TELE-FONIKA Kable S.A.

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Manufactory in the factory BYDGOSZCZ

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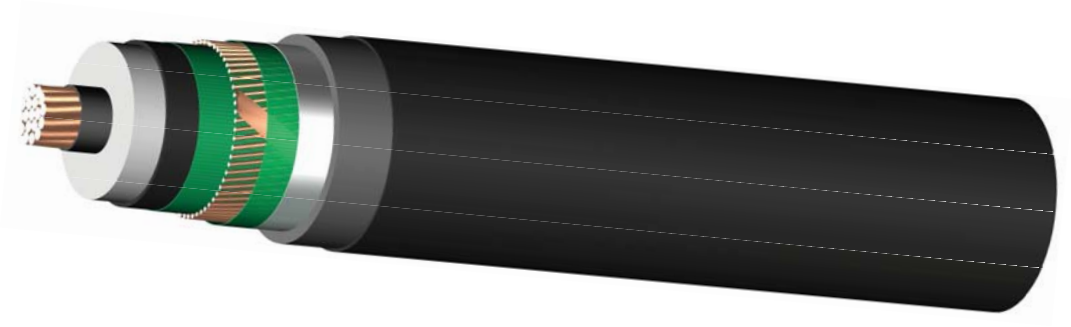


SINGLE CORE, CROSS-LINKED POLYETHYLENE INSULATED, POWER CABLES VOLTAGES RATINGS: 6/10(12)kV up to 18/30(36)kV Acc to ZN-TF-500 and DIN VDE 0276-620, HD 620

CONTENTS

1. INTRODUCTION

Telefonika Kable SA manufacture plant in Bydgoszcz is the oldest cable, wires and conductors manufacturer in Poland. Ever since the start production in the BFK (earlier KABEL POLSKI) products have been known for their good quality and technological level. BFK has an over 70 year tradition in the manufacture of medium voltage power cables.
First power cables, insulated with oil impregnated paper and lead sheathed, rated up to 35kV, were made at BFK in 1935. Manufacture of those cables, known for their high quality has been continued and improved until 1973.
Progress in the worlds cable industry, which brought above the replacement of oil paper insulation by polyethylene, allowing:

- Any cable laying angle
- Lower weight
- Easier assembly and service
- Longer lengths (less joint)
- Reliable and no maintenance fittings
- Lower transmission losses
- Greater current carrying capacity
- Smaller cable bending radius
- Possibility to make and use ecological cable

Prompted BFK to discontinue the production of paper insulated cables and undertake in 1973 the manufacture of those in thermoplastic polyethylene insulation. It first only medium voltage, thermoplastic polyethylene insulated cables were made. They were designed to work at long lasting phase conductor temperature of maximum 70^0C, they were not sealed and sensitive to water treeing. Now, having gained experience of thermoplastic polyethylene cable production and purchased a number of machines, among those most modern NOKIA (today Maillefer) catenary lines to apply in triple crossheads and dry crosslink the polyethylene in degassing nitrogen (N_2) the insulation and semi-conductive screens. In 1988 we began to manufacture cables with new generation polyethylene insulation. They are chemical cross-linked polyethylene insulated cables (name - XLPE, VPE). Designed for long operation at phase conductor temperature 90^0C. Due to our experience, machinery, clean rooms, testing equipment and using in production only certificated materials of such renowned manufacturer as Borealis of Sweden or Belgium, or Union Carbide, DOW of USA, we are not only the only Polish manufacturer, but also a significant exporter of good European standard and quality XLPE insulated cables of medium and high voltage ratings.

The XLPE cables are made in compliance with both Polish and international standards, e.g.: DIN VDE – Germany, BS – United Kingdom, AEIC – America, NEK – Norway, SS – Swedish, SABS – South Africa and other. Our products are Certificated by many domestics and foreign Quality Certification Bodies:

BBJ SEP	-	Poland
VDE	-	Germany
UL	-	USA
NEMKO	-	Norway
BASEC	-	United Kingdom

2. TECHNOLOGY OF XLPE CABLE MANUFACTURE

The cable quality depends, to a considerable extend, on the technological equipment and the quality of materials used. To produce high quality XLPE cables we use the most modern state of the art machinery and manufacturing equipment, best raw material and measuring – monitoring equipment. The polyethylene insulation technology and cross-linking are based on the entirely dry process of cross-linking and cooling. This eliminate micro-inclusions of water that can lead to so called water treeing. The conductor screens and insulations screens are extruded inside a triple crosshead in a single technological operation, jointly with the insulation. The insulation and semi-conductive materials are taken from clean room in which clean, filtered air overpressure prevails. This prevents the ambient impurities to penetrates this insulation. The raw materials used for the insulations and conductor and

insulations screens meet stringent requirements which have been set taking into consideration the parameters of the best internationally available insulating and semi-conductive polyethylene.
The metallic screen is made of soft copper wires applied helically with interstices, accompanied by a reversed lay copper tape. The metallic screen can, if required, by made of copper tapes alone. The screen cross section meets the requirements of DIN VDE 0276-620, BS 6622, ZN-TF-500. If the ordered wants to have another metallic screen cross section, we can make it.
The cable sheath is made of PVC, medium density polyethylene (MDPE), medium density polyethylene flame retardant or halogen-free flame retardant plastics of low emission of fumes and corrosive gases (LSF). The sheathing materials are adopted to a long time cable operation temperature 90^0C, the are resistant to solar radiation and weather conditions.
Equivalent of those material are:

- **PVC** - type YM5 to VDE 0207 part 5 or type 9 to BS 6746.
- **MDPE** - type 2YM3 to VDE 0207 part 3.
- **MDPE** - flame retardant - not requirements.
- **LSF** - to VDE 0276-622 or BS 7835.

The sheath made with PVC or MDPE – flame retardant can by made **RED** colour, made with polyethylene MDPE – **BLACK** colour or any others requested by the buyer. For the special demands cable can be made acc to IEC Publication 60332-1 or IEC Publication 60332-3.

Dielectric field

The insulation screens should be effectively at ground potential. There is no resulting distortion of the electrostatic flux or equipotential lines. Electrostatic flux lines are spaced symmetrically and perpendicular to equipotential lines. The equipotential lines are concentric and parallel with respect to each other, the conductor screen, and the insulation screen. The presence of the screen results in field lines as depicted in Figure 1

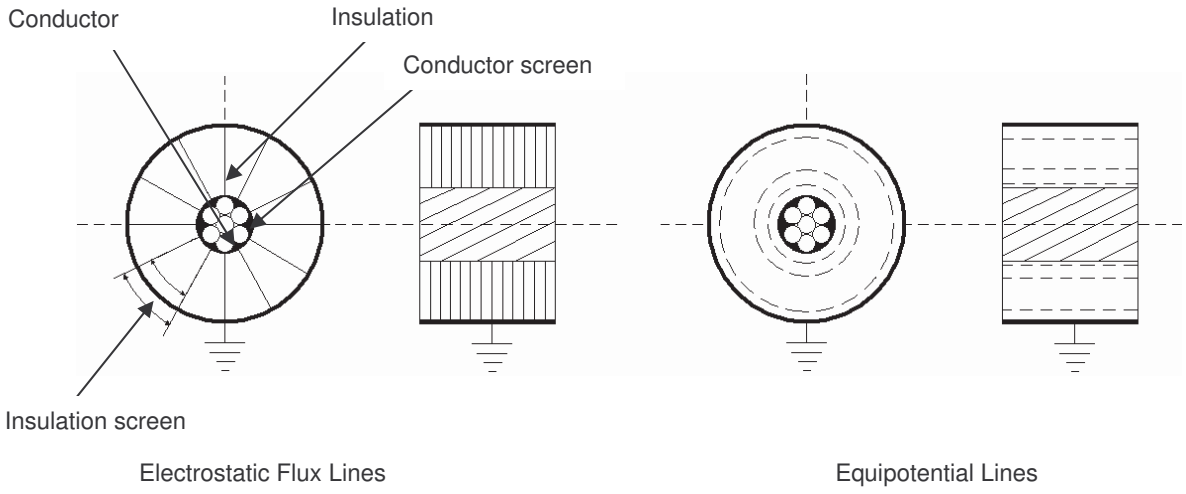


Figure 1 Dielectric field of power cable

In a screened cable all the voltage difference between conductor and electrical ground is contained within the cable. For a non-screened cable the voltage difference between conductor and electrical ground is divided between the cable dielectric and any intervening air or others materials.
In Figure A, observe that the field lines are closer to each other near the conductor screen as compared to the insulation screen. The radial stresses or voltage gradients increase near the conductor.
Electrical insulation surrounding a conductor creates a capacitors when the conductor is electrical energized. Thus all insulated conductors are capacitors.
In the majority of non-shielded cable systems, the cable surface maces intermittent contact with an electrical ground. Where intimate contact with this ground is not made, the intervening air spaces also act primarily as capacitors in A.C. circuits and as resistors in D.C. circuits. This forms a series circuit of

cable dielectric and air dielectric. The voltage across this series circuit varies along the length of the cable dependent upon the voltage across the air gap. The cable surface becomes a floating voltage point a voltage divider. This floating point voltage can vary considerably, dependent upon the cable design and the characteristics of the air gap. If the voltage is high enough, the cable surface can experience detrimental surface tracking or arcing discharges to electrical ground. The cable surface can also became potentially hazardous causing an electrical shock if contacted by field personnel. Screened the cable dielectric surface and grounding of this screens, eliminates tracking and arcing discharges. The grounding of this screens prevents the accumulation of an electrical potential on the surface of the cable that could be hazardous to individuals coming into contact with the cable surface.

Voltage stress

The average radial stress is determined by the ratio of the applied voltage to the total insulation thickness.
The cable geometry creates a nonlinear dielectric field. This results in higher radial stress, or voltage gradients, near the conductor screen when compared to those near the insulation screen.

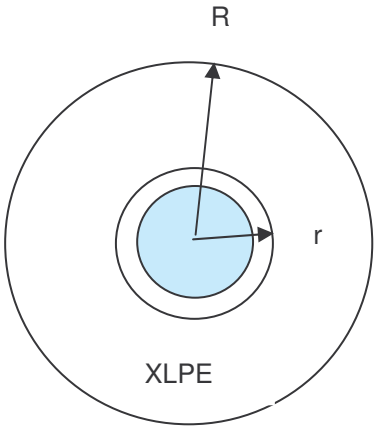
Formula for electric stress:

On the conductor screen:

$$E_{screen} = \frac{Uo}{r \ln\left\{\frac{R}{r}\right\}} \qquad [V/mm]$$

On the insulation:

$$E_{insulation} = \frac{Uo}{R \ln\frac{R}{r}} \qquad [V/mm]$$



r = radius of conductor screen [mm]
R = radius of insulation [mm]
U_0 = voltage across insulation [V]

3. TYPES OF CABLES MANUFACTURED.

acc to ZN-TF-500, **acc to DIN VDE 0276-620**

PVC sheathed cables:

YHAKXS **YHKXS**	Power cables with radial field, aluminium or copper phase conductor, XLPE insulated, PVC sheathed, RED colour.	**NA2XSY** **N2XSY**	Power cables with radial field, aluminium or copper phase conductor, VPE insulated, PVC sheathed, RED colour

LSF sheathed cables (special version):

NHAKXS **NHKXS**	Power cables with radial field, aluminium or copper phase conductor, XLPE insulated, LSF sheathed, RED or BLACK colour	**NA2XSH** **N2XSH**	Power cables with radial field, aluminium or copper phase conductor, VPE insulated, LSF sheathed, RED or BLACK colour.

MDPE sheathed cables:

XHAKXS **XHKXS**	Power cables with radial field, aluminium or copper phase conductor, XLPE insulated, MDPE sheathed, BLACK colour	**NA2XS2Y** **N2XS2Y**	Power cables with radial field, aluminium or copper phase conductor, VPE insulated, MDPE sheathed, BLACK colour.

Longitudinally sealed cables:

XUHAKXS **XUHKXS** **NUHAKXS** **NUHKXS**	Power cables with radial field, aluminium or copper phase conductor, XLPE insulated, longitudinally sealed to prevent water propagation, MDPE or LSF sheathed, BLACK colour	**NA2XS(F)2Y** **N2XS(F)2Y** **NA2X(F)H** **N2X(F)H**	Power cables with radial field, aluminium or copper phase conductor, VPE insulated, longitudinally sealed to prevent water propagation, MDPE or LSF sheathed, BLACK colour

Longitudinally and radially sealed cables:

XRUHAKXS **XRUHKXS**	Power cables with radial field, aluminium or copper phase conductor, XLPE insulated, longitudinally and radially sealed against water propagation, MDPE sheathed, BLACK colour	**NA2XS(FL)2Y** **N2XS(FL)2Y**	Power cables with radial field, aluminium or copper phase conductor, VPE insulated, longitudinally and radially sealed against water propagation, MDPE sheathed, BLACK colour

4. CABLE IDENTIFICATION

Acc to ZN-TF-500.
Conductor identification:
A – aluminium conductor.
- copper conductors (no symbols)
RMC – round multi wires compacted aluminium or copper conductor.
RE - round solid aluminium conductor.
RMS – round, stranded multi wires aluminium and copper conductor, Milliken type.

Cable symbols identification:
Y - PVC sheath.
X - PE sheath
Xn - PE flame retardant sheath.
N - LSF, halogen free, flame retardant plastic of low smoke and corrosive gasses emission sheath.
U – longitudinal water tightness
R – radially sealed against water propagation under sheath.
H – cable with radial field.
K - cable.
XS - XLPE, insulation of cross-linked polyethylene.

Number of cores times nominal cross section area of conductor in [mm^2] and after a stroke nominal section area of copper screen.
Identification of shape and type conductor given hereafter.
Rated voltage U_o/U in [kV].

Cables acc to ZN-TF-500 are designed by:

XRUHAKXS 1x240RMC/50 mm^2 12/20kV ZN-TF-500.

Acc to DIN VDE 0276-620.
Conductor identification:
A – aluminium conductor.
- copper conductors (no symbols)

RM - round multi wires compacted aluminium or copper conductor.
RE - round solid aluminium conductor.
RMS – round, stranded multi wires aluminium and copper conductor, Milliken type.

Cable symbols identification:
N – Cable acc to DIN VDE 0276-620.
2X - VPE, insulation of cross-linked polyethylene.
S – copper screen.
(F) – longitudinal sealing preventing water propagation in the vicinity of the metallic screen.
(FL) - longitudinally and radially sealed against water propagation under sheath.
Y - PVC sheath.
2Y - PE sheath
H - LSF, halogen free, flame retardant plastic of low smoke and corrosive gasses emission sheath.

