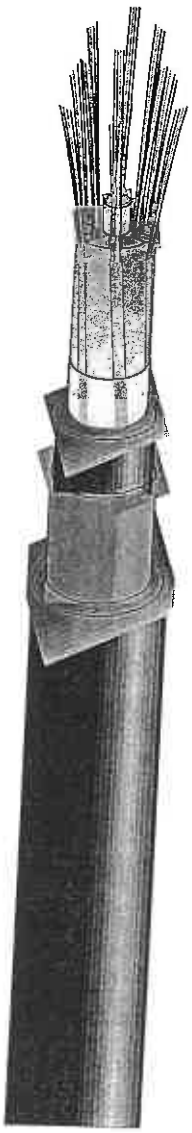
4.7. Fiber optic cable

The fiber optic cable is the same type (copper tube and PE sheath) as we have used in the wind farms at "Utgrunden", "Yttre Stengrund", "Samsø", "Nysted", and other projects.
The fiber optic cable is of ribbon type.

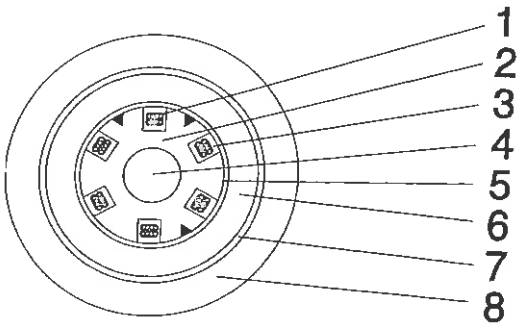
Typical fiber optic cable design & properties



CABLE PROPERTIES

Bending radius, permanently and during installation minimum	0,75 m
Crush resistance	100 kN/m
Impact resistance	50 J
Tensile strength,	1 kN
Cable net weight	0,4 kg/m
Factory length, without splice	24 km

CONSTRUCTION		Diameter
1 Acrylate coated ribbon		1.1x0.4 mm
2 Slotted core:	Polyethylene	8.5 mm
3 Filling compound:	Thixotropic gel	
4 Strength member:	Fibre Reinforced Plastic	3.5 mm
5 Wrapping:	Polyester tape	
6 Sheath:	Polyethylene, black	13 mm
7 Copper sheath		14 mm
8 Sheath:	Polyethylene, black	18 mm



4.7.1. Typical geometrical and mechanical data for the fibres

Maximum strength of fibre	50[2] N	N
Proof test tension	8,6 N	N
Proof test extention	1 %	%
Proof test time	1 s	s
Extention at maximum cable tention	<0,3 %	%
Impact at maximum cable tention	<216 N/mm²	N/mm²
Continuous extention after maximum cable tention	<0,05%	%
Continuous impact after maximum cable tention	< 36 N/mm²	N/mm²
Fibre lifetime at continuous impact/extention as indicated above	> 40 year	year
Maximum supply length	25 000 m	m

1; 60 mm and 100 turns gives a maximum of 0.05 dB at 1550 nm.
2; Typical value for testing 0.5 m lengths.

Optical data for the fibres:

Attenuation in fibres at 1310 nm (mean value)	≤ 0.35 dB/km	dB/km
Attenuation in fibres at 1310 nm (maximum value)	≤ 0.39 dB/km	dB/km
Attenuation in fibres at 1550 nm (mean value)	≤ 0.200 dB/km	dB/km
Attenuation in fibres at 1550 nm (maximum value)	≤ 0.210 dB/km	dB/km
Total dispersion at 1310 nm	≤ 2,8 ps/km x nm	ps/km x nm
Total dispersion at 1550 nm	≤ 18 ps/km x nm	ps/km x nm
Cut-off wave length after cabling	< 1260nm	nm

4.8. Cable core binder

A woven polymeric tape will keep the three cable-cores, polymeric profiles and fiber optic cable together.

4.9. Bedding

Bitumen impregnated tape.

4.10. Armour

Galvanized steel wires covered by a layer of bitumen (∅ 4mm) will protect the cable during laying and against anchors, fishing-gear etc.

4.11. Outer serving

The outer protective cover consist of bitumen and two layers of polypropylene yarn, where the outer layer will be black with different numbers of orange lines in order to simplify identification between the different cross sections.

4. MECHANICAL DATA FOR FXCTV 3X500MM² CABLE

Bending radius complete cable:			
at installation:		2,0	m
at laying with tension:		2,5	m
when installed:		1,4	m
Bending radius each phase):			
at installation:		0,9	m
when installed:		0,6	m
Coil:			
circular: (diameter)	(alt.1)	8,0	m
oval : (size)	(alt.2)	5 x 14	m
	(alt.3)	6 x 12	m
	(alt.4)	7 x 10	m
min. drop height alt.1		8,0	m
min. drop height alt.2		10,0	m
min. drop height alt.3		10,0	m
min. drop height alt.4		9,0	m
Maximum tension at laying:		160	kN
< 100 m from conductor joint:		110	kN

5. MECHANICAL DATA FOR FXCTV 3X240MM² CABLE

Bending radius complete cable:		
at installation:	2,1	m
at laying with tension:	2,5	m
when installed:	1,2	m
Bending radius each phase:		
at installation:	0,8	m
when installed:	0,6	m
Maximum tension at laying	75	kN

6. Mechanical Data for FXCTV 3x95mm² cable

Bending radius complete cable:		
at installation:	2,1	m
at laying with tension:	2,5	m
when installed:	1,1	m
Bending radius each phase:		
at installation:	0,7	m
when installed:	0,5	m
Maximum tension at laying:	31	kN

7. Testing of FXCTV Cables

Each completed cable length including possible factory joints will be tested according to Inspection and Test Plan (ITP), please see appendix.

