	7.1
500	26.2	20.5	71.0	150	3.8	85	7.4
630	30.6	19.3	73.4	150	3.8	87	7.8
800	34.8	19.8	78.6	150	4.0	93	8.9
1000	39.3	20.2	83.9	150	4.0	98	9.9
1200	43.3	20.7	91.9	150	4.0	106	11.3
1400	46.7	20.9	95.7	150	4.0	110	12.3
1600	50.3	21.1	99.7	150	4.0	114	13.2
2000	56.6	21.5	106.8	150	4.0	121	15.0
2500	63.3	22.0	114.5	150	4.0	129	17.2

**) Verified by technical experience lower values for the insulation thickness may be offered*

132 kV (U_{max} = 145 kV) to 220 kV (U_{max} = 245 kV)

weight with Cu-conductor	conductor resistance Al, 20°C	conductor resistance Cu, 20°C	capaci-tance	charging current/phase at 50 Hz	charging power/system at 50 Hz	inductance o oo	inductance ooo	max. field-strength at cond. at U_0	surge impedance	reduction factor
kg/m	Ω/km	Ω/km	µF/km	A/km	MVA/km	mH/km	mH/km	kV/mm	Ω	
5.9	0.125	0.0754	0.13	3.2	0.73	0.47	0.67	8.0	38.0	0.25
6.6	0.100	0.0601	0.14	3.4	0.78	0.45	0.65	7.7	35.5	0.25
7.7	0.0778	0.0470	0.16	3.7	0.85	0.43	0.62	7.4	32.6	0.25
8.8	0.0605	0.0366	0.17	4.0	0.91	0.42	0.60	7.1	30.2	0.25
10.4	0.0469	0.0283	0.19	4.5	1.03	0.40	0.56	6.8	26.9	0.25
12.2	0.0367	0.0221	0.21	4.9	1.12	0.39	0.54	6.6	24.7	0.25
14.4	0.0291	0.0176	0.22	5.4	1.23	0.37	0.51	6.4	22.6	0.25
16.9	0.0247	0.0151	0.25	5.9	1.35	0.37	0.49	6.2	20.4	0.25
19.0	0.0212	0.0129	0.26	6.3	1.44	0.36	0.48	6.1	19.4	0.25
21.0	0.0186	0.0113	0.28	6.6	1.51	0.35	0.46	6.1	18.3	0.25
25.0	0.0149	0.0090	0.30	7.2	1.65	0.34	0.44	5.9	16.8	0.20
30.0	0.0120	0.0072	0.33	7.9	1.81	0.33	0.42	5.8	15.4	0.20
6.3	0.125	0.0754	0.12	3.4	0.88	0.48	0.67	8.4	41.0	0.25
7.0	0.100	0.0601	0.13	3.6	0.94	0.46	0.65	8.1	38.4	0.25
8.1	0.0778	0.0470	0.14	3.9	1.01	0.44	0.62	7.8	35.3	0.25
9.3	0.0605	0.0366	0.15	4.2	1.09	0.43	0.60	7.5	32.7	0.25
10.9	0.0469	0.0283	0.17	4.7	1.22	0.41	0.56	7.1	29.3	0.25
12.8	0.0367	0.0221	0.19	5.1	1.33	0.40	0.54	6.9	26.9	0.25
14.9	0.0291	0.0176	0.20	5.6	1.45	0.38	0.51	6.7	24.7	0.25
17.4	0.0247	0.0151	0.23	6.1	1.58	0.38	0.49	6.5	22.4	0.25
19.6	0.0212	0.0129	0.24	6.5	1.69	0.37	0.48	6.4	21.2	0.20
21.6	0.0186	0.0113	0.25	6.8	1.77	0.36	0.46	6.3	20.1	0.20
25.6	0.0149	0.0090	0.27	7.5	1.95	0.35	0.44	6.1	18.4	0.20
30.7	0.0120	0.0072	0.30	8.1	2.10	0.34	0.42	6.0	17.0	0.20
9.6	0.0778	0.0470	0.13	5.1	1.94	0.47	0.62	10.1	39.7	0.15
10.5	0.0605	0.0366	0.14	5.7	2.17	0.44	0.60	10.1	35.7	0.15
11.8	0.0469	0.0283	0.16	6.6	2.51	0.42	0.56	10.0	30.8	0.15
13.8	0.0367	0.0221	0.18	7.0	2.67	0.41	0.54	9.4	28.8	0.15
16.1	0.0291	0.0176	0.19	7.5	2.86	0.39	0.51	9.0	26.9	0.15
18.8	0.0247	0.0151	0.20	8.1	3.09	0.39	0.49	8.5	24.9	0.15
21.0	0.0212	0.0129	0.21	8.5	3.24	0.38	0.48	8.3	23.8	0.15
23.2	0.0186	0.0113	0.22	8.9	3.39	0.37	0.46	8.1	22.7	0.15
27.4	0.0149	0.0090	0.24	9.5	3.62	0.36	0.44	7.8	21.2	0.15
32.8	0.0120	0.0072	0.25	10.1	3.85	0.35	0.42	7.5	19.9	0.15