Number of cores times nominal cross section area of conductor in [mm^2] and after a stroke nominal section area of copper screen.
Identification of shape and type conductor given hereafter.
Rated voltage U_o/U in [kV].

Cables acc to DIN VDE 0276-620 are designed by:

NA2XS(FL)2Y 1x240RM/35mm^2 12/20kV DIN VDE 0276-620

5. COMPARISION OF SHEATH TYPES

The MDPE sheaths if compared with the PVC and LSF ones, show the following properties:

- Better mechanical strength (PVC – 12.5 MPa; MDPE – 18 MPa; LSF – 10 MPa)
- Better pressure resistance (PVC - 80^0C, 50%; MDPE - 115^0C, 30%; LSF - 80^0C, 50%)
- Significant resistance to low temperatures
- Better insulating properties
- Greater resistance to moisture penetration
- Greater resistance to mechanical damages when being laid.

6. SEALING

Longitudinal sealing (U or F) – the cable has a longitudinal moisture barrier between its screened insulation and sheath (moisture swelling tapes wrap, blocking moisture migration along the cable). If the customer wishes so, the cable phase conductor can be longitudinally sealed too (voids between conductor wires are filled with moisture swelling powder or moisture swelling string.

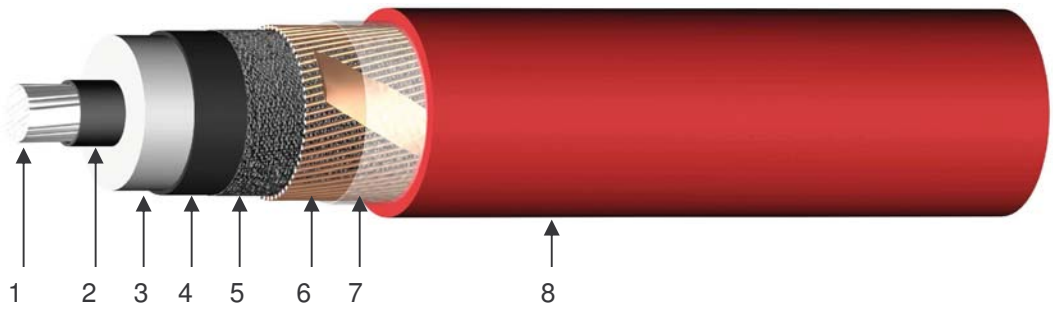
Radial sealing (R or FL) – the cable is longitudinally sealed, with additional moisture barrier of polyethylene polymer coated aluminium tape that covers the entire inner surface of the cable sheath and bonded to it.

- Minimum bonding force in aluminium tape – copolymer overlap is minimum 0.5 [N/mm]
- Minimum bonding force the copolimered aluminium tape to the outer sheath is minimum 0.5 [N/mm]

7. CABLE DESIGN

The cable designs are shown in the following illustrations:

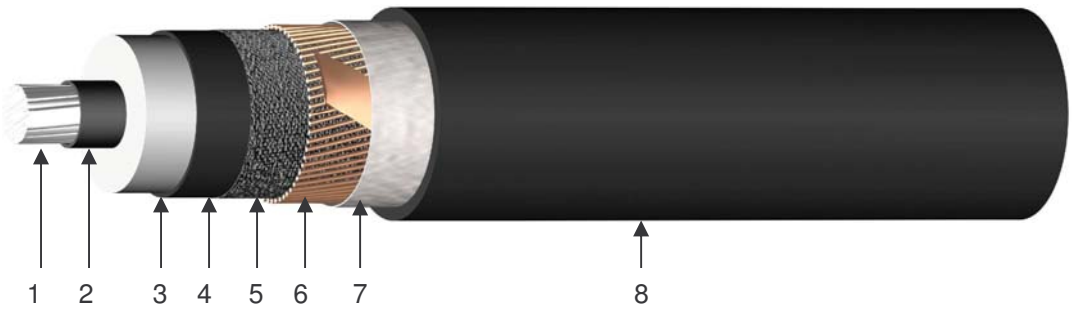
Fig 2 Cable type: YHAKXS, YHKXS - NA2XSY, N2XSY - XHAKXS, XHKXS - NA2XS2Y, N2XS2Y, NHAKXS, NHKXS - NA2XSH, N2XSH.



Legend to the figure 2

1 – Aluminium or copper conductor.
2 – Semi-conductive screen extruded on the phase conductor.
3 – XLPE insulation.
4 – Semi-conductive screen extruded on insulation.
5 – Semi-conductive tape wrap, non swelling under action of water.
6 – Metallic screen.
7 – Wrapping of polyester tape.
8 – Outer sheath: PVC, MDPE, LSF

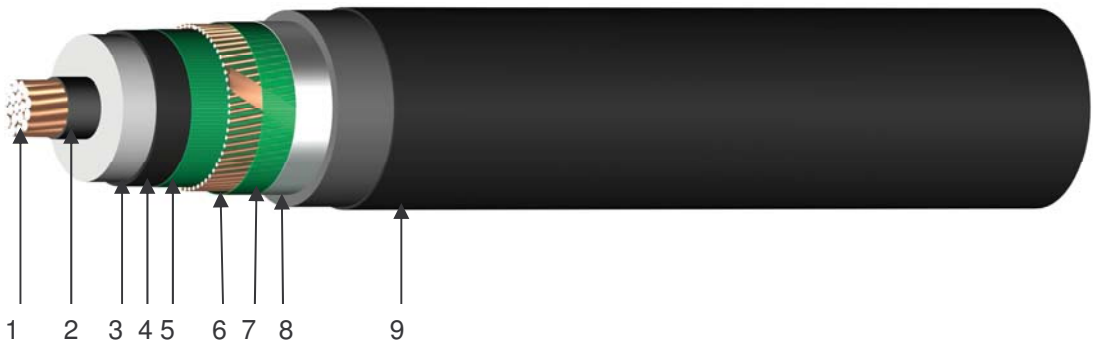
Fig. 3 Cable type: XUHAKXS, XUHKXS - NA2XS(F)2Y, N2XS(F)2Y, NUHAKXS, NUHKXS - NA2XS(F)H, N2XS(F)H.



Legend to the figure 3

1 – Aluminium or copper conductor.
2 – Semi-conductive screen extruded on the phase conductor.
3 – XLPE insulation.
4 – Semi-conductive screen extruded on insulation.
5 – Wrapping of semi-conductive water swelling tape
6 – Metallic screen.
7 – Wrapping of non conductive water swelling tape
8 – Outer sheath: MDPE, LSF

Fig. 4 Cable type: XRUHAKXS, XRUHKXS - NA2XS(FL)2Y, N2XS(FL)2Y.

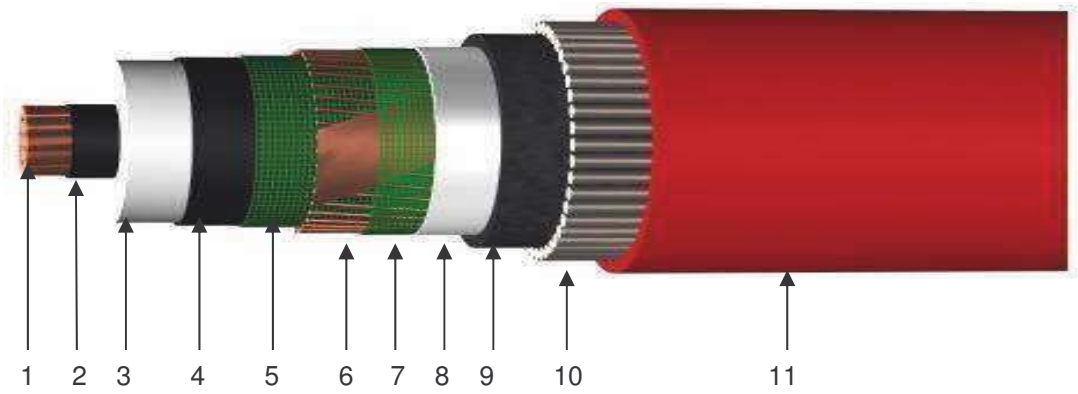


Legend to the figure 4

1 – Aluminium or copper conductor.
2 – Semi-conductive screen extruded on the phase conductor.
3 – XLPE insulation.
4 – Semi-conductive screen extruded on insulation.
5 – Wrapping of semi-conductive water swelling tape
6 – Metallic screen.
7 – Wrapping of semi-conductive water swelling tape
8 – Longitudinally applied aluminium tape coated with PE copolymer.
9 – MDPE outer sheath.

For the special application Tele-Fonika Kable S.A. offered single-core cables with aluminium armour type YH(A)KXSFoy, XH(A)KXSFox, XUH(A)KXSFox, XRUH(A)KXSFox.

Fig. 5 Cable type: XRUH(A)KXSFox.



Legend to the figure 5

1 – Aluminium or copper conductor.
2 – Semi-conductive screen extruded on the phase conductor.
3 – XLPE insulation.
4 – Semi-conductive screen extruded on insulation.
5 – Wrapping of semi-conductive water swelling tape

6 – Metallic screen.
7 – Wrapping of semi-conductive water swelling tape
8 – Longitudinally applied aluminium tape coated with PE copolymer.
9 – MDPE inner sheath.
10- Wires of aluminium armour
11- MDPE outer sheath.

Tele - Fonika Kable SA supplies different types of TRIPLEX power cables depending on specific requirements and site conditions.
A typical design of a XLPE medium voltage cable range 3 x 1 x 50mm^2 to 3 x 1 x 630mm^2 with an operating voltage up to 36 kV.

Fig. 6 Cable type: TRIPLEX – YH(A)KXS, NH(A)KXS, XH(A)KXS, XUH(A)KXS, XRUH(A)KXS, N(A)2XSY, N(A)2XSH, N(A)2XS2Y, N(A)2XS(F)2Y, N(A)2XS(FL)2Y.

Legend to the figure 6

1 – Aluminium or copper conductor.
2 – Semi-conductive screen extruded on the phase conductor.
3 – XLPE insulation.
4 – Semi-conductive screen extruded on insulation.
5 – Semi-conductive tape wrap, swelling under action of water.
6 – Metallic screen.
7 – Wrapping of semi-conductive tape wrap, swelling under action of water.
8 - Longitudinally applied aluminium tape coated with PE copolymer.
9 – Outer sheath: PVC, MDPE, LSF

All cables in the catalogue are based on the mayor national and international standards, European Harmonized standards, e.g. HD, DIN VDE. The demands of IEC 60502 with regard to construction and properties were also fulfilled.

8. CABLE MARKING

On their outer sheaths the cable are embossing maximum every 500m in one or two lines, reading as called for DIN VDE 0276-620 –
TF KABLE NA2XS(FL)2Y 1x240RM/35 20kV acc to VDE 0276 Year of manufacture and meter marking or
acc to ZN-TF-500:2002 –
TF KABLE XRUHAKXS 1x240RMC/50 20kV acc to ZN-TF-500 Year of manufacture and meter marking

9. CABLE TESTING

Follows DIN VDE 0276-620 requirements including:

- Routine test (R): performed in-house on all ready lengths and, as appropriate, e.g. spark test in course of cable manufacture.

The following test shell by carried out:

- Conductor examination
- Measurement of electrical resistance of conductor
- Measurement of thickness of insulation and non-metallic sheaths
- Measurement of diameters
- Hot set test for XLPE
- Spark test voltage on outer sheaths (50 Hz, U= 6 e [kV], e- nominal thickness of sheath in mm)
- Partial discharge test (2 x U_o, 5pC)
- Voltage test (2,5 x U_0, in during 5 min)
- Test length of the ready cable

- Sample test (S): performed on representative specimens selected by the manufacturer, or requested by buyer when placing enquiry or order.

- Special sample tests (SS): performed on specimens if determined by buyers enquiry or order, their frequency agreed between the buyer and the manufacturer, provided the quantity ordered does not exceed 10 km.

- Type test (T): performed on cable specimens, made to demonstrate the ability to satisfactory range of designated cables and their adherence to the standard. Single testing to obtain satisfactory range of designated cables and their adherence to the standard. Single testing to obtain satisfactory results and valid until modification to construction or raw material used.

10. CONSTRUCTION DETAILS

Constructional details for the individual cable type are shows in Tables 1 to 16. The cross-sections of the metallic screens have bin selected as required by DIN VDE 0276-620 and are 35mm^2 copper. Any other cross-sections cab by tailored to customers wishes, upon agreement made when ordering cables.

Power **YHAKXS, YHKXS, NA2XSY, N2XSY -** single core cable with copper and aluminium conductors, XLPE (cross-linked polyethylene) insulation and PVC sheathed; or **NAHKXS, NHKXS, NA2XSH, N2XSH -** LSF, halogen free, flame retardant plastic of low smoke and corrosive gasses emission sheathed rated voltage 6/10kV; 8,5/15kV; 12/20kV; 18/30kV.