8. CALCULATED RESULTS FXCTV 3x500MM² (ACCORDING TO IEC 60287)

Calculated results, three core cables	FXCTV 3x500mm² 34kV	2005-09-29
a.c resistance at max. temperature, R_{ac}	0,0499 Ω/km	At I_{max}
Loss factor for sheath and screen:		
λ_1	0,0681	
λ_2	0,2688	
Thermal resistance of insulation, T_1	0,3405 K.m/W	
Thermal resistance of bedding, T_2	0,1336 K.m/W	
Thermal resistance of outer covering, T_3	0,0573 K.m/W	
Thermal resistance of surrounding, T_4	0,2378 K.m/W	
Max continuous conductor current, I_{max}	**640,5 A**	**37,7 MVA at 34 kV**
Non-adiabatic short circuit current, I	**101,9 kA/0,5 sec.**	**Conductor**
Non-adiabatic short circuit current, I	**4,0 kA/0,5 sec.**	**Copper screen (per phase)**
Conductor losses per phase	20,49 W/m	At I_{max}
Screen losses per phase	1,39 W/m	At I_{max}
Armour losses per phase	5,51 W/m	At I_{max}
Dielectric losses per phase, W_d	0,007 W/m	At 34 kV
Total losses per phase	27,40 W/m	
Capacitance, per phase	0,309 µF/km	
Capacitive charging current, per phase	1,906 A/km	At 34 kV
Inductance between conductors, per phase	0,334 mH/km	
Inductive reactance, (star reactance)	0,105 Ω/km	
Electric stress at conductor screen	3,28 kV/mm	At 36 kV
Electric stress at insulation screen	2,09 kV/mm	At 36 kV
Positive sequence impedance per phase, Z_+	0,0668 0,1050	(1+j) Ω/km
Negative sequence impedance per phase, Z_-	0,0668 0,1050	(1+j) Ω/km

** Max continuous conductor current, I_{max} is based on 50°C air temperature.*

9. CALCULATED RESULTS FXCTV 3x240MM² (ACCORDING TO IEC 60287)

Calculated results, three core cables	FXCTV 3 x 240mm² 34kV	2005-09-29
a.c resistance at max. temperature, R_{ac}	0,0975 Ω/km	At I_{max}
Loss factor for sheath and screen:		
λ_1	0,0341	
λ_2	0,1331	
Thermal resistance of insulation, T_1	0,4476 K.m/W	
Thermal resistance of bedding, T_2	0,1405 K.m/W	
Thermal resistance of outer covering, T_3	0,0545 K.m/W	
Thermal resistance of surrounding, T_4	0,2702 K.m/W	
Max continuous conductor current, I_{max}	*** 450,6 A**	**26,5 MVA at 34 kV**
Non-adiabatic short circuit current, I	**49,0 kA/0,5 sec.**	**Conductor**
Non-adiabatic short circuit current, I	**3,3 kA/0,5 sec.**	**Copper screen (per phase)**
Conductor losses per phase	19,79 W/m	At I_{max}
Screen losses per phase	0,67 W/m	At I_{max}
Armour losses per phase	2,63 W/m	At I_{max}
Dielectric losses per phase, W_d	0,0052 W/m	At 34 kV
Total losses per phase	23,11 W/m	
Capacitance, per phase	0,217 µF/km	
Capacitive charging current, per phase	1,336 A/km	At 34 kV
Inductance between conductors, per phase	0,386 mH/km	
Inductive reactance, (star reactance)	0,121 Ω/km	
Electric stress at conductor screen	3,54 kV/mm	At 36 kV
Electric stress at insulation screen	1,96 kV/mm	At 36 kV
Positive sequence impedance per phase, Z_+	0,1138 0,1212	(1+j) Ω/km
Negative sequence impedance per phase, Z_-	0,1138 0,1212	(1+j) Ω/km