for High and Extra-High Voltage XLPE Cables

cross-section of conductor mm²	diameter of conductor mm	insulation thickness*) mm	diameter of core mm	cross-section of screen mm²	sheath thickness mm	diameter of cable mm	weight with Al-conductor kg/m
nominal voltage 275 kV							
500	26.2	29.2	88.4	150	4.0	103	9.9
630	30.6	27.0	88.8	150	4.0	103	10.0
800	34.8	25.3	89.6	150	4.0	104	10.4
1000	39.3	24.0	91.5	150	4.0	106	11.0
1200	43.3	22.7	95.9	150	4.0	110	12.0
1400	46.7	22.2	98.3	150	4.0	113	12.8
1600	50.3	21.7	100.9	150	4.0	115	13.4
2000	56.6	21.5	106.8	150	4.0	121	15.0
2500	63.3	22.0	114.5	150	4.0	129	17.2
nominal voltage 345 kV							
630	30.6	26.5	87.8	250	4.0	103	10.9
800	34.8	25.0	89.0	250	4.0	105	11.5
1000	39.3	23.7	90.9	250	4.0	107	12.1
1200	43.3	22.7	95.9	250	4.0	112	13.2
1400	46.7	23.0	99.9	250	4.0	116	14.2
1600	50.3	23.2	103.9	250	4.0	120	15.1
2000	56.6	23.7	112.2	250	4.0	127	17.0
2500	63.3	24.0	118.5	250	4.0	134	19.1
nominal voltage 380 kV							
630	30.6	29.5	93.8	250	4.0	109	11.8
800	34.8	27.6	94.2	250	4.0	110	12.3
1000	39.3	26.2	95.9	250	4.0	112	12.9
1200	43.3	25.4	101.3	250	4.0	117	14.0
1400	46.7	25.8	105.5	250	4.0	121	15.0
1600	50.3	26.1	109.7	250	4.0	125	16.0
2000	56.6	26.7	117.2	250	4.0	133	18.1
2500	63.3	27.0	124.5	250	4.0	140	20.2
nominal voltage 500 kV							
800	34.8	34.0	107.0	250	4.0	123	14.4
1000	39.3	32.0	107.5	250	4.0	123	14.7
1200	43.3	30.0	110.5	250	4.0	126	15.6
1400	46.7	29.0	111.9	250	4.0	128	16.3
1600	50.3	28.0	113.5	250	4.0	129	16.7
2000	56.6	28.5	120.8	250	4.0	136	18.7
2500	63.3	29.0	128.5	250	4.0	144	21.1

**) Verified by technical experience lower values for the insulation thickness may be offered*

275 kV (U_{max} = 300 kV) to 500 kV (U_{max} = 550 kV)