Table 1 **Cable type: YHKXS, N2XSY, NHKXS, N2XSH, YHAKXS, NA2XSY, NHAKXS, NA2XSH, rated voltage 6/10 kV**

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
YHKXS, N2XSY, NHKXS, N2XSH	35	16	minimum 0,3	3,4	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	15,2	16,2	24,4	880	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	16,4	17,5	25,7	1020	
	70	25					$9,6^{+0,20}$	10,8	17,8	18,8	27,1	1330	
	95	35					$11,5^{+0,20}$	12,7	19,7	20,7	29,0	1700	
	120	50					$12,9^{+0,25}$	14,1	23,2	24,1	32,4	2090	
	150	50					$14,5^{+0,30}$	15,8	24,8	25,8	34,1	2380	
	185	50					$16,0^{+0,30}$	17,3	26,3	27,3	35,6	2740	
	240	50					$18,5^{+0,30}$	19,8	28,8	29,8	38,1	3300	
	300	50					$20,5^{+0,30}$	21,8	30,8	31,8	40,1	3890	
	400	50					$23,5^{+0,30}$	25,0	32,1	33,3	41,6	4790	
	500	50					$26,5^{+0,40}$	28,1	35,2	36,4	44,7	5850	
	630	50				2,6	$30,3^{+0,40}$	31,9	39,0	40,2	48,7	7180	
	800	50				2,7	$34,6^{+0,50}$	37,1	44,2	45,4	54,1	8900	
	1000	50				2,8	$37,6^{+0,50}$	40,1	47,2	48,4	57,3	10800	
YHAKXS, NA2XSY, NHAKXS, NA2XSH	35	16	minimum 0,3	3,4	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	15,0	16,0	24,3	670	
	50	16					$8,15^{+0,10}$	9,2	16,3	17,3	25,5	730	
	70	25					$9,5^{+0,10}$	10,6	17,6	18,6	26,9	910	
	95	35					$11,3^{+0,20}$	12,5	19,5	20,5	28,8	1120	
	120	50					$12,5^{+0,20}$	13,7	20,7	21,7	30,0	1360	
	150	50					$14,2^{+0,20}$	15,4	22,4	23,4	31,7	1470	
	185	50					$15,8^{+0,20}$	17,0	24,0	25,0	33,3	1610	
	240	50					$17,8^{+0,10}$	18,9	25,9	26,9	35,2	1810	
	300	50					$20,0^{+0,30}$	21,3	28,3	29,3	37,6	2030	
	400	50					$22,9^{+0,30}$	24,4	31,5	32,7	41,0	2370	
	500	50					$25,7^{+0,40}$	27,3	34,4	35,6	43,9	2740	
	630	50					$29,3^{+0,50}$	31,0	38,1	39,3	47,6	3200	
	800	50				2,7	$33,0^{+0,50}$	35,5	42,6	43,8	52,5	3860	
	1000	50				2,9	$38,0^{+0,50}$	40,5	47,6	48,8	57,9	4620	

Table 2 **Cable type: YHKXS, N2XSY, NHKXS, N2XSH, YHAKXS, NA2XSY, NHAKXS, NA2XSH, rated voltage 8,7/15 kV**

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
YHKXS, N2XSY, NHKXS, N2XSH	35	16	minimum 0,3	4,5	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	17,3	18,3	26,6	960	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	18,6	19,6	27,9	1110	
	70	25					$9,6^{+0,20}$	10,8	20,0	21,0	29,3	1420	
	95	35					$11,5^{+0,20}$	12,7	21,9	22,9	31,2	1800	
	120	50					$12,9^{+0,25}$	14,1	23,3	24,3	32,6	2200	
	150	50					$14,5^{+0,30}$	15,8	25,0	26,0	34,3	2490	
	185	50					$16,0^{+0,30}$	17,3	26,5	27,5	35,8	2850	
	240	50					$18,5^{+0,30}$	19,8	29,0	30,0	38,3	3420	
	300	50					$20,5^{+0,30}$	21,8	31,0	32,0	40,3	4010	
	400	50					$23,5^{+0,30}$	25,0	34,3	35,5	43,8	4930	
	500	50					$26,5^{+0,40}$	28,1	37,4	38,6	46,9	5990	
	630	50				2,6	$30,3^{+0,40}$	31,9	41,2	42,4	50,9	7340	
	800	50				2,8	$34,6^{+0,50}$	37,1	46,4	47,6	56,5	9110	
	1000	50				2,9	$37,6^{+0,50}$	40,1	49,4	50,6	59,7	11010	
YHAKXS, NA2XSY, NHAKXS, NA2XSH	35	16	minimum 0,3	4,5	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	17,2	18,2	26,5	750	
	50	16					$8,15^{+0,10}$	9,2	18,4	19,4	27,7	820	
	70	25					$9,5^{+0,10}$	10,6	19,8	20,8	29,1	1000	
	95	35					$11,3^{+0,20}$	12,5	21,7	22,7	31,0	1220	
	120	50					$12,5^{+0,20}$	13,7	22,9	23,9	32,2	1460	
	150	50					$14,2^{+0,20}$	15,4	24,6	25,6	33,9	1580	
	185	50					$15,8^{+0,20}$	17,0	26,2	27,2	35,5	1730	
	240	50					$17,8^{+0,10}$	18,9	28,1	29,1	37,4	1930	
	300	50					$20,0^{+0,30}$	21,3	30,5	31,5	39,8	2160	
	400	50					$22,9^{+0,30}$	24,4	33,7	34,9	43,2	2500	
	500	50					$25,7^{+0,40}$	27,3	36,6	37,8	46,1	2880	
	630	50				2,6	$29,3^{+0,50}$	31,0	40,3	41,5	50,0	3380	
	800	50				2,8	$33,0^{+0,50}$	35,5	44,8	46,0	54,9	4060	
	1000	50				2,9	$38,0^{+0,50}$	40,5	49,8	51,0	60,1	4810	

Table 3 Cable type: YHKXS, N2XSY, NHKXS, N2XSH, YHAKXS, NA2XSY, NHAKXS, NA2XSH, rated voltage 12/20 kV

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
YHKXS, N2XSY, NHKXS, N2XSH	35	16	minimum 0,3	5,5	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	19,4	20,3	28,6	1040	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	20,6	21,6	29,9	1190	
	70	25					$9,6^{+0,20}$	10,8	22,0	23,0	31,3	1510	
	95	35					$11,5^{+0,20}$	12,7	23,9	24,9	33,2	1890	
	120	50					$12,9^{+0,25}$	14,1	25,3	26,3	34,6	2290	
	150	50					$14,5^{+0,30}$	15,8	27,0	28,0	36,3	2590	
	185	50					$16,0^{+0,30}$	17,3	28,5	29,5	37,8	2960	
	240	50					$18,5^{+0,30}$	19,8	31,0	32,0	40,3	3530	
	300	50					$20,5^{+0,30}$	21,8	33,0	34,0	42,3	4130	
	400	50					$23,5^{+0,30}$	25,0	36,3	37,5	45,8	5060	
	500	50				2,6	$26,5^{+0,40}$	28,1	39,4	40,6	49,1	6150	
	630	50				2,7	$30,3^{+0,40}$	31,9	43,2	44,4	53,1	7510	
	800	50				2,9	$34,6^{+0,50}$	37,1	48,4	49,6	58,7	9310	
	1000	50				3,0	$37,6^{+0,50}$	40,1	51,4	52,6	61,9	11220	
YHAKXS, NA2XSY, NHAKXS, NA2XSH	35	16	minimum 0,3	5,5	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	19,2	20,2	28,5	830	
	50	16					$8,15^{+0,10}$	9,2	20,4	21,4	29,7	900	
	70	25					$9,5^{+0,10}$	10,6	21,8	22,8	31,1	1090	
	95	35					$11,3^{+0,20}$	12,5	23,7	24,7	33,0	1310	
	120	50					$12,5^{+0,20}$	13,7	24,9	25,9	34,2	1560	
	150	50					$14,2^{+0,20}$	15,4	26,6	27,6	35,9	1680	
	185	50					$15,8^{+0,20}$	17,0	28,2	29,2	37,5	1830	
	240	50					$17,8^{+0,10}$	18,9	30,1	31,1	39,4	2040	
	300	50					$20,0^{+0,30}$	21,3	32,5	33,5	41,8	2280	
	400	50					$22,9^{+0,30}$	24,4	35,7	36,9	45,2	2630	
	500	50					$25,7^{+0,40}$	27,3	38,6	39,8	48,1	3020	
	630	50				2,7	$29,3^{+0,50}$	31,0	42,3	43,5	52,2	3550	
	800	50				2,8	$33,0^{+0,50}$	35,5	46,8	48,0	56,9	4060	
	1000	50				3,0	$38,0^{+0,50}$	40,5	51,8	53,0	62,3	4220	

Table 4 Cable type: YHKXS, N2XSY, NHKXS, N2XSH, YHAKXS, NA2XSY, NHAKXS, NA2XSH, rated voltage 18/30 kV

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
YHKXS, N2XSY, NHKXS, N2XSH	35	16	minimum 0,3	8,0	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	24,4	25,4	33,6	1270	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	25,6	26,6	34,9	1430	
	70	25					$9,6^{+0,20}$	10,8	27,0	28,0	36,3	1760	
	95	35					$11,5^{+0,20}$	12,7	28,9	29,9	38,2	2150	
	120	50					$12,9^{+0,25}$	14,1	30,3	31,3	39,6	2570	
	150	50					$14,5^{+0,30}$	15,8	32,0	33,0	41,3	2880	
	185	50					$16,0^{+0,30}$	17,3	33,5	34,5	42,8	3260	
	240	50					$18,5^{+0,30}$	19,8	36,0	37,0	45,3	3850	
	300	50					$20,5^{+0,30}$	21,8	38,0	39,0	47,3	4460	
	400	50				2,6	$23,5^{+0,30}$	25,0	41,3	42,5	51,0	5430	
	500	50				2,7	$26,5^{+0,40}$	28,1	44,4	45,6	54,3	6560	
	630	50				2,9	$30,3^{+0,40}$	31,9	48,2	49,4	58,5	7970	
	800	50				3,1	$34,6^{+0,50}$	37,1	53,4	54,6	64,1	9810	
	1000	50				3,2	$37,6^{+0,50}$	40,1	56,4	57,6	67,3	11750	
YHAKXS, NA2XSY, NHAKXS, NA2XSH	35	16	minimum 0,3	8,0	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	24,2	25,2	33,5	1060	
	50	16					$8,15^{+0,10}$	9,2	25,4	26,4	34,7	1140	
	70	25					$9,5^{+0,10}$	10,6	26,8	27,8	36,1	1340	
	95	35					$11,3^{+0,20}$	12,5	28,7	29,7	38,0	1580	
	120	50					$12,5^{+0,20}$	13,7	29,9	30,9	39,2	1830	
	150	50					$14,2^{+0,20}$	15,4	31,6	32,6	40,9	1960	
	185	50					$15,8^{+0,20}$	17,0	33,2	34,2	42,5	2130	
	240	50					$17,8^{+0,10}$	18,9	35,1	36,1	44,4	2350	
	300	50					$20,0^{+0,30}$	21,3	37,5	38,5	46,8	2600	
	400	50				2,6	$22,9^{+0,30}$	24,4	40,7	41,9	50,4	3000	
	500	50				2,7	$25,7^{+0,40}$	27,3	43,6	44,8	53,5	3440	
	630	50				2,8	$29,3^{+0,50}$	31,0	47,3	48,5	57,4	3980	
	800	50				3,0	$33,0^{+0,50}$	35,5	51,8	53,0	62,3	4710	
	1000	50				3,2	$38,0^{+0,50}$	40,5	56,8	58,0	67,7	5550	

Table 5 Cable type: XHKXS, N2XS2Y, XnHKXS, XHAKXS, NA2XS2Y, XnHAKXS, rated voltage 6/10 kV

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XHKXS, N2XS2Y, XnHKXS,	35	16	minimum 0,3	3,4	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	15,2	16,2	24,4	800	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	16,4	17,5	25,7	940	
	70	25					$9,6^{+0,20}$	10,8	17,8	18,8	27,1	1240	
	95	35					$11,5^{+0,20}$	12,7	19,7	20,7	29,0	1600	
	120	50					$12,9^{+0,25}$	14,1	23,2	24,1	32,4	2000	
	150	50					$14,5^{+0,30}$	15,8	24,8	25,8	34,1	2280	
	185	50					$16,0^{+0,30}$	17,3	26,3	27,3	35,6	2630	
	240	50					$18,5^{+0,30}$	19,8	28,8	29,8	38,1	3180	
	300	50					$20,5^{+0,30}$	21,8	30,8	31,8	40,1	3760	
	400	50					$23,5^{+0,30}$	25,0	32,1	33,3	41,6	4650	
	500	50					$26,5^{+0,40}$	28,1	35,2	36,4	44,7	5700	
	630	50				2,6	$30,3^{+0,40}$	31,9	39,0	40,2	48,7	7010	
	800	50				2,7	$34,6^{+0,50}$	37,1	44,2	45,4	54,1	8720	
	1000	50				2,8	$37,6^{+0,50}$	40,1	47,2	48,4	57,3	10590	
XHAKXS, NA2XS2Y, XnHAKXS,	35	16	minimum 0,3	3,4	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	15,0	16,0	24,3	590	
	50	16					$8,15^{+0,10}$	9,2	16,3	17,3	25,5	650	
	70	25					$9,5^{+0,10}$	10,6	17,6	18,6	26,9	830	
	95	35					$11,3^{+0,20}$	12,5	19,5	20,5	28,8	1030	
	120	50					$12,5^{+0,20}$	13,7	20,7	21,7	30,0	1260	
	150	50					$14,2^{+0,20}$	15,4	22,4	23,4	31,7	1370	
	185	50					$15,8^{+0,20}$	17,0	24,0	25,0	33,3	1510	
	240	50					$17,8^{+0,10}$	18,9	25,9	26,9	35,2	1670	
	300	50					$20,0^{+0,30}$	21,3	28,3	29,3	37,6	1910	
	400	50					$22,9^{+0,30}$	24,4	31,5	32,7	41,0	2230	
	500	50					$25,7^{+0,40}$	27,3	34,4	35,6	43,9	2590	
	630	50					$29,3^{+0,50}$	31,0	38,1	39,3	47,6	3050	
	800	50				2,7	$33,0^{+0,50}$	35,5	42,6	43,8	52,5	3680	
	1000	50				2,9	$38,0^{+0,50}$	40,5	47,6	48,8	57,9	4400	

Table 6 Cable type: XHKXS, N2XS2Y, XnHKXS, XHAKXS, NA2XS2Y, XnHAKXS, rated voltage 8,7/15 kV

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XHKXS, N2XS2Y, XnHKXS	35	16	minimum 0,3	4,5	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	17,3	18,3	26,6	880	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	18,6	19,6	27,9	1020	
	70	25					$9,6^{+0,20}$	10,8	20,0	21,0	29,3	1330	
	95	35					$11,5^{+0,20}$	12,7	21,9	22,9	31,2	1700	
	120	50					$12,9^{+0,25}$	14,1	23,3	24,3	32,6	2090	
	150	50					$14,5^{+0,30}$	15,8	25,0	26,0	34,3	2380	
	185	50					$16,0^{+0,30}$	17,3	26,5	27,5	35,8	2740	
	240	50					$18,5^{+0,30}$	19,8	29,0	30,0	38,3	3290	
	300	50					$20,5^{+0,30}$	21,8	31,0	32,0	40,3	3880	
	400	50					$23,5^{+0,30}$	25,0	34,3	35,5	43,8	4780	
	500	50					$26,5^{+0,40}$	28,1	37,4	38,6	46,9	5840	
	630	50				2,6	$30,3^{+0,40}$	31,9	41,2	42,4	50,9	7170	
	800	50				2,8	$34,6^{+0,50}$	37,1	46,4	47,6	56,5	8900	
	1000	50				2,9	$37,6^{+0,50}$	40,1	49,4	50,6	59,7	10790	
XHAKXS, NA2XS2Y, XnHAKXS	35	16	minimum 0,3	4,5	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	17,2	18,2	26,5	670	
	50	16					$8,15^{+0,10}$	9,2	18,4	19,4	27,7	730	
	70	25					$9,5^{+0,10}$	10,6	19,8	20,8	29,1	910	
	95	35					$11,3^{+0,20}$	12,5	21,7	22,7	31,0	1120	
	120	50					$12,5^{+0,20}$	13,7	22,9	23,9	32,2	1360	
	150	50					$14,2^{+0,20}$	15,4	24,6	25,6	33,9	1470	
	185	50					$15,8^{+0,20}$	17,0	26,2	27,2	35,5	1610	
	240	50					$17,8^{+0,10}$	18,9	28,1	29,1	37,4	1810	
	300	50					$20,0^{+0,30}$	21,3	30,5	31,5	39,8	2030	
	400	50					$22,9^{+0,30}$	24,4	33,7	34,9	43,2	2360	
	500	50					$25,7^{+0,40}$	27,3	36,6	37,8	46,1	2730	
	630	50				2,6	$29,3^{+0,50}$	31,0	40,3	41,5	50,0	3210	
	800	50				2,8	$33,0^{+0,50}$	35,5	44,8	46,0	54,9	3860	
	1000	50				2,9	$38,0^{+0,50}$	40,5	49,8	51,0	60,1	4580	