** Max continuous conductor current, I_{max} is based on 50°C air temperature.*

10. CALCULATED RESULTS FXCTV 3X95MM² (ACCORDING TO IEC 60287)

Calculated results, three core cables	FXCTV 3x95mm² 34kV	2005-09-29
a.c resistance at max. temperature, R_{ac}	0,2465 Ω/km	**At I_{max}**
Loss factor for sheath and screen:		
λ_1	0,0124	
λ_2	0,0481	
Thermal resistance of insulation, T_1	0,6134 K.m/W	
Thermal resistance of bedding, T_2	0,1572 K.m/W	
Thermal resistance of outer covering, T_3	0,0625 K.m/W	
Thermal resistance of surrounding, T_4	0,3101 K.m/W	
Max continuous conductor current, I_{max}	*** 267,0 A**	**15,7 MVA at 34 kV**
Non-adiabatic short circuit current, I	**19,5 kA/0,5 sec.**	**Conductor**
Non-adiabatic short circuit current, I	**2,8 kA/0,5 sec.**	**Copper screen (per phase)**
Conductor losses per phase	17,57 W/m	**At I_{max}**
Screen losses per phase	0,22 W/m	**At I_{max}**
Armour losses per phase	0,84 W/m	**At I_{max}**
Dielectric losses per phase, W_d	0,0039 W/m	**At 34 kV**
Total losses per phase	18,64 W/m	
Capacitance, per phase	0,159 µF/km	
Capacitive charging current, per phase	0,982 A/km	**At 34 kV**
Inductance between conductors, per phase	0,452 mH/km	
Inductive reactance, (star reactance)	0,142 Ω/km	
Electric stress at conductor screen	3,99 kV/mm	**At 36 kV**
Electric stress at insulation screen	1,79 kV/mm	**At 36 kV**
Positive sequence impedance per phase, Z_+	0,2615 0,1420	(1+j) Ω/km
Negative sequence impedance per phase, Z_-	0,2615 0,1420	(1+j) Ω/km

**** Max continuous conductor current, I_{max} is based on 50°C air temperature.***

Burbo Offshore Windfarm
ABB Power Technologies AB High Voltage Cables

11. CALCULATED LOSSES IN GRID LAYOUT:

The loss calculations are based on:

- Continuous load on each turbine. 3,6 MVA
- Number of turbines (Wtg) 25
- Seabed temperature at 3,0 m depth. 15 °C
- Thermal resistivity of seabed 0,7 K.m/W
- R at 30 MW (500mm²) 0,0524
- R at 30 MW (240mm²) 0,1084
- R at 30 MW (95mm²) 0,2479

A-1; B-2; C-3

From Wtg	To Wtg	Load MW	Current at 34 kV A	Cable size mm²	Length Wtg - Wtg m	Length Vertical m	Loss / unit Load W/m	Loss / unit Dielectric W/m	Loss total Load kW
Shore	A2	32,4	550,18	3 x 500	8470 8450	40 20	56,94	0,0210	483,40
A2	A3	28,8	489,05	3 x 500	600 560	80 40	44,99	0,0210	28,79
A3	A4	25,2	427,92	3 x 240	600 560	80 40	60,65	0,0210	38,81
A4	A5	21,6	366,79	3 x 240	600 560	80 40	44,56	0,0210	28,52
A5	A6	18	305,66	3 x 240	600 560	80 40	30,94	0,0156	19,80
A6	A7	14,4	244,52	3 x 95	600 560	80 40	43,68	0,0156	27,95
A7	A8	10,8	183,39	3 x 95	600 560	80 40	24,57	0,0156	15,72
A8	B8	7,2	122,26	3 x 95	740 750	80 40	10,92	0,0156	9,06
B8	B9	3,6	61,13	3 x 95	600 560	80 40	2,73	0,0156	1,75
Shore	B2	28,8	489,05	3 x 500	8480 8460	40 20	44,99	0,0210	382,40
B2	B3	25,2	427,92	3 x 240	600 560	80 40	60,65	0,0210	38,81
B3	B4	21,6	366,79	3 x 240	" 560	80 40	44,56	0,0210	28,52
B4	B5	18	305,66	3 x 240	" 560	80 40	30,94	0,0156	19,80
B5	B6	14,4	244,52	3 x 95	" 560	80 40	43,68	0,0156	27,95
B6	B7	10,8	183,39	3 x 95	" 560	80 40	24,57	0,0156	15,72
B7	C7	7,2	122,26	3 x 95	740 750	80 40	10,92	0,0156	9,06
C7	C8	3,6	61,13	3 x 95	600 560	80 40	2,73	0,0156	1,75
Shore	C1	28,8	489,05	3 x 500	8510 8490	40 20	44,99	0,0210	383,75
C1	C2	18	305,66	3 x 240	600 560	80 40	30,94	0,0156	19,80
C2	C3	14,4	244,52	3 x 95	" 560	80 40	43,68	0,0156	27,95
C3	C4	10,8	183,39	3 x 95	" 560	80 40	24,57	0,0156	15,72
C4	C5	7,2	122,26	3 x 95	" 560	80 40	10,92	0,0156	6,99
C5	C6	3,6	61,13	3 x 95	" 560	80 40	2,73	0,0156	1,75
C1	D1	7,2	122,26	3 x 95	740 750	80 40	10,92	0,0156	9,06
D1	D2	3,6	61,13	3 x 95	600 560	80 40	2,73	0,0156	1,75
									1644,61