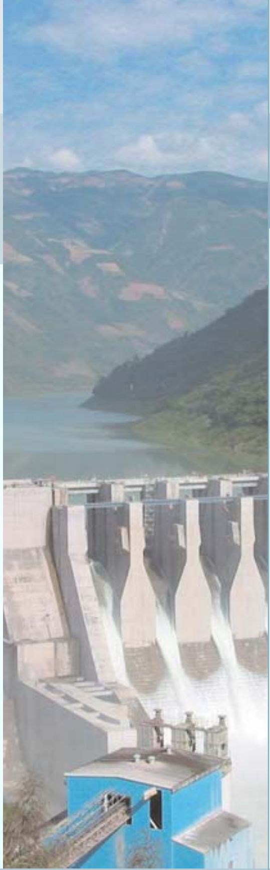
weight with Cu-conductor kg/m	conductor resistance Al, 20°C Ω/km	conductor resistance Cu, 20°C Ω/km	capacitance µF/km	charging current/phase at 50 Hz A/km	charging power/system at 50 Hz MVA/km	inductance o oo mH/km	inductance ooo mH/km	max. field-strength at cond. at U_0 kV/mm	surge impedance Ω	reduction factor
13.0	0.0605	0.0366	0.11	5.7	2.71	0.48	0.60	10.1	44.6	0.15
13.9	0.0469	0.0283	0.13	6.5	3.10	0.45	0.56	9.9	38.5	0.15
15.4	0.0367	0.0221	0.15	7.4	3.52	0.43	0.54	10.0	34.1	0.15
17.3	0.0291	0.0176	0.17	8.3	3.95	0.41	0.51	10.0	30.4	0.15
19.4	0.0247	0.0151	0.19	9.5	4.52	0.40	0.49	10.0	26.6	0.15
21.5	0.0212	0.0129	0.20	10.1	4.81	0.39	0.48	10.0	24.9	0.15
23.3	0.0186	0.0113	0.22	10.9	5.19	0.37	0.46	10.0	23.2	0.15
27.4	0.0149	0.0090	0.24	11.9	5.67	0.36	0.44	9.8	21.2	0.15
32.8	0.0120	0.0072	0.25	12.7	6.05	0.35	0.42	9.4	19.9	0.15
14.8	0.0469	0.0283	0.13	8.3	4.96	0.45	0.56	12.6	38.0	0.10
16.5	0.0367	0.0221	0.15	9.4	5.62	0.43	0.54	12.6	33.8	0.10
18.3	0.0291	0.0176	0.17	10.5	6.27	0.41	0.51	12.6	30.1	0.10
20.6	0.0247	0.0151	0.19	11.9	7.11	0.40	0.49	12.5	26.6	0.10
22.9	0.0212	0.0129	0.20	12.4	7.41	0.39	0.48	12.2	25.5	0.10
25.1	0.0186	0.0113	0.21	12.9	7.71	0.38	0.46	11.9	24.4	0.10
29.4	0.0149	0.0090	0.22	13.8	8.25	0.37	0.44	11.4	22.9	0.10
34.6	0.0120	0.0072	0.24	14.9	8.90	0.36	0.42	11.0	21.3	0.10
15.8	0.0469	0.0283	0.12	8.6	5.66	0.46	0.56	13.0	40.7	0.10
17.2	0.0367	0.0221	0.14	9.6	6.32	0.44	0.54	13.0	36.1	0.10
19.1	0.0291	0.0176	0.16	10.8	7.11	0.42	0.51	12.9	32.3	0.10
21.5	0.0247	0.0151	0.18	12.1	7.96	0.41	0.49	12.7	28.9	0.10
23.7	0.0212	0.0129	0.18	12.5	8.23	0.40	0.48	12.3	27.8	0.10
26.0	0.0186	0.0113	0.19	13.1	8.62	0.39	0.46	12.0	26.7	0.10
30.5	0.0149	0.0090	0.20	13.9	9.15	0.38	0.44	11.5	25.0	0.10
35.8	0.0120	0.0072	0.22	14.9	9.81	0.37	0.42	11.1	23.3	0.10
19.4	0.0367	0.0221	0.12	11.1	9.61	0.46	0.54	15.0	41.3	0.10
21.0	0.0291	0.0176	0.14	12.4	10.74	0.44	0.51	14.9	36.9	0.10
23.1	0.0247	0.0151	0.16	14.1	12.21	0.42	0.49	14.9	32.4	0.10
25.0	0.0212	0.0129	0.17	15.2	13.16	0.41	0.48	14.9	30.2	0.10
26.7	0.0186	0.0113	0.18	16.4	14.20	0.40	0.46	15.0	28.0	0.10
31.1	0.0149	0.0090	0.19	17.5	15.16	0.38	0.44	14.4	26.2	0.10
36.6	0.0120	0.0072	0.21	18.6	16.11	0.37	0.42	13.8	24.6	0.10

Südkabel – References

Worldwide

- Abu Dhabi
- Algeria
- Angola
- Austria
- Bhutan
- Botswana
- Brazil
- Canada
- Cayman Islands
- Chile
- China
- Cyprus
- Czech Republic
- Dubai
- Egypt
- Finland
- Germany
- Great Britain
- Greece
- Guinea
- Hungary
- Iceland
- Indonesia
- Iran
- Iraq
- Italy
- Jordan
- Kazakhstan
- Kuwait
- Liberia

Libya
Macao
Malaysia
Mexico
Mozambique
Netherlands
Nigeria
Oman
Pakistan
Philippines
Poland
Portugal
Romania
Russia
Saudi Arabia
Singapore
Slovakia
Slovenia
Spain
Sri Lanka
St Lucia
South Africa
Switzerland
Syria
Taiwan
Thailand
Turkey
United States
Ukraine
Venezuela



1 9 7 3
First 123 kV XLPE cable system in Germany

1 9 8 8
Germany´s first 245 kV XLPE cable system

1 9 9 2
Type Test for 420 kV XLPE cable system

1 9 9 5
Successful pre-qualification testing for 420 kV XLPE cable systems at CESI, Italy

1 9 9 6
Europe’s first 420 kV XLPE installation

1 9 9 8
First 420 kV XLPE Cable System including joints in Germany

2 0 0 0

Successful pre-qualification testing for 550 kV XLPE cable systems at FGH, Germany

2 0 0 1

550 kV XLPE system in China

2 0 0 1 - 2 0 0 2

Orders for Extra-High Voltage XLPE Cable Systems with approximately 200 core-km of cable for commissioning during 2003-2004.

Reference lists and brochures describing major completed projects are available as hard-copies.

CMYK, Mannheim

Südkabel 0404-2 2001 GD

Südkabel GmbH
P.O. Box
D-68147 Mannheim
Rhenaniastraße 12-30
D-68199 Mannheim
Phone +49 (0)621 8507 01
Fax +49 (0)621 8507 294
e-mail info@suedkabel.com

ÎÎ Î Î Ê- Ýëåêòðîòåõíèê
644083 ã. Î ìñê-83
Õèìèêîâ 56
Òåë. 33 59 23
27 27 06
Ôàêñ. 69 51 41
E-mail: info@elektrotechnik.ru
URL: www.suedkabel.ru
www.elektrotechnik.ru