Table 7 Cable type: XHKXS, N2XS2Y, XnHKXS, XHAKXS, NA2XS2Y, XnHAKXS, rated voltage 12/20 kV

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XHKXS, N2XS2Y, XnHKXS	35	16	minimum 0,3	5,5	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	19,4	20,3	28,6	950	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	20,6	21,6	29,9	1100	
	70	25					$9,6^{+0,20}$	10,8	22,0	23,0	31,3	1410	
	95	35					$11,5^{+0,20}$	12,7	23,9	24,9	33,2	1790	
	120	50					$12,9^{+0,25}$	14,1	25,3	26,3	34,6	2180	
	150	50					$14,5^{+0,30}$	15,8	27,0	28,0	36,3	2470	
	185	50					$16,0^{+0,30}$	17,3	28,5	29,5	37,8	2840	
	240	50					$18,5^{+0,30}$	19,8	31,0	32,0	40,3	3400	
	300	50					$20,5^{+0,30}$	21,8	33,0	34,0	42,3	4000	
	400	50					$23,5^{+0,30}$	25,0	36,3	37,5	45,8	4910	
	500	50				2,6	$26,5^{+0,40}$	28,1	39,4	40,6	49,1	5990	
	630	50				2,7	$30,3^{+0,40}$	31,9	43,2	44,4	53,1	7330	
	800	50				2,9	$34,6^{+0,50}$	37,1	48,4	49,6	58,7	9090	
	1000	50				3,0	$37,6^{+0,50}$	40,1	51,4	52,6	61,9	10980	
XHAKXS, N2AXS2Y, XnHAKXS	35	16	minimum 0,3	5,5	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	19,2	20,2	28,5	740	
	50	16					$8,15^{+0,10}$	9,2	20,4	21,4	29,7	810	
	70	25					$9,5^{+0,10}$	10,6	21,8	22,8	31,1	990	
	95	35					$11,3^{+0,20}$	12,5	23,7	24,7	33,0	1200	
	120	50					$12,5^{+0,20}$	13,7	24,9	25,9	34,2	1450	
	150	50					$14,2^{+0,20}$	15,4	26,6	27,6	35,9	1570	
	185	50					$15,8^{+0,20}$	17,0	28,2	29,2	37,5	1710	
	240	50					$17,8^{+0,10}$	18,9	30,1	31,1	39,4	1920	
	300	50					$20,0^{+0,30}$	21,3	32,5	33,5	41,8	2140	
	400	50					$22,9^{+0,30}$	24,4	35,7	36,9	45,2	2490	
	500	50					$25,7^{+0,40}$	27,3	38,6	39,8	48,1	2860	
	630	50				2,6	$29,3^{+0,50}$	31,0	42,3	43,5	52,2	3370	
	800	50				2,8	$33,0^{+0,50}$	35,5	46,8	48,0	56,9	3550	
	1000	50				2,9	$38,0^{+0,50}$	40,5	51,8	53,0	62,3	4770	

Table 8 Cable type: XHKXS, N2XS2Y, XnHKXS, XHAKXS, NA2XS2Y, XnHAKXS, rated voltage 18/30 kV

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XHKXS, N2XS2Y, XnHKXS	50	16					$8,25^{+0,20}$	9,4	25,6	26,6	34,9	1320	
	70	25					$9,6^{+0,20}$	10,8	27,0	28,0	36,3	1640	
	95	35					$11,5^{+0,20}$	12,7	28,9	29,9	38,2	2030	
	120	50					$12,9^{+0,25}$	14,1	30,3	31,3	39,6	2440	
	150	50					$14,5^{+0,30}$	15,8	32,0	33,0	41,3	2740	
	185	50					$16,0^{+0,30}$	17,3	33,5	34,5	42,8	3120	
	240	50					$18,5^{+0,30}$	19,8	36,0	37,0	45,3	3700	
	300	50					$20,5^{+0,30}$	21,8	38,0	39,0	47,3	4310	
	400	50				2,6	$23,5^{+0,30}$	25,0	41,3	42,5	51,0	5260	
	500	50				2,7	$26,5^{+0,40}$	28,1	44,4	45,6	54,3	6360	
	630	50				2,9	$30,3^{+0,40}$	31,9	48,2	49,4	58,5	7750	
	800	50				3,1	$34,6^{+0,50}$	37,1	53,4	54,6	64,1	9550	
	1000	50				3,2	$37,6^{+0,50}$	40,1	56,4	57,6	67,3	10840	
XHAKXS, NA2XS2Y, XnHAKXS	50	16	minimum 0,3	8,0	0,3 - 0,6	2,5	$8,15^{+0,10}$	9,2	25,4	26,4	34,7	1030	
	70	25					$9,5^{+0,10}$	10,6	26,8	27,8	36,1	1220	
	95	35					$11,3^{+0,20}$	12,5	28,7	29,7	38,0	1450	
	120	50					$12,5^{+0,20}$	13,7	29,9	30,9	39,2	1700	
	150	50					$14,2^{+0,20}$	15,4	31,6	32,6	40,9	1830	
	185	50					$15,8^{+0,20}$	17,0	33,2	34,2	42,5	1990	
	240	50					$17,8^{+0,10}$	18,9	35,1	36,1	44,4	2200	
	300	50					$20,0^{+0,30}$	21,3	37,5	38,5	46,8	2450	
	400	50				2,6	$22,9^{+0,30}$	24,4	40,7	41,9	50,4	2830	
	500	50				2,7	$25,7^{+0,40}$	27,3	43,6	44,8	53,5	3250	
	630	50				2,8	$29,3^{+0,50}$	31,0	47,3	48,5	57,4	3770	
	800	50				3,0	$33,0^{+0,50}$	35,5	51,8	53,0	62,3	4470	
	1000	50				3,2	$38,0^{+0,50}$	40,5	56,8	58,0	67,7	5270	

Table 9 Cable type: XUHKXS, N2XS(F)2Y, XnUHKXS, XUHAKXS, NA2XS(F)2Y, XnUHAKXS, rated voltage 6/10 kV

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XUHKXS, N2XS(F)2Y, XnUHKXS,	35	16	minimum 0,3	3,4	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	15,2	16,2	25,1	810	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	16,4	17,5	26,3	950	
	70	25					$9,6^{+0,20}$	10,8	17,8	18,8	27,7	1250	
	95	35					$11,5^{+0,20}$	12,7	19,7	20,7	29,7	1610	
	120	50					$12,9^{+0,25}$	14,1	23,2	24,1	31,1	2010	
	150	50					$14,5^{+0,30}$	15,8	24,8	25,8	32,7	2290	
	185	50					$16,0^{+0,30}$	17,3	26,3	27,3	34,2	2640	
	240	50					$18,5^{+0,30}$	19,8	28,8	29,8	36,7	3190	
	300	50					$20,5^{+0,30}$	21,8	30,8	31,8	38,7	3770	
	400	50					$23,5^{+0,30}$	25,0	32,1	33,3	42,2	4660	
	500	50					$26,5^{+0,40}$	28,1	35,2	36,4	45,3	5710	
	630	50				2,6	$30,3^{+0,40}$	31,9	39,0	40,2	49,3	7020	
	800	50				2,8	$34,6^{+0,50}$	37,1	44,2	45,4	54,9	8740	
	1000	50				2,9	$37,6^{+0,50}$	40,1	47,2	48,4	58,1	10610	
XUHAKXS, NA2XS(F)2Y, XnUHAKXS,	35	16	minimum 0,3	3,4	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	15,0	16,0	24,9	600	
	50	16					$8,15^{+0,10}$	9,2	16,3	17,3	26,3	660	
	70	25					$9,5^{+0,10}$	10,6	17,6	18,6	27,6	840	
	95	35					$11,3^{+0,20}$	12,5	19,5	20,5	29,4	1040	
	120	50					$12,5^{+0,20}$	13,7	20,7	21,7	30,6	1270	
	150	50					$14,2^{+0,20}$	15,4	22,4	23,4	32,3	1380	
	185	50					$15,8^{+0,20}$	17,0	24,0	25,0	33,9	1520	
	240	50					$17,8^{+0,10}$	18,9	25,9	26,9	35,8	1710	
	300	50					$20,0^{+0,30}$	21,3	28,3	29,3	38,2	1920	
	400	50					$22,9^{+0,30}$	24,4	31,5	32,7	41,6	2240	
	500	50					$25,7^{+0,40}$	27,3	34,4	35,6	44,5	2600	
	630	50				2,6	$29,3^{+0,50}$	31,0	38,1	39,3	48,4	3060	
	800	50				2,7	$33,0^{+0,50}$	35,5	42,6	43,8	53,1	3690	
	1000	50				2,9	$38,0^{+0,50}$	40,5	47,6	48,8	58,5	4410	

Table 10 Cable type: XUHKXS, N2XS(F)2Y, XnUHKXS, XUHAKXS, NA2XS(F)2Y, XnUHAKXS, rated voltage 8,7/15 kV

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XUHKXS, N2XS(F)2Y, XnUHKXS	35	16	minimum 0,3	4,5	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	17,3	18,3	27,3	890	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	18,6	19,6	28,6	1030	
	70	25					$9,6^{+0,20}$	10,8	20,0	21,0	29,9	1340	
	95	35					$11,5^{+0,20}$	12,7	21,9	22,9	31,9	1710	
	120	50					$12,9^{+0,25}$	14,1	23,3	24,3	33,3	2100	
	150	50					$14,5^{+0,30}$	15,8	25,0	26,0	34,9	2390	
	185	50					$16,0^{+0,30}$	17,3	26,5	27,5	35,4	2750	
	240	50					$18,5^{+0,30}$	19,8	29,0	30,0	38,9	3300	
	300	50					$20,5^{+0,30}$	21,8	31,0	32,0	40,9	3890	
	400	50					$23,5^{+0,30}$	25,0	34,3	35,5	44,5	4790	
	500	50					$26,5^{+0,40}$	28,1	37,4	38,6	47,5	5850	
	630	50				2,7	$30,3^{+0,40}$	31,9	41,2	42,4	51,7	7190	
	800	50				2,8	$34,6^{+0,50}$	37,1	46,4	47,6	57,1	8910	
	1000	50				2,9	$37,6^{+0,50}$	40,1	49,4	50,6	60,3	10800	
XUHAKXS, NA2XS(F)2Y, XnUHAKXS	35	16	minimum 0,3	4,5	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	17,2	18,2	27,1	675	
	50	16					$8,15^{+0,10}$	9,2	18,4	19,4	28,5	740	
	70	25					$9,5^{+0,10}$	10,6	19,8	20,8	29,8	920	
	95	35					$11,3^{+0,20}$	12,5	21,7	22,7	31,6	1125	
	120	50					$12,5^{+0,20}$	13,7	22,9	23,9	32,8	1365	
	150	50					$14,2^{+0,20}$	15,4	24,6	25,6	34,5	1480	
	185	50					$15,8^{+0,20}$	17,0	26,2	27,2	36,1	1620	
	240	50					$17,8^{+0,10}$	18,9	28,1	29,1	38,0	1820	
	300	50					$20,0^{+0,30}$	21,3	30,5	31,5	40,4	2040	
	400	50					$22,9^{+0,30}$	24,4	33,7	34,9	43,8	2370	
	500	50					$25,7^{+0,40}$	27,3	36,6	37,8	46,7	2740	
	630	50				2,6	$29,3^{+0,50}$	31,0	40,3	41,5	50,6	3220	
	800	50				2,8	$33,0^{+0,50}$	35,5	44,8	46,0	55,5	3870	
	1000	50				3,0	$38,0^{+0,50}$	40,5	49,8	51,0	60,9	4610	

Table 11 **Cable type: XUHKXS, N2XS(F)2Y, XnUHKXS, XUHAKXS, NA2XS(F)2Y, XnHAKXS, rated voltage 12/20 kV**

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XUHKXS, N2XS(F)2Y, XnUHKXS	35	16	minimum 0,3	5,5	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	19,4	20,3	29,3	960	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	20,6	21,6	30,6	1110	
	70	25					$9,6^{+0,20}$	10,8	22,0	23,0	31,9	1420	
	95	35					$11,5^{+0,20}$	12,7	23,9	24,9	33,9	1800	
	120	50					$12,9^{+0,25}$	14,1	25,3	26,3	35,3	2190	
	150	50					$14,5^{+0,30}$	15,8	27,0	28,0	36,9	2480	
	185	50					$16,0^{+0,30}$	17,3	28,5	29,5	38,4	2850	
	240	50					$18,5^{+0,30}$	19,8	31,0	32,0	40,9	3410	
	300	50					$20,5^{+0,30}$	21,8	33,0	34,0	42,9	4010	
	400	50					$23,5^{+0,30}$	25,0	36,3	37,5	46,4	4920	
	500	50				2,6	$26,5^{+0,40}$	28,1	39,4	40,6	49,7	6000	
	630	50				2,7	$30,3^{+0,40}$	31,9	43,2	44,4	53,7	7340	
	800	50				2,9	$34,6^{+0,50}$	37,1	48,4	49,6	59,3	10000	
	1000	50				3,0	$37,6^{+0,50}$	40,1	51,4	52,6	62,5	10990	
XUHAKXS, N2AXS(F)2Y, XnUHAKXS	35	16	minimum 0,3	5,5	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	19,2	20,2	29,1	745	
	50	16					$8,15^{+0,10}$	9,2	20,4	21,4	30,5	815	
	70	25					$9,5^{+0,10}$	10,6	21,8	22,8	31,8	1000	
	95	35					$11,3^{+0,20}$	12,5	23,7	24,7	33,6	1210	
	120	50					$12,5^{+0,20}$	13,7	24,9	25,9	34,8	1460	
	150	50					$14,2^{+0,20}$	15,4	26,6	27,6	36,5	1580	
	185	50					$15,8^{+0,20}$	17,0	28,2	29,2	38,1	1720	
	240	50					$17,8^{+0,10}$	18,9	30,1	31,1	40,0	1930	
	300	50					$20,0^{+0,30}$	21,3	32,5	33,5	42,4	2150	
	400	50					$22,9^{+0,30}$	24,4	35,7	36,9	45,8	2500	
	500	50				2,6	$25,7^{+0,40}$	27,3	38,6	39,8	48,9	2880	
	630	50				2,7	$29,3^{+0,50}$	31,0	42,3	43,5	52,8	3380	
	800	50				2,9	$33,0^{+0,50}$	35,5	46,8	48,0	57,7	4400	
	1000	50				3,0	$38,0^{+0,50}$	40,5	51,8	53,0	62,9	4780	