1.6MW/90MW

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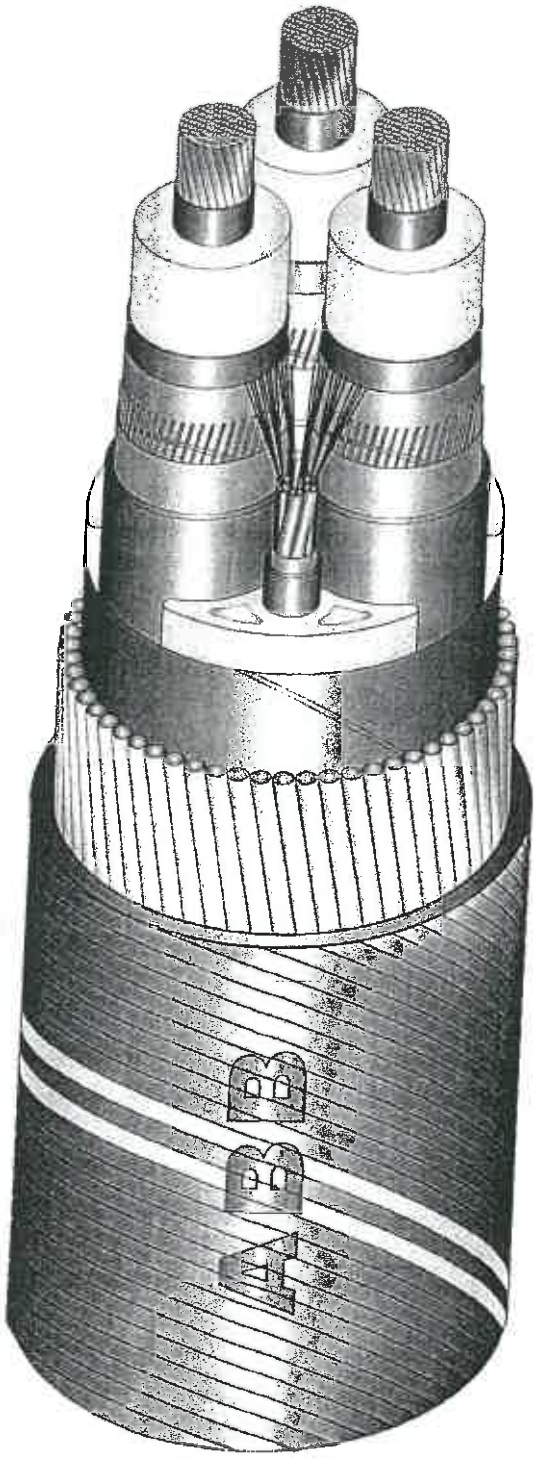
12. CABLE DESIGN FXCTV 3x500MM²



Designation	FXCTV 3 x 500 mm²	
Rated voltage	18/30 kV U_{max} 36kV	
Impulse level	170 kV	
Conductor		
type	round, compact	
material	copper	
longitudinal water seal	compound + swelling tape	
cross-section	3 x 500 mm²	
diameter	26,2 mm	12,1
Conductor screen		
material	conductive PE	
thickness	1,0 mm	14,1
Insulation		
type	dry cured, triple extruded	
material	XLPE	
thickness	8 mm	22,1
Insulation screen		
material	conductive PE	
thickness	1,0 mm	23,1
Longitudinal water seal		
material	swelling tape	
thickness	0,6 mm	25,7
Metallic screen		
material	copper wires	
cross-section	3 x 17 mm²	23,72
Longitudinal water seal		
material	swelling tape	
thickness	0,6 mm	24,3
Inner sheath		
material	conductive PE	
thickness	2,0 mm	26,3
Assembling		
material 1	polymeric profiles	
material 2	fibre optical cable	
material 3	grease	
Cable core binder		
material	polymeric tape	
thickness	0,2 mm	
Bedding		
material	Bitumen impregnated tape	
thickness	0,5 mm	
Armour		
material 1	Galvanized steel wires	
material 2	Bitumen	
wire diameter	4,0 mm	
Armour		
material 1	Polypropylene yarns	
material 2	Bitumen	
thickness	4,0 mm	
Complete cable		
diameter	≈ 140 mm	
weight	≈ 35 kg / m	

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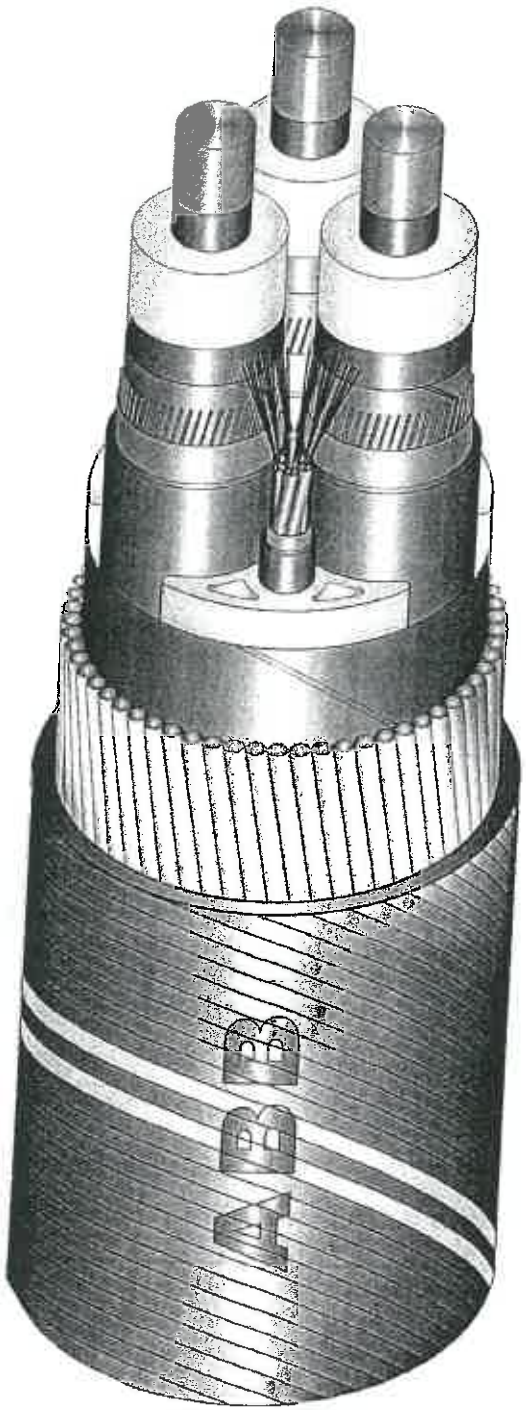
13. CABLE DESIGN FXCTV 3x240MM²



Designation	FXCTV 3 x 240 mm²
Rated voltage	18/30 kV U_{max} 36kV
Impulse level	170 kV
Conductor	
type	round, solid (or compacted)
material	copper
cross-section	3 x 240 mm²
Conductor screen	
material	conductive PE
thickness	1,0 mm
Insulation	
type	dry cured, triple extruded
material	XLPE
thickness	8 mm
Insulation screen	
material	conductive PE
thickness	1,0 mm
Longitudinal water seal	
material	swelling tape
thickness	0,6 mm
Metallic screen	
material	copper wires
cross-section	3 x 14 mm²
Longitudinal water seal	
material	swelling tape
thickness	0,6 mm
Inner sheath	
material	PE
thickness	3,0 mm
Assembling	
material 1	polymeric profiles
material 2	fibre optical cable
material 3	grease
Cable core binder	
material	polymeric tape
thickness	0,2 mm
Bedding	
material	Bitumen impregnated tape
thickness	0,5 mm
Armour	
material 1	Galvanized steel wires
material 2	Bitumen
wire diameter	4,0 mm
Armour	
material 1	Polypropylene yarns
material 2	Bitumen
thickness	4,0 mm
Complete cable	
diameter	≈ 120 mm
weight	≈ 22 kg / m