Table 12 **Cable type: XUHKXS, N2XS(F)2Y, XnUHKXS, XUHAKXS, NA2XS(F)2Y, XnUHAKXS, rated voltage 18/30 kV**

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XUHKXS, N2XS(F)2Y, XnUHKXS	50	16					$8,25^{+0,20}$	9,4	25,6	26,6	35,6	1325	
	70	25					$9,6^{+0,20}$	10,8	27,0	28,0	36,9	1645	
	95	35					$11,5^{+0,20}$	12,7	28,9	29,9	38,9	2035	
	120	50					$12,9^{+0,25}$	14,1	30,3	31,3	40,3	2445	
	150	50					$14,5^{+0,30}$	15,8	32,0	33,0	41,9	2760	
	185	50					$16,0^{+0,30}$	17,3	33,5	34,5	43,4	3130	
	240	50					$18,5^{+0,30}$	19,8	36,0	37,0	45,9	3710	
	300	50					$20,5^{+0,30}$	21,8	38,0	39,0	47,9	4320	
	400	50				2,6	$23,5^{+0,30}$	25,0	41,3	42,5	51,6	5270	
	500	50				2,8	$26,5^{+0,40}$	28,1	44,4	45,6	55,1	6390	
	630	50				2,9	$30,3^{+0,40}$	31,9	48,2	49,4	59,1	7760	
	800	50				3,0	$34,6^{+0,50}$	37,1	53,4	54,6	64,5	9550	
	1000	50				3,2	$37,6^{+0,50}$	40,1	56,4	57,6	67,9	11470	
XUHAKXS, NA2XS(F)2Y, XnUHAKXS	50	16	minimum 0,3	8,0	0,3 - 0,6	2,5	$8,15^{+0,10}$	9,2	25,4	26,4	34,7	1035	
	70	25					$9,5^{+0,10}$	10,6	26,8	27,8	36,1	1230	
	95	35					$11,3^{+0,20}$	12,5	28,7	29,7	38,0	1460	
	120	50					$12,5^{+0,20}$	13,7	29,9	30,9	39,2	1710	
	150	50					$14,2^{+0,20}$	15,4	31,6	32,6	40,9	1840	
	185	50					$15,8^{+0,20}$	17,0	33,2	34,2	42,5	2000	
	240	50					$17,8^{+0,10}$	18,9	35,1	36,1	44,4	2210	
	300	50					$20,0^{+0,30}$	21,3	37,5	38,5	46,8	2460	
	400	50				2,6	$22,9^{+0,30}$	24,4	40,7	41,9	50,4	2840	
	500	50				2,7	$25,7^{+0,40}$	27,3	43,6	44,8	53,5	3260	
	630	50				2,9	$29,3^{+0,50}$	31,0	47,3	48,5	57,4	3790	
	800	50				3,0	$33,0^{+0,50}$	35,5	51,8	53,0	62,3	4480	
	1000	50				3,2	$38,0^{+0,50}$	40,5	56,8	58,0	67,7	5280	

Table 13 **Cable type: XRUHKXS, N2XS(FL)2Y, XnRUHKXS, XRUHAKXS, NA2XS(FL)2Y, XnRUHAKXS, rated voltage 6/10 kV**

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XRUHKXS, N2XS(FL)2Y, XnRUHKXS,	35	16	minimum 0,3	3,4	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	15,2	16,2	25,8	860	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	16,4	17,5	27,1	1000	
	70	25					$9,6^{+0,20}$	10,8	17,8	18,8	28,5	1300	
	95	35					$11,5^{+0,20}$	12,7	19,7	20,7	30,4	1680	
	120	50					$12,9^{+0,25}$	14,1	23,2	24,1	31,8	2070	
	150	50					$14,5^{+0,30}$	15,8	24,8	25,8	33,5	2350	
	185	50					$16,0^{+0,30}$	17,3	26,3	27,3	35,0	2710	
	240	50					$18,5^{+0,30}$	19,8	28,8	29,8	37,5	3260	
	300	50					$20,5^{+0,30}$	21,8	30,8	31,8	39,5	3850	
	400	50					$23,5^{+0,30}$	25,0	32,1	33,3	43,0	4740	
	500	50					$26,5^{+0,40}$	28,1	35,2	36,4	46,1	5800	
	630	50				2,6	$30,3^{+0,40}$	31,9	39,0	40,2	50,1	7120	
	800	50				2,8	$34,6^{+0,50}$	37,1	44,2	45,4	55,7	8850	
	1000	50				2,9	$37,6^{+0,50}$	40,1	47,2	48,4	58,9	10730	
XRUHAKXS, NA2XS(FL)2Y, XnRUHAKXS,	35	16	minimum 0,3	3,4	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	15,0	16,0	25,7	650	
	50	16					$8,15^{+0,10}$	9,2	16,3	17,3	26,9	710	
	70	25					$9,5^{+0,10}$	10,6	17,6	18,6	28,4	890	
	95	35					$11,3^{+0,20}$	12,5	19,5	20,5	30,2	1100	
	120	50					$12,5^{+0,20}$	13,7	20,7	21,7	31,4	1330	
	150	50					$14,2^{+0,20}$	15,4	22,4	23,4	33,1	1450	
	185	50					$15,8^{+0,20}$	17,0	24,0	25,0	34,7	1580	
	240	50					$17,8^{+0,10}$	18,9	25,9	26,9	36,6	1780	
	300	50					$20,0^{+0,30}$	21,3	28,3	29,3	39,0	1990	
	400	50					$22,9^{+0,30}$	24,4	31,5	32,7	42,4	2320	
	500	50					$25,7^{+0,40}$	27,3	34,4	35,6	45,3	2690	
	630	50				2,6	$29,3^{+0,50}$	31,0	38,1	39,3	49,2	3160	
	800	50				2,7	$33,0^{+0,50}$	35,5	42,6	43,8	53,9	3790	
	1000	50				2,9	$38,0^{+0,50}$	40,5	47,6	48,8	59,3	4520	

Table 14 Cable type: XRUHKXS, N2XS(FL)2Y, XnRUHKXS, XRUHAKXS, NA2XS(FL)2Y, XnRUHAKXS, rated voltage 8,7/15 kV

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XRUHKXS, N2XS(FL)2Y, XnRUHKXS	35	16	minimum 0,3	4,5	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	17,3	18,3	28,0	940	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	18,6	19,6	29,3	1090	
	70	25					$9,6^{+0,20}$	10,8	20,0	21,0	30,7	1390	
	95	35					$11,5^{+0,20}$	12,7	21,9	22,9	32,6	1770	
	120	50					$12,9^{+0,25}$	14,1	23,3	24,3	34,0	2170	
	150	50					$14,5^{+0,30}$	15,8	25,0	26,0	35,7	2450	
	185	50					$16,0^{+0,30}$	17,3	26,5	27,5	37,2	2820	
	240	50					$18,5^{+0,30}$	19,8	29,0	30,0	39,7	3380	
	300	50					$20,5^{+0,30}$	21,8	31,0	32,0	41,7	3970	
	400	50					$23,5^{+0,30}$	25,0	34,3	35,5	45,2	4880	
	500	50				2,6	$26,5^{+0,40}$	28,1	37,4	38,6	48,3	5940	
	630	50				2,7	$30,3^{+0,40}$	31,9	41,2	42,4	52,5	7290	
	800	50				2,9	$34,6^{+0,50}$	37,1	46,4	47,6	58,1	9040	
	1000	50				3,0	$37,6^{+0,50}$	40,1	49,4	50,6	60,3	10930	
XRUHAKXS, NA2XS(FL)2Y, XnRUHAKXS	35	16	minimum 0,3	4,5	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	17,2	18,2	27,9	730	
	50	16					$8,15^{+0,10}$	9,2	18,4	19,4	29,1	790	
	70	25					$9,5^{+0,10}$	10,6	19,8	20,8	30,6	980	
	95	35					$11,3^{+0,20}$	12,5	21,7	22,7	32,4	1190	
	120	50					$12,5^{+0,20}$	13,7	22,9	23,9	33,6	1430	
	150	50					$14,2^{+0,20}$	15,4	24,6	25,6	35,3	1550	
	185	50					$15,8^{+0,20}$	17,0	26,2	27,2	36,9	1690	
	240	50					$17,8^{+0,10}$	18,9	28,1	29,1	38,8	1890	
	300	50					$20,0^{+0,30}$	21,3	30,5	31,5	41,2	2120	
	400	50					$22,9^{+0,30}$	24,4	33,7	34,9	44,6	2460	
	500	50					$25,7^{+0,40}$	27,3	36,6	37,8	47,5	2830	
	630	50				2,6	$29,3^{+0,50}$	31,0	40,3	41,5	51,4	3320	
	800	50				2,8	$33,0^{+0,50}$	35,5	44,8	46,0	56,3	3970	
	1000	50				3,0	$38,0^{+0,50}$	40,5	49,8	51,0	61,7	4730	

Table 15 **Cable type: XRUHKXS, N2XS(FL)2Y, XnRUHKXS, XRUHAKXS, NA2XS(FL)2Y, XnRHAKXS, rated voltage 12/20 kV**

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XRUHKXS, N2XS(FL)2Y, XnRUHKXS	35	16	minimum 0,3	5,5	0,3 – 0,6	2,5	$7,0^{+0,15}$	8,2	19,4	20,3	30,0	1020	to be agreed on between the purchaser and the supplier
	50	16					$8,25^{+0,20}$	9,4	20,6	21,6	31,3	1170	
	70	25					$9,6^{+0,20}$	10,8	22,0	23,0	32,7	1470	
	95	35					$11,5^{+0,20}$	12,7	23,9	24,9	34,6	1860	
	120	50					$12,9^{+0,25}$	14,1	25,3	26,3	36,0	2260	
	150	50					$14,5^{+0,30}$	15,8	27,0	28,0	37,7	2550	
	185	50					$16,0^{+0,30}$	17,3	28,5	29,5	39,2	2920	
	240	50					$18,5^{+0,30}$	19,8	31,0	32,0	41,7	3490	
	300	50					$20,5^{+0,30}$	21,8	33,0	34,0	43,7	4090	
	400	50					$23,5^{+0,30}$	25,0	36,3	37,5	47,2	5010	
	500	50				2,6	$26,5^{+0,40}$	28,1	39,4	40,6	50,5	6090	
	630	50				2,7	$30,3^{+0,40}$	31,9	43,2	44,4	54,5	7440	
	800	50				2,9	$34,6^{+0,50}$	37,1	48,4	49,6	60,1	9200	
	1000	50				3,0	$37,6^{+0,50}$	40,1	51,4	52,6	63,3	11110	
XRUHAKXS, N2AXS(FL)2Y, XnRUHAKXS	35	16	minimum 0,3	5,5	0,3 - 0,6	2,5	$6,9^{+0,10}$	8,0	19,2	20,2	29,9	810	
	50	16					$8,15^{+0,10}$	9,2	20,4	21,4	31,1	870	
	70	25					$9,5^{+0,10}$	10,6	21,8	22,8	32,6	1060	
	95	35					$11,3^{+0,20}$	12,5	23,7	24,7	34,4	1280	
	120	50					$12,5^{+0,20}$	13,7	24,9	25,9	35,6	1520	
	150	50					$14,2^{+0,20}$	15,4	26,6	27,6	37,3	1650	
	185	50					$15,8^{+0,20}$	17,0	28,2	29,2	38,9	1800	
	240	50					$17,8^{+0,10}$	18,9	30,1	31,1	40,8	2000	
	300	50					$20,0^{+0,30}$	21,3	32,5	33,5	43,2	2230	
	400	50					$22,9^{+0,30}$	24,4	35,7	36,9	46,6	2580	
	500	50				2,6	$25,7^{+0,40}$	27,3	38,6	39,8	49,7	2980	
	630	50				2,7	$29,3^{+0,50}$	31,0	42,3	43,5	53,6	3480	
	800	50				2,9	$33,0^{+0,50}$	35,5	46,8	48,0	58,5	4150	
	1000	50				3,0	$38,0^{+0,50}$	40,5	51,8	53,0	63,7	4900	

Table 16 Cable type: XRUHKXS, N2XS(FL)2Y, XnRUHKXS, XRUHAKXS, NA2XS(FL)2Y, XnRUHAKXS, rated voltage 18/30 kV

Cable type	Cross-section		Nominal thickness				Layer diameter					Cable weight	Lengths
	Phase conductor	Metallic screen	Conductor screen	Insulation XLPE	Insulation screen	Outer sheath	Conductor diameter	OD conductor screen	OD insulation	OD insulation screen	Cable diameter		
-	mm^2		mm				mm					kg/m	m
1	2	3	4	5	6	7	8	9	10	11	12	13	14
XRUHKXS, N2XS(FL)2Y, XnRUHKXS	50	16	minimum 0,3	8,0	0,3 - 0,6	2,5	$8,25^{+0,20}$	9,4	25,6	26,6	36,4	1400	
	70	25					$9,6^{+0,20}$	10,8	27,0	28,0	37,7	1710	
	95	35					$11,5^{+0,20}$	12,7	28,9	29,9	39,6	2110	
	120	50					$12,9^{+0,25}$	14,1	30,3	31,3	41,0	2520	
	150	50					$14,5^{+0,30}$	15,8	32,0	33,0	42,7	2830	
	185	50					$16,0^{+0,30}$	17,3	33,5	34,5	44,2	3210	
	240	50					$18,5^{+0,30}$	19,8	36,0	37,0	46,7	3790	
	300	50				2,6	$20,5^{+0,30}$	21,8	38,0	39,0	48,9	4430	
	400	50				2,7	$23,5^{+0,30}$	25,0	41,3	42,5	52,6	5390	
	500	50				2,8	$26,5^{+0,40}$	28,1	44,4	45,6	55,9	6500	
	630	50				2,9	$30,3^{+0,40}$	31,9	48,2	49,4	59,9	7870	
	800	50				3,1	$34,6^{+0,50}$	37,1	53,4	54,6	65,5	9680	
	1000	50				3,2	$37,6^{+0,50}$	40,1	56,4	57,6	68,7	11610	
XRUHAKXS, NA2XS(FL)2Y, XnRUHAKXS	50	16	minimum 0,3	8,0	0,3 - 0,6	2,5	$8,15^{+0,10}$	9,2	25,4	26,4	36,1	1100	
	70	25					$9,5^{+0,10}$	10,6	26,8	27,8	37,6	1300	
	95	35					$11,3^{+0,20}$	12,5	28,7	29,7	39,4	1530	
	120	50					$12,5^{+0,20}$	13,7	29,9	30,9	40,6	1780	
	150	50					$14,2^{+0,20}$	15,4	31,6	32,6	42,3	1920	
	185	50					$15,8^{+0,20}$	17,0	33,2	34,2	43,9	2080	
	240	50					$17,8^{+0,10}$	18,9	35,1	36,1	45,8	2300	
	300	50					$20,0^{+0,30}$	21,3	37,5	38,5	48,2	2550	
	400	50				2,7	$22,9^{+0,30}$	24,4	40,7	41,9	52,0	2960	
	500	50				2,8	$25,7^{+0,40}$	27,3	43,6	44,8	55,1	3380	
	630	50				2,9	$29,3^{+0,50}$	31,0	47,3	48,5	59,0	3900	
	800	50				3,0	$33,0^{+0,50}$	35,5	51,8	53,0	63,7	4600	
	1000	50				3,2	$38,0^{+0,50}$	40,5	56,8	58,0	69,1	5410	

10. ELECTRICAL DATA

Resistance of:

a) Phase conductor

Cross-section	Copper		Aluminium	
	20^{0}C D.C.	90^{0}C A.C.	20^{0}C D.C.	90^{0}C A.C.
[mm^2]	[Ω/km]		[Ω/km]	
35	0,524	0,668	0,868	0,987
50	0,387	0,496	0,641	0,825
70	0,268	0,345	0,443	0,571
95	0,193	0,249	0,320	0,413
120	0,153	0,198	0,253	0,328
150	0,124	0,163	0,206	0,268
185	0,0991	0,131	0,164	0,215
240	0,0754	0,101	0,125	0,165
300	0,0601	0,083	0,100	0,133
400	0,0470	0,066	0,0778	0,107
500	0,0366	0,053	0,0605	0,085
630	0,0283	0,043	0,0469	0,068
800	0,0221	0,035	0,0367	0,055
1000	0,0176	0,030	0,0291	0,046

Conversion of conductor resistance values for deviating ambient temperatures:

for copper conductors: $R\delta = R_{20} * \frac{234,5 + \delta}{254,5}$

for aluminium conductors: $R\delta = R_{20} * \frac{228 + \delta}{248}$

δ = conductor temperature [^{0}C]
R_{20} = conductor resistance at 20^{0}C [Ω/km]
Rδ = conductor resistance at δ ^{0}C [Ω/km]

b) Metallic screen

Metallic screen, nominal cross – section [mm^2]	Metallic screen resistance [Ω/km]	
	20^{0}C D.C.	80^{0}C A.C.
10*	1,75	2,17
16*	1,06	1,32
25*	0,72	0,89
35*	0,51	0,63
50*	0,35	0,43

* Options

Short circuit current carrying capacity

The highest permissible values of 1 second short circuit current:

- **cable phase conductors:** determined for the highest permissible conductor temperature at short-circuit, j. e. 250^{0}C and for initial short-circuit temperature 90^{0}C and the maximum duration of 5 seconds, given in Table 17.

Table 17

Phase conductor, cross-section [mm^2]	Maximum short-circuit current on the conductor during 1 sec, [kA] Conductor temperature before the short-circuit 90^{0}C	
	Copper conductor	Aluminium conductor
35	5,0	3,3
50	7,2	4,7
70	10,0	6,6
95	13,6	8,9
120	17,2	11,3
150	21,5	14,1
185	26,5	17,4
240	34,3	22,6
300	42,9	28,2
400	57,2	37,6
500	71,5	47,0
630	90,1	59,2
800	114,4	75,0
1000	143,0	94,0

Maximum short currents due to thermal restrictions.

The thermal energy developed during a short-circuit is determined by the short-circuit magnitude and duration. For design purposes, an equivalent short-circuit current with a duration of 1 sec is used according to formula below. This formula is valid a short-circuit duration of 0,2 to 5,0 sec.

$$I_{sh} = \frac{I1}{\sqrt{tsh}}$$

I_{sh} = short-circuit current during time t_{sh} [kA]
I_1 = short-circuit current during 1 second [kA]. See the 1_{sec} value in Table 17 for the conductor and in Table 18 for the metallic screen.
t_{sh} = short-circuit duration [sec]

- **metallic screens:** determined for the greatest permissible metallic screen temperature 350^{0}C and for the short-circuit initial temperature 90^{0}C and maximum short-circuit duration 5 seconds, is given in Table 18.

Table 18

Metallic screen, cross-section [mm^2]	Permissible value for 1 sec. fault current [kA]
10	2,6
16	3.7
25	5.3
35	7,1
50	9,8

The admissible density of 1 seconds phase conductor fault current, determined for the highest permissible conductor temperature 250^{0}C and for various values of initial short-circuit temperature and maximum short-circuit duration 5 second is given in Table 19.

Table 19

Conductor temperature before short-circuit [^{0}C]	Admissible 1 sec. fault current density [A/mm^2] in conductors	
	Copper conductor	Aluminium conductor
90	143	94
80	149	98
70	154	102
65	157	104
60	159	105
50	165	109
40	170	113
20	181	120

Dynamic forces at short circuits

Apart from the thermal stress in case of short-circuit, the dynamic stresses I cables and accessories must be taken into consideration.
The dynamic effect of parallel conductors carrying current is responsible for the dynamic stress.
The dynamic forces between conductors, can be calculated as:

$$F = \frac{0,2}{s} * I^2_{peak}$$

I_{pek} = 2,5 I_{sh} [kA]
I_{sh} = Short-current [kA] (r.m.s.)
s = Centre to centre spacing between conductors [m]
F = maximum force [N/m]

Current carrying capacity of cables

For cables to be buried and suspended overhead: given in Table 20.
Current carrying capacity values determined with the following assumptions:

Buried in ground:

- Laying depth - 0,7 m
- Soil temperature at laying depth - 20^0C
- Loading - 0,7
- Specific ground thermal stability in damp area - 1,0 K*m/W
- Specific ground thermal stability in dry areas - 2,5 K*m/W

Calculation factors "***fz***" for other soil temperatures and a.m. laying conditions as given in the below table (the Table 20 value to be multiplied by the "***fz***" factor)

Table 20

Soil temperature [^{0}C]	5	10	15	20	25	30
fz	1,07	1,05	1,02	1,0	0,98	0,95

Cables suspended in air

- Ambient temperature: + 25^0C

Calculation factors "***fp***" for other air temperatures and the above laying conditions as given in the below table (Table 21. values should be the multiplied by the "fp" factor).

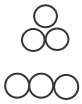
Table 21

Air temperature, [^{o}C]	10	15	20	25	30	35	40	45	50
fp	1,11	1,07	1,04	1,0	0,96	0,92	0,88	0,83	0,78

Table 22.

Nominal conductor cross-section [mm^2]	Prolonged ampacity of cables voltage 6/10kV laying: [A]							
	in air				in ground			
	having conductors							
	Copper		Aluminium		Copper		Aluminium	
								
35	211	327	160	183	192	255	145	165
50	245	290	190	225	220	250	170	195
70	305	360	235	280	270	305	210	235
95	370	435	285	340	320	360	250	280
120	425	500	330	395	365	405	285	320
150	480	560	375	440	405	440	315	350
185	550	635	430	505	455	495	360	395
240	645	745	510	595	530	565	415	455
300	735	845	580	680	595	625	470	505
400	850	935	675	770	665	675	530	560
500	960	1045	775	870	740	745	600	620

630	1070	1165	890	1000	805	810	665	690
800	1200	1310	1010	1235	880	885	745	770
1000	1315	1415	1130	1425	940	945	810	840

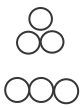


- triangular arrangement cables touching each other

- flat arrangement cables; inter cable spacing equal to outer cable diameter (suspended in air) or 7cm (buried)

Table 23.

Nominal conductor cross-section [mm^2]	Current carrying capacity of cables voltage 8,7/15kV; 12/20kV; 18/30kV laying: [A]							
	in air				in ground			
	having conductors							
	Copper		Aluminium		Copper		Aluminium	
								
35	200	240	160	187	189	210	142	172
50	250	290	190	225	225	250	175	195
70	310	360	240	280	275	305	210	235
95	370	435	290	340	325	360	250	280
120	430	500	335	395	370	405	285	320
150	485	560	375	440	410	445	320	355
185	555	640	430	500	465	500	360	395
240	650	745	515	595	535	570	420	455
300	745	845	585	680	600	635	475	510
400	850	940	680	770	675	685	540	565
500	965	1050	775	870	750	755	605	630
630	1075	1170	890	1005	820	825	675	700
800	1205	1315	1015	1140	890	900	750	780
1000	1325	1445	1135	1275	955	960	820	850

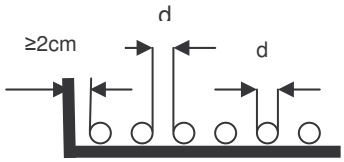
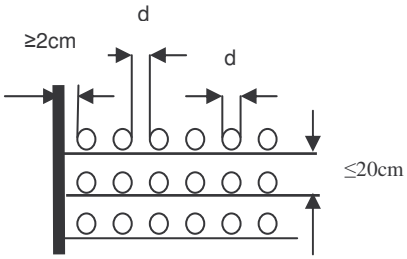
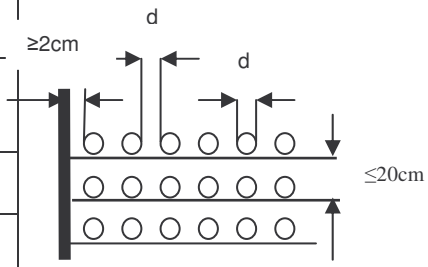
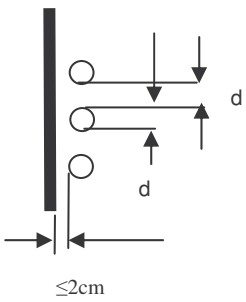


- triangular arrangement cables touching each other

- flat arrangement cables; inter cable spacing equal to outer cable diameter (suspended in air) or 7cm (buried)

Calculate factor f_1 for the cable laying in air

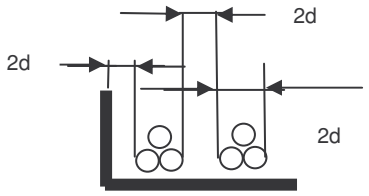
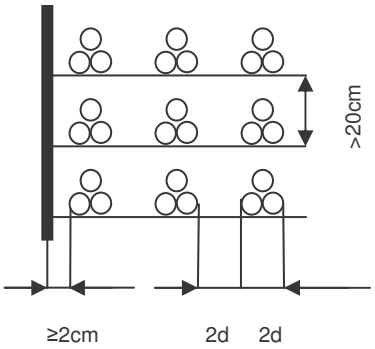
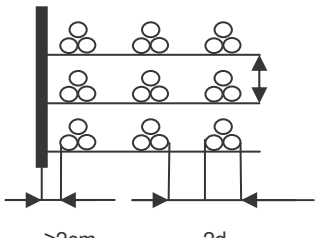
Table 24

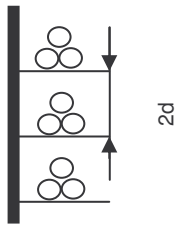
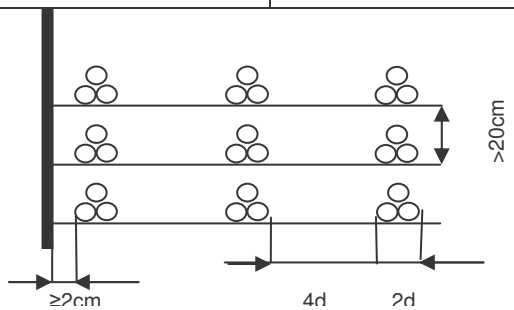
Laying system		Flat laying, inter-cable interstice “d” – diameter of the cable, distance from wall = 2cm			
No of system laying beside		1	2	3	
Cable laying on the floor		0,92	0,89	0,88	
Cable laying of the cable rack (weak air circulation)	Number of the rack				
	1	0,92	0,89	0,88	
	2	0,87	0,84	0,83	
	3	0,84	0,82	0,81	
	6	0,82	0,80	0,79	
Cable laying of the cable ladder (Batter air circulation)	Number of the grate				
	1	1,00	0,97	0,96	
	2	0,97	0,94	0,93	
	3	0,96	0,93	0,92	
	6	0,94	0,91	0,90	
System numbers, first under second		1	2	3	
Cable laying on the brackets or fixed to the wall		0,94	0,91	0,89	
In the small rooms or when cables is grade concentrate, temperature of the air increase, when use f_3					

factor from a Table 23

Calculate factor f_2 for the cable laying in air

Table 25

Laying system		Flat laying, inter-cable interstice “d” – diameter of the cable, distance from wall = 2cm			
No of system laying beside		1	2	3	
Cable laying on the floor		0,95	0,90	0,88	
Cable laying of the cable rack (weak air circulation)	Number of the rack				
	1	0,95	0,90	0,88	
	2	0,90	0,85	0,83	
	3	0,88	0,83	0,81	
	6	0,86	0,81	0,79	
Cable laying of the cable ladder (Batter air circulation)	Number of the grate				
	1	1,00	0,98	0,96	
	2	1,00	0,95	0,93	
	3	1,00	0,94	0,92	
	6	1,00	0,93	0,90	

System numbers, first under second	1 2 3	
Cable laying on the brackets or fixed to the wall	0,89 0,86 0,84	
Cable fixed system without reduced current rating		
In the small rooms or when cables is grade concentrate, temperature of the air increase, when use f_3 factor from a Table 23		

Cable capacitance

Capacitances for different types of cables and parameters associated with capacitance for f=50Hz are shown in table 26.