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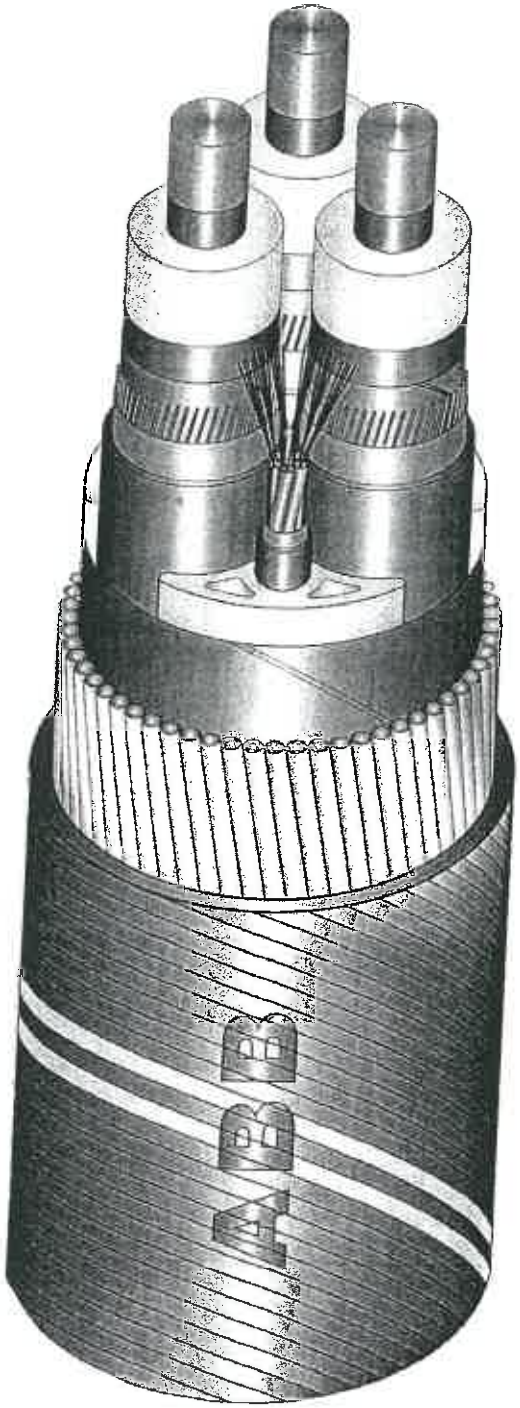
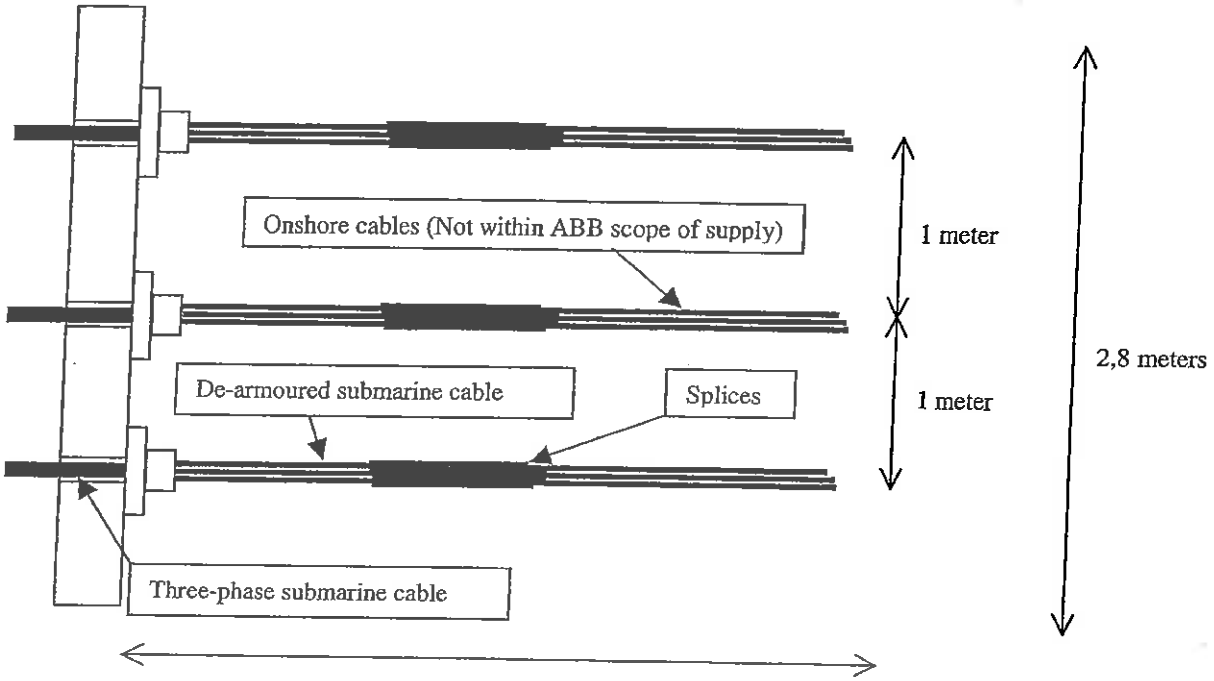
14. CABLE DESIGN FXCTV 3x95mm²

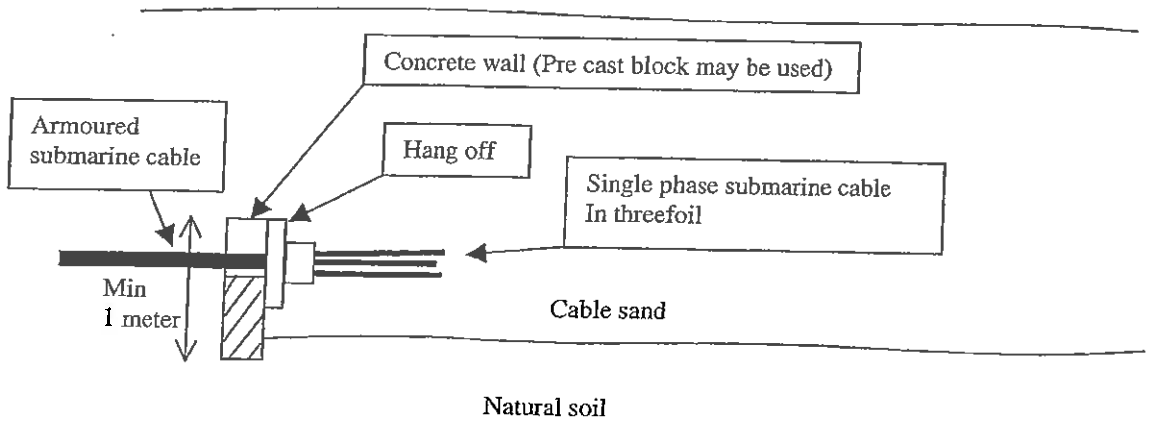


Designation	FXCTV 3 x 95 mm²	
Rated voltage	20/34 kV U_{max} 36kV	
Impulse level	170 kV	
Conductor		
type	round, solid	
material	copper	
cross-section	3 x 95	mm²
Conductor screen		
thickness	0,8	mm
Insulation		
type	dry cured, triple extruded	
material	XLPE	
thickness	8,0	mm
diameter	31	mm
Insulation screen		
thickness	1,0	mm
Longitudinal water seal 1		
material	conductive swelling tape	
thickness	0,6	mm
Metallic screen		
material	copper wires	mm
cross-section	3 x 12	mm²
Longitudinal water seal 2		
material	conductive swelling tape	
thickness	0,6	mm
Inner sheath		
material	PE	
thickness	3,0	mm
Fillers		
material	polymeric profiles	
material	grease	
material	fiber optic cable	
Cable core binder		
material	nylon	
thickness	0,15	mm
Bedding		
material	bitumen impregnated tape	
Armour		
type	wires, single layer	
material	galv. steel wires	
thickness	4	mm
Outer cover		
material	polypropylene yarn	
thickness	4 mm	
Complete cable		
diameter	≈ 106	mm
weight	≈ 16	kg / m

- Sketch of onshore jointing chamber. (CIF)
  This is based on the assumption that the jointing chamber is an open design with only a concrete wall where the hang-off is fitted.



Where the armoured submarine cable enters the CIF, there shall be a concrete wall with open slots for the cableto attach the hang-off. These hang off devices will be of the same type as those being installed on the wind turbines.
Splicing will be done in an open dug jointbay in a temporary jointing facility. After splicing the splices shall be buried in cable sand and the following layers backfilled and compacted.



Standby rate. Example.

The master time schedule states at what date we should have access to the different WT:s. When our personell are on site, and these dates are not met by another contractor such as foundation contractor, WT contractor or Cable laying contractor, the standby rate would be applicable, unless we are given access to other WT:s where we could continue with our work.

Example:

WT installation on foundations are delayed outside the time schedule for any technical reasons. This would be situation where the standby rate would be applicable.

All situations with standby time would have to be considered as separate items. We will ofcource try our best to work together with all contractors to minimize standby time, for instance work in parallel with other contractors on WT:s whenever possible technically and concidering safety for personnel.
Standby time would only be applicable for delays compared to the master time schedule. If we would work faster then our given time in the schedule, standby time would not be applicable for the time to the next planned operation.
Our offer is based on that we can work in one continous operation.

Inspection and Test Plan

OBJECT: FXCTV 3x500/17 36 kV

Voltages and Cable Dimensions

U =	34	kV Rated voltage
U_m=	36	kV Highest voltage for equipment (between conductors)
U_0=	18	kV Value of U_0 for determination of test voltages
d =	26,2	mm Nominal diameter of conductor
t_n=	8,0	mm Nominal thickness of insulation
t_n=	2,0	mm Nominal thickness of cable oversheath
d_n=	4,0	mm Nominal diameter armour wires
D =	140	mm Nominal diameter of cable
C_n=	0,33	µF/km Nominal capacitance of cable core
R_c=	0,0366	ohm/km Conductor resistance DC 20 °C
R_s=	1,2	ohm/km Screen/sheath resistance DC 20 °C

Contents

No.	Name of item Characteristics, method or type of inspection	Specifying documents ; Clause	Requirements	Code 1, 2, 3
1.	**Routine test** Routine test shall be carried out on each manufactured length of cable			
1.1	Measurement of electrical resistance of conductor	IEC 60502-2 16.2	20°C R_{DC}≤ 0,0366 ohm/km	A-C
1.2	Measurement of electrical resistance of screen	IEC 60502-2 16.2	20°C R_{DC}≤ 1,2 ohm/km	A-C
1.3	* Partial Discharge Test	IEC 60502-2 16.3	Test voltage raised to 36 kV held 10 s. ≤ 10 pC at U = 31 kV	A-C
1.4	Voltage Test	IEC 60502-2 16.4	5 minutes at U= 63 kV	A-C
1.5	Test on fiber optical cable		Please see page 4 in this document	

Code 1. Place of inspection	*Code 2.Inspector*	*Code 3. Distribution of report*
A at manufacturer (ABB company) M at manufacturer outside ABB S at a subcontractor of the manufacturer E at erection site X other, specified under "Remarks"	B customer/owner representative, mandatory hold point C customer/owner representative N representative of responsible ABB company D representative of the manufacturers design function P repr. of the manufact. quality function, mandatory hold point Q representative of the manufacturers quality function Y other, specified under "Remarks" - witnessing not specified	C customer/owner and manufacturers quality function N responsible ABB company and the manufacturers quality function D the manufacturers design and quality functions Q the manufacturers quality function J journal is kept, no reporting for each delivery order Z other, specified under "Remarks" - reporting not specified

Remarks, notes

In order to avoid inaccuracy (due to temperature variations) all resistance measurement will be performed prior to assembling

* 1.3 is for information only. A PD-test will be performed on samples taken from beginning and end from each extrusion serie (Refering to Electra 189 2.2.2