Formula for capacitance:

$$C = \frac{\varepsilon}{18 \ln\left\{\frac{Dins}{Dscr}\right\}} \quad \mu F/km$$

Where: ε - relative permittivity of the insulation
D_{ins} - external diameter of the insulation [mm]
D_{scr} - diameter of the conductor including screen [mm]
ε_{XLPE} - 2,3

Formula for charging current:

The capacitance of the cable causes a current to flow from the source to ground. This charging current (I_c) is independent of the load current and is usually very small when compared to the load current. Charging current of a cable is dependent on its operating frequency, operating voltage and length.

$$I_c = 2 \pi f C U_0 \ell \quad [A/km]$$

Where - f = frequency [Hz]
C = capacitance [μF/km]
U_0 = voltage [V]

ℓ = cable length [km]

Table 26

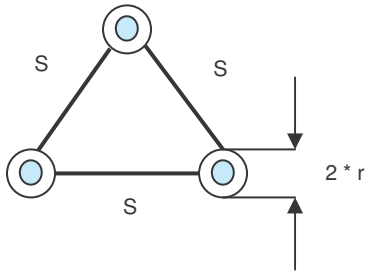
Phase conductor cross-section	Voltage	Capacitance	Capacitive reactance	Charging current	Earth fault capacitive current
[mm^2]	[V]	[µF/km]	[kΩ/km]	[A/km]	[A/km]
1	2	3	4	5	6
35	6/10	0,22	13,89	0,41	1,36
50		0,25	12,74	0,47	1,41
70		0,28	11,37	0,53	1,59
95		0,31	10,27	0,58	1,74
120		0,34	9,37	0,64	1,92
150		0,37	8,61	0,70	2,10
185		0,40	7,96	0,75	2,25
240		0,44	7,24	0,83	2,49
300		0,48	6,63	0,90	2,70
400		0,55	5,79	1,03	3,06
500		0,60	5,31	1,13	3,39
630		0,66	4,83	1,24	3,72
800		0,74	4,30	1,39	4,17
1000		0,82	3,88	1,54	4,62
35	8,7/15	0,19	16,59	0,61	1,69
50		0,21	15,17	0,57	1,71
70		0,23	13,85	0,63	1,89
95		0,26	12,25	0,71	2,13
120		0,27	11,80	0,74	2,22
150		0,29	10,98	0,79	2,37
185		0,32	9,95	0,87	2,61
240		0,35	9,10	0,96	2,88
300		0,38	8,38	1,03	3,09
400		0,43	7,41	1,17	3,51
500		0,47	6,78	1,28	3,84
630		0,52	6,12	1,42	4,26
800		0,59	5,40	1,61	4,83
1000		0,64	4,98	1,75	5,25
35	12/20	0,16	18,15	0,57	1,83
50		0,18	17,70	0,68	2,04
70		0,20	15,92	0,75	2,25
95		0,22	14,48	0,83	2,49
120		0,23	13,85	0,87	2,61
150		0,25	12,74	0,94	2,82
185		0,27	11,80	1,02	3,06
240		0,30	10,62	1,13	3,39
300		0,32	9,95	1,21	3,63
400		0,36	8,85	1,36	4,08
500		0,40	7,96	1,50	4,50
630		0,44	7,24	1,66	4,98
800		0,49	6,50	1,85	5,55
1000		0,54	5,90	2,03	6,09
50	18/30	0,14	22,75	0,79	2,37
70		0,15	21,23	0,85	2,55
95		0,17	18,73	0,96	2,88
120		0,18	17,96	1,02	3,06
150		0,19	16,76	1,07	3,21

185		0,20	15,92	1,13	3,39
240		0,22	14,48	1,24	3,72
300		0,24	13,27	1,36	4,08
400		0,27	11,80	1,53	4,59
500		0,29	10,98	1,64	4,92
630		0,32	9,95	1,81	5,43
800		0,35	9,10	1,98	5,94
1000		0,38	8,38	2,15	6,45

Cable inductance

Inductance and reactance values for the respective cable types with different laying methods are given in Tables 27 to 32

Formula for inductance:



$$L = 0{,}05 + 0{,}2 \ln\left(\frac{K * S}{r}\right) \quad [mH/km]$$

Were - trefoil formation: $K = 1$
flat formation: $K = 1{,}26$
S = distance between conductor axes [mm]
r = conductor radius [mm]

Table 27

Phase conductor nominal cross-section [mm^2]	Inductance [mH/km] of cable rated voltage			
	6/10kV	8,7/15	12/20	18/30
	Cable arrangement in 			
1	2	3	4	5
35	0,44	0,46	0,47	0,51
50	0,42	0,44	0,45	0,48
70	0,40	0,42	0,43	0,46
95	0,39	0,40	0,41	0,44
120	0,37	0,38	0,39	0,42
150	0,35	0,36	0,37	0,40
185	0,34	0,35	0,37	0,39
240	0,33	0,34	0,35	0,38
300	0,32	0,33	0,34	0,36
400	0,30	0,31	0,32	0,34
500	0,29	0,30	0,31	0,33

630	0,29	0,29	0,30	0,32
800	0,28	0,29	0,29	0,31
1000	0,27	0,28	0,28	0,30

Table 28

Phase conductor nominal cross-section [mm^2]	Inductance [mH/km] of cable rated voltage			
	6/10kV	8,7/15	12/20	18/30
	Cable arrangement in flat formation  inter - cable interstice equal to cable diameter			
1	2	3	4	5
35	0,64	0,66	0,66	0,70
50	0,62	0,64	0,64	0, 68
70	0,60	0,60	0,62	0,64
95	0,58	0,58	0,60	0,62
120	0,55	0,57	0,58	0,60
150	0,53	0,56	0,56	0,58
185	0,53	0,54	0,55	0,58
240	0,52	0,53	0,54	0,56
300	0,50	0,51	0,53	0,55
400	0,49	0,50	0,51	0,52
500	0,48	0,49	0,49	0,52
630	0,47	0,48	0,48	0,51
800	0,47	0,47	0,48	0,49
1000	0,46	0,46	0,47	0,49

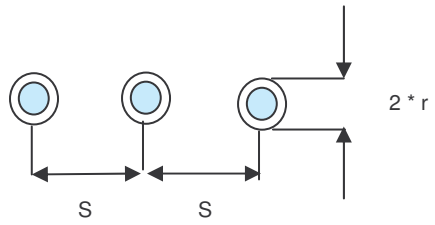
Table 29.

Phase conductor nominal cross-section [mm^2]	Inductance [mH/km] of cable rated voltage			
	6/10kV	8,7/15	12/20	18/30
	Cable arrangement in flat formation, inter - cable interstice 70mm			
1	2	3	4	5
35	0,74	0,75	0,76	0,76
50	0,72	0,73	0,73	0, 74
70	0,70	0,70	0,71	0,72
95	0,67	0,68	0,68	0,69
120	0,65	0,66	0,66	0,67
150	0,63	0,63	0,64	0,65
185	0,61	0,62	0,62	0,63
240	0,60	0,60	0,60	0,61
300	0,57	0,58	0,58	0,59
400	0,55	0,56	0,56	0,57
500	0,53	0,54	0,54	0,55
630	0,52	0,52	0,52	0,53
800	0,49	0,49	0,50	0,51

1000	0,47	0,48	0,48	0,49

Inductive reactance:

Formula for inductive reactance:



$$X_L = 2\,\pi\,f * \frac{L}{1000} \quad [\Omega/km]$$

Where - f = frequency [Hz]
L = inductance [mH/km]

Capacitive reactance:

Formula for capacitive reactance;

The capacitive reactance *(X_c)* of a cable systems is dependent on the capacitance of the cable and its operating frequency.

$$X_c = \frac{1}{2\pi f C} \quad [\Omega/km]$$

Where - f = frequency [Hz]
C = capacitance [µF/km]

Total reactance:

Formula for total reactance:

The total cable reactance *(X)* is the vector sum of the inductive reactance and the capacitive reactance of the cable.

$$X = X_L + X_c \quad [\Omega/km]$$

Table 30

Phase conductor nominal cross-section [mm^2]	Inductive reactance [Ω/km] of cable rated voltage			
	6/10kV	8,7/15	12/20	18/30
	Cable arrangement in 			
1	2	3	4	5
35	0,133	0,144	0,147	0,157
50	0,132	0,138	0,141	0,151
70	0,122	0,132	0,135	0,144
95	0,122	0,126	0,129	0,138
120	0,116	0,119	0,122	0,132
150	0,110	0,113	0,116	0,126
185	0,107	0,110	0,116	0,122
240	0,104	0,107	0,110	0,119
300	0,100	0,104	0,107	0,113
400	0,094	0,097	0,100	0,107
500	0,091	0,094	0,097	0,104
630	0,091	0,091	0,094	0,100
800	0,088	0,091	0,091	0,097
1000	0,085	0,088	0,087	0,094

Table 31

Phase conductor nominal cross-section [mm^2]	Inductive reactance [Ω/km] of cable rated voltage			
	6/10kV	8,7/15	12/20	18/30
	Cable arrangement in  inter - cable interstice equal to cable diameter			
1	2	3	4	5
35	0,202	0,205	0,207	0,219
50	0,195	0,201	0,201	0, 212
70	0,188	0,188	0,195	0,201
95	0,182	0,182	0,188	0,195
120	0,172	0,179	0,182	0,188
150	0,166	0,176	0,176	0,182
185	0,166	0,170	0,173	0,182
240	0,163	0,166	0,170	0,176
300	0,157	0,160	0,166	0,173
400	0,154	0,157	0,160	0,163
500	0,151	0,154	0,154	0,163
630	0,148	0,151	0,151	0,160
800	0,148	0,148	0,151	0,154
1000	0,144	0,144	0,148	0,154

Table 32

Phase conductor nominal cross-section [mm^2]	Inductive reactance [Ω/km] of cable rated voltage			
	6/10kV	8,7/15	12/20	18/30
	Cable arrangement in flat formation, inter - cable interstice 70mm			
1	2	3	4	5
35	0,232	0,236	0,237	0,242
50	0,226	0,229	0,230	0, 234
70	0,220	0,220	0,222	0,225
95	0,210	0,213	0,214	0,217
120	0,204	0,207	0,208	0,211
150	0,198	0,199	0,200	0,203
185	0,192	0,195	0,196	0,199
240	0,188	0,189	0,190	0,193
300	0,180	0,181	0,182	0,185
400	0,174	0,175	0,176	0,179
500	0,167	0,168	0,169	0,172
630	0,162	0,164	0,165	0,168
800	0,154	0,155	0,156	0,159
1000	0,149	0,150	0,151	0,154

Impedances

Impedance values for respective cable types, at different configuration at symmetric three-phase arrangement are given in Table 33

Table 33

Phase conductor cross-section [mm^2]	Impedance [Ω/km] at alternating current (50Hz) and conductor temperature 90^{0}C of cables with aluminium conductors rated voltage 6/10kV; 8,7/15kV; 12/20kV; 18/30kV		
	Cable arrangement		
			
	Cable interstices	Distance between cables	
		Interstice equal to cable diameter	Interstice 70 mm
1	2	3	4
35	0,967	0.982	0,990
50	0,833	0,846	0,854
70	0,582	0,598	0,610
95	0,429	0,449	0,463
120	0,345	0,369	0,384
150	0,287	0,316	0,329
185	0,237	0,270	0,287
240	0,192	0,232	0245
300	0,164	0,207	0,221
400	0,140	0,187	0,199
500	0,122	0,172	0,187

630	0,110	0,161	0,174
800	0,102	0,157	0,165
1000	0,094	0,151	0,157

Table 34

Phase conductor cross-section [mm^2]	Impedance [Ω/km] at alternating current (50Hz) and conductor temperature 90^{0}C of cables with copper conductors rated voltage 6/10kV; 8,7/15kV; 12/20kV; 18/30kV		
	Cable arrangement		
			
	Cable interstices	Distance between cables	
		Interstice equal to cable diameter	Interstice 70 mm
1	2	3	4
35	0,685	0,701	0,713
50	0,511	0,531	0,547
70	0,365	0,391	0,410
95	0,277	0,307	0,328
120	0,228	0,264	0,286
150	0,194	0,235	0,256
185	0,167	0,213	0,235
240	0,143	0,193	0213
300	0,128	0,179	0,199
400	0,116	0,169	0,185
500	0,109	0,165	0,178
630	0,099	0,154	0,168
800	0,094	0,152	0,161
1000	0,089	0,148	0,155

Formula for dielectric losses:

$$W = \frac{U^2}{3} * 2\,\pi\, f\, C * \tan\delta \qquad [W/km]$$

Where - U = rated voltage [kV]
f = frequency [Hz]
C = capacitance [µF/km]
$\tan\delta$ = loss angle

12. RECOMMENDATION FOR CABLE SELECTION AND INSTALATION

Cable selection

The cable voltage rating should suit the operation conditions in the system the cable is to be used. To simplify cable selection the system are divided in 3 categories:

- **Category A**

System in which any phase conductor in contact with earth, or earthed conductor is disconnected from the system within 1 minute.

- **Category B**

System which, at short-circuit situations keep working for a short time with one phase earthed. That time should not exceed 1 hour. Occasionally one can tolerate a longer period for the cables, however not exceeding 8 hours. The overall annual earth fault duration should not go beyond 125 hours.

- **Category C**

All systems pertaining to categories A and B.

Cable selection for the respective systems is shown in Table 35.

Table 35.

Voltage system [kV]			
Voltage rating (U)	Max. voltage kept (U_m)	System category	Min. cable voltage rating (U/U_0)
[kV]		-	[kV]
1	2	3	4
10	12	A or B	6/10
10	12	C	8,7/15
15	17,5	A or B	8,7/15
15	17,5	C	12/20
20	24	A or B	12/20
20	24	C	18/30
30	36	A or B	18/30

Cable installation

Cable installed into conduits or trays have installation parameters such as maximum pulling tensions sidewall pressure, clearance, and jamming with must by considered.
Other installations, such as buried and aerial, have different installation parameters. Most installations involve some general considerations such as field handling, storage, training of ends, and junction box size. These and other considerations can make the difference between a good installation and one resulting in damaged cable.
Cable damaged during installation can cause service failures. Mechanical stress during installation are generally more severe than those encountered while in service.
The following information provides guidance in recognizing those conditions and provides a methodology to aid in keeping them within acceptable limits.
Calculations should be made to indicate whether the pull looks “easy” or “impossible”, making the decision to pull obvious. When a marginal situation is encountered, the entire pull should be reviewed. This may include more rigorous calculations or trial pulls. A final decision should by made based on factors known to the end user and installer.

The size of the conduit are determined based on calculations of the clearances, jamming and fill. Pulling tensions may then be evaluated by determining the maximum tension based on the pulling device used, and the maximum tension that can by applied to the cable.
The pulling tension required to pull the cable through the conduit is then calculated and compared to the maximum allowable tension. If the pulling tension exceeds the allowable tension, then conditions should be changed to ensure a successful pull. After calculating pulling tensions, sidewall pressures may be calculated.

Pulling different conductor size at the same time is not recommended if the conductor size or other cable characteristics are significantly different. If you must pull different size conductors it must be done with care.

Pulling additional cables into an existing conduit system is generally not recommended. If this must be done, extreme caution must be taken. Of special concern is the cutting action of the tensioned pulling rope.

Calculated permissible pulling forces

When laying power cables by machine, particular attention must be paid to the permissible tensile forces.
The formula for obtaining those values are give in Table 36.
If three single core cables are laid simultaneously with a common pulling grip the same maximum pulling forces as they are applicable for single-core cables, are valid. For laid-up three single-core cables the calculation of the permissible pulling forces is based on three cables, where as it is based on 2 cables if the 3 single-core cables are not laid-up.

Table 36.

S – Total conductor cross-section in [mm^2] (without screen and armour)
D – Outer diameter of the cable in [mm]
T – Tensile force in [N]

Pulling method	Construction of cables	Tensile force
Use pulling head on the conductor	All types of cables without armour	$T = S * 50 N/mm^2$ (cable with Cu conductor) $T = S * 30 N/mm^2$ (cable with Al conductor)
With pulling grip	All types of single-core cables and three single-core cables	$T = S * 50 N/mm^2$ (cable with Cu conductor) $T = S * 30 N/mm^2$ (cable with Al conductor)
	All wire armoured cables	$T = K * D^2$ ($K = 9 N/mm^2$)

Sidewall pressure

Sidewall pressure S_p is exerted on a cable as it is pulled around a bend section. Excessive sidewall pressure can cause cable damage and is the most restrictive factor in many installations.

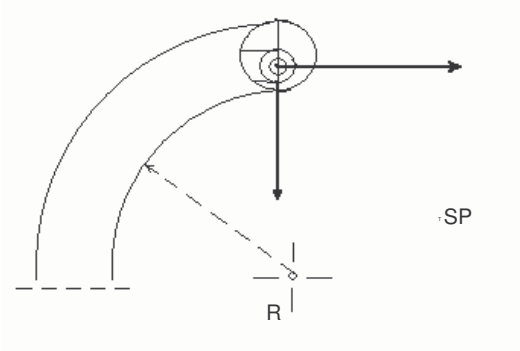
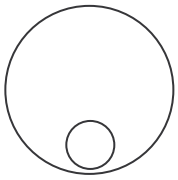


Figure 7 Sidewall pressure factor

Sidewall pressure is calculated as follows:

For one single conductor cable or multiple conductor cable under a common sheath.

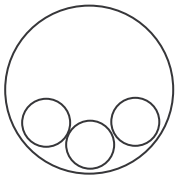
$$S_p = \frac{T}{R}$$



Single

For three single conductor cables, cradled.

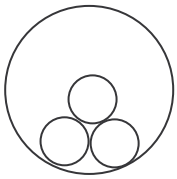
$$S_p = (3w - 2)^* \frac{T}{3R}$$



Cradled

For three single conductor cables, triplex or triangular.

$$S_p = w^* \frac{T}{2R}$$



Triangular

Where: T - tension coming out of the bended in [N]
R – bend radius in [m]
w - weight correction factor, dimensionless
S_p – sidewall pressure in [N/m]

Weight correction factor

For one (single) cable $w = 1$

For three cables (triangular or triplex) $w = \frac{1}{\sqrt{1-\left[\frac{d}{D-d}\right]}}2$

For three cable (cradled) $w = 1 + \frac{4}{3} * \left[\frac{d}{D-d}\right]^2$

Where: w – weight correction factor
D – inner diameter of conduit [mm]
d – outside diameter of the cable [mm]

Recommended maximum sidewall pressures are in the range of 3000 to 5000 N per m, dependent upon type of cable.

Configuration

The configuration of three single conductor cables in a conduit is determined by the ratio of the conduit inner diameter to the outer diameter of one of the single cables (D/d ratio).

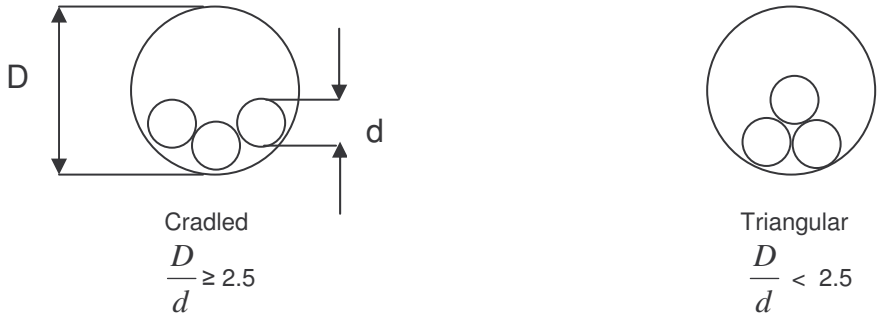


Figure 8 Configuration of three single conductors

A cradled configuration develops when three single conductor cable are pulled into a conduit where the D/d ratio is 2,5 or greater. A triangular configuration develops when three single conductor cables are pulled into a conduit where the D/d ratio is lees then 2,5. These cables may by pulled from individual reels, tandem reels, or a single reel with parallel wound cables.

Trefoil or flat formation

One group of XLPE cables may by placed in trefoil (triangular) or flat formation according to figure. The choice depends on several factors like screen bonding method, conductor area and available space for installation.

Trefoil formation Flat formation

Clearance

Clearance is the distance between the top of the uppermost cable in the conduit and the inner top surface of the conduit. It should be at least 10 percent of the conduit inner diameter or 25mm for large cables or installations involving numerous bends.

Equations for calculating clearance (C_L) are presented as follows:

Single cable:

$$C_L = D - d$$

Three cables, triplex or triangular:

$$C_L = \frac{D}{2} - 1{,}366\ d + \frac{D-d}{2} \cdot \sqrt{1-\left(\frac{d}{2(D-d)}\right)2}$$

Three cables, cradled:

$$C_L = \frac{D}{2} - \frac{d}{2} + \frac{D-d}{2} \cdot \sqrt{1-\left(\frac{d}{2(D-d)}\right)2}$$

Where:

D – conduit inner diameter in [mm]
d - cable outer diameter in [mm]

When calculating clearance, ensure all cable diameters are equal. Use the triplex configuration equation if in doubt. The cables may be of single or multiple conductor construction.

Permissible laying temperatures

The temperature of the cable when being installed ought to be at least 0^0C. For even temperature distribution in all the cable volume, it should, for minimum 24 hour stay at the a.m. temperature. During installation special steps have to be keep the cable above that temperature. Other means are allowed to be used to keep the cable temperature during laying at minimum 0^0C.
For laying the temperatures of power cables should not fall below:

XLPE insulated cable with PVC sheaths: - 5 ^{0}C

XLPE insulated cable with PE sheaths: - 20 ^{0}C

Bending radii

When laying power cables, the radii should not be smaller then the values given bellow.
The minimum cable bending radii when installing are: D – outer diameter of the cable in [mm]

- Non armoured cable in PVC sheath: 15 x D - in [mm]
- Cable without radial sealing in PE sheath: 15 x D - in [mm]
- Cable with radial sealing in PE sheath: 25 x D - in [mm]

- Armoured cable with radial sealing in PE sheath: 25 x D - in [mm]

The radii can be smaller close to joint and terminations, provided a bending templet is used. Then the radii are as follows:

- Non armoured cable in PVC sheath: 12 x D - in [mm]
- Cable without radial sealing in PE sheath: 12 x D - in [mm]
- Cable with radial sealing in PE sheath: 20 x D - in [mm]
- Armoured cable with radial sealing in PE sheath: 20 x D - in [mm]

For single bends, e.g. in front of sealing ends, these radii may in the extreme case be reduced, if proper handling – heating to approx. 30^0C, bending over a former – is ensured.

Water of the cables ends sealing

Ingress of water into the cable conductor must be avoided. The cable ends are therefore sealed during transport, storage and installation. The end sealing should be checked after pulling out the cable. The cable ends must never be left under water in a trench.

Cable testing after installation

Voltage test with D.C.
Test voltage 4,5 x U_o (r.m.s.)
Time 20 min

Voltage test with A.C. 45 to 65 Hz
Test voltage 2 x U_o (r.m.s.)
Time 60 min

Alternative:
Voltage test with A.C. 0,1 Hz *
Test voltage 3 x U_o (r.m.s.)
Time 60 min

* The test levels and times are preference values and were settled on the basis of experiences from laboratories and the practices.

Sheath testing

For tests on polymer outer sheath of screened or armoured cables the following D.C. test voltage may be applied between screen or armouring and ground in time 2 min:

PE – sheath 5kV
PVC – sheath 3kV

It should be choosed such test methods which do not cause any damage on the cable by e.g. the energy of the impulse waves.

CERTIFICATES:

Tele-Fonika Kable S.A. has well developed system for quality and environmental management which put the needs and wishes of the customer first. Our system comply with the requirements of ISO 9001 and ISO 14001 and are certified by BASEC, British Approval Service for Cables.

ISO 9001 Certificate of Approval

B • A • S • E • C

BRITISH APPROVALS SERVICE FOR CABLES

CERTIFICATE OF CONFORMITY

This is to certify that the

Quality Management System

of

TELE-FONIKA KABLE S.A.

Head Office located at:
30-663 Krakow
ul. Wielicka 114
Poland

conforms to the requirements of

ISO 9001: 2000

in respect of the sites, products and of services specified in the attached schedule(s).

Schedule nos:-

CS1-171/001
CS1-171/002
CS1-171/003
CS1-171/004
CS1-171/005

Certificate No: **CS1-171** Issue date: 23rd December 2005

Date of original certification: 20th December 1991 Expiry Date: 22nd December 2008

This certificate is issued subject to and in accordance with BASEC Regulations and continued compliance.

Signed for and on behalf of the British Approvals Service for Cables

Graham R Oleran Date 20/1/06

QB/07A/99 A1425, A1450, A1084; A1039 & A1128 /Copy No: 1

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23 Presley Way, Crownhill, Milton Keynes MK8 0ES
Telephone: +44 01908 267300 (2lines) Facsimile: +44 01908 267255
Website: www.basec.org.uk Email: mail@basec.org.uk
This Certificate & Schedule(s) remains the property of BASEC, and shall be returned when required.

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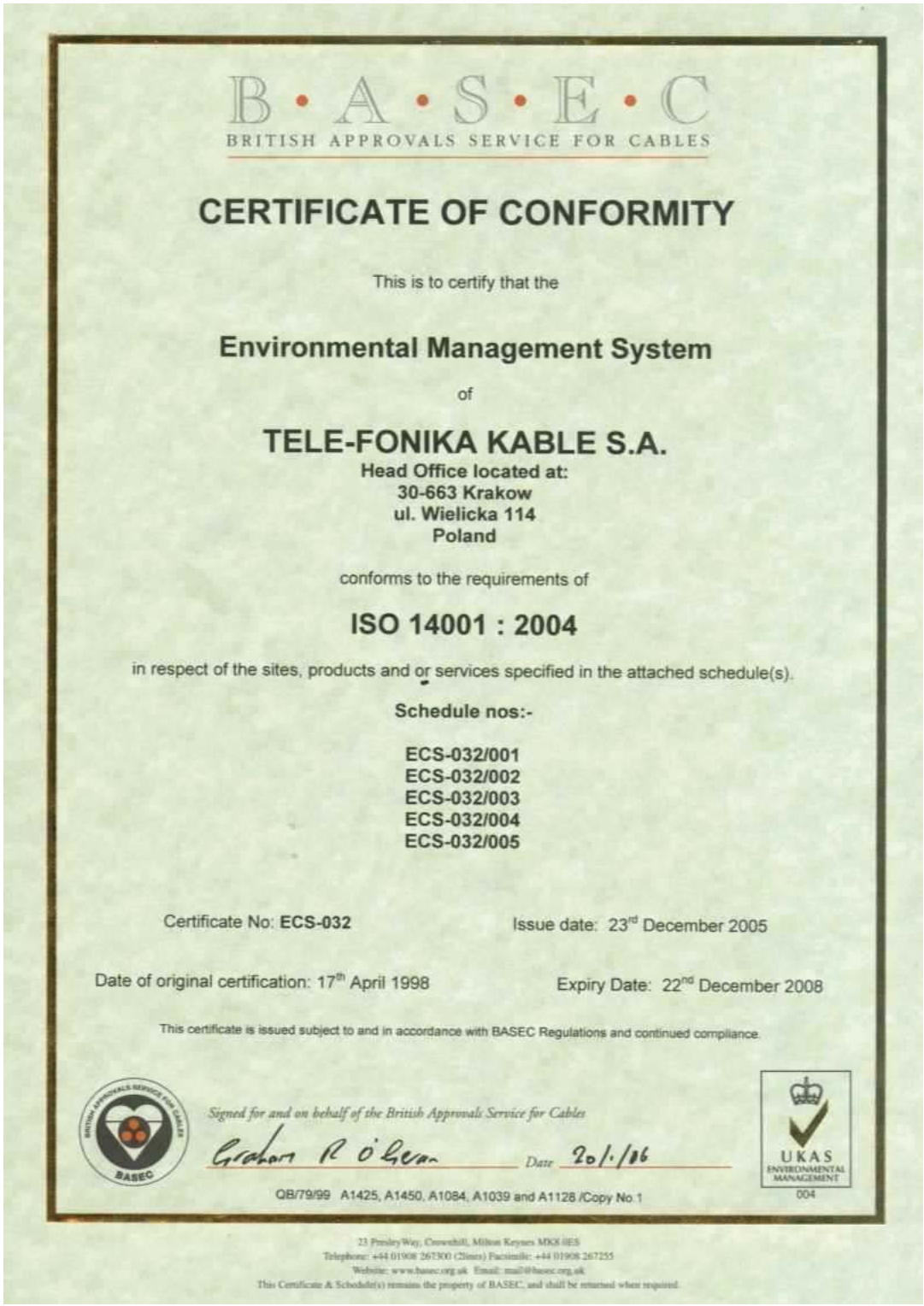

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BRITISH APPROVALS SERVICE FOR CABLES

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Poland

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ISO 14001 : 2004

in respect of the sites, products and or services specified in the attached schedule(s).

Schedule nos:-

ECS-032/001
ECS-032/002
ECS-032/003
ECS-032/004
ECS-032/005

Certificate No: **ECS-032**

Issue date: 23rd December 2005

Date of original certification: 17th April 1998

Expiry Date: 22nd December 2008

This certificate is issued subject to and in accordance with BASEC Regulations and continued compliance.

BASEC

Signed for and on behalf of the British Approvals Service for Cables

Graham R O'Brien Date 20/1/06

QB/79/99 A1425, A1450, A1084, A1039 and A1128 /Copy No.1

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This Certificate & Schedule(s) remains the property of BASEC, and shall be returned when required.

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