Rev. ind.		Specification of revision	Approved	Date

Responsible department Technical Department	(Customer, Plant, Order, etc.) Seascape Energy UK (BURBO)		
Prepared by TK Flemming Krogh			
Approved by TK Kenneth Johannesson	Title ITP xxxxx		Language E
Take over departments PVT, TM, Q, CC	FXCTV 3x500/17 36 kV		No of sh. 4
Manufacturer **ABB Power Technologies High Voltage Cables**	Document No. **Draft**	Date **2005-10-04**	Sheet 1

OBJECT: FXCTV 3x500/17 36 kV

Voltages and Cable Dimensions

U =	34	kV Rated voltage
U_m=	36	kV Highest voltage for equipment (between conductors)
U_0=	18	kV Value of U_0 for determination of test voltages
d =	26,2	mm Nominal diameter of conductor
t_n=	8,0	mm Nominal thickness of insulation
t_n=	2,0	mm Nominal thickness of inner PE-sheath
d_n=	4,0	mm Nominal diameter of armour wires
D =	140	mm Nominal diameter of cable
C_n=	0,33	µF/km Nominal capacitance of cable core
R_c=	0,0366	ohm/km Conductor resistance DC 20 °C
R_s=	1,2	ohm/km Screen/sheath resistance DC 20 °C

Contents

No.	Name of item. Characteristics, method or type of inspection	Specifying documents ; Clause	Requirements	Code 1, 2, 3
2.	**Sample test**			
	The sample tests 2.1- 2.4 will be performed on samples taken from beginning and end from each extrusion serie			
	The sample test 2.5 will be performed on samples taken from beginning and end from each completed cable length			
2.1	Conductor examination	IEC 60502-2 17.4	≥ 53 wires	A-C
2.2	Measurement of thickness of insulation and non-metallic sheath			
2.2.1	Measurement of insulation	IEC 60502-2 17.5.2	t_{min} ≥ 7,1 mm t_{max}-t_{min}/t_{max} < 0,15 mm	A-C
2.2.2	Measurement of cable oversheath	IEC 60502-2 17.5.3	t_{min} ≥ 1,40 mm	A-C
2.3	Partial Discharge Test	IEC 60502-2 16.3	Test voltage raised to 36 kV held 10 s. ≤ 10 pC at U = 31 kV	A-C
2.4	Hot Set Test for XLPE-Insulation	IEC 60502-2 17.5.10	IEC60502-2 Table 22 XLPE	A-C
2.5	Measurement of diameter of armour wires	IEC 60502-2 17.7.7	d_{min} ≥ 3,8 mm	A-C

Code 1. Place of inspection	Code 2.Inspector	Code 3. Distribution of report
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Remarks, notes

Rev. ind.		Specification of revision	Approved	Date

Responsible department: Technical Department		(Customer, Plant, Order, etc.): Seascape Energy UK (BURBO)	
Prepared by: TK Flemming Krogh			
Approved by: TK Kenneth Johannesson		Title: ITP xxxxx	Language: E
Take over departments: PVT, TM, Q, CC		FXCTV 3x500/17 36 kV	No of sh.: 4
Manufacturer: **ABB Power Technologies High Voltage Cables**	Document No.: **Draft**	Date: **2005-10-04**	Sheet: 2

OBJECT: FXCTV 3x500/17 36 kV

Voltages and Cable Dimensions

U =	34	kV Rated voltage
U_m=	36	kV Highest voltage for equipment (between conductors)
U_0=	18	kV Value of U_0 for determination of test voltages
d =	26,2	mm Nominal diameter of conductor
t_n=	8,0	mm Nominal thickness of insulation
t_n=	2,0	mm Nominal thickness of inner PE-sheath
d_n=	4,0	mm Nominal diameter of armour wires
D =	140	mm Nominal diameter of cable
C_n=	0,33	µF/km Nominal capacitance of cable core
R_c=	0,0366	ohm/km Conductor resistance DC 20 °C
R_s=	1,2	ohm/km Screen/sheath resistance DC 20 °C

Contents

No.	Name of item. Characteristics, method or type of inspection	Specifying documents ; Clause	Requirements	Code 1, 2, 3
	3. Electrical tests after installation After installation test shall be carried out on installed cable			
3.1	AC or DC test	IEC 60502-2 20)	(to be decided)	ECC
3.2	Test on fiber optical cable		Please see page 4 in this document	ECC

Code 1. Place of inspection	*Code 2.Inspector*	*Code 3. Distribution of report*
A at manufacturer (ABB company) M at manufacturer outside ABB S at a subcontractor of the manufacturer E at erection site X other, specified under "Remarks"	B customer/owner representative, mandatory hold point C customer/owner representative N representative of responsible ABB company D representative of the manufacturers design function P repr. of the manufact. quality function, mandatory hold point Q representative of the manufacturers quality function Y other, specified under "Remarks" - witnessing not specified	C customer/owner and manufacturers quality function N responsible ABB company and the manufacturers quality function D the manufacturers design and quality functions Q the manufacturers quality function J journal is kept, no reporting for each delivery order Z other, specified under "Remarks" - reporting not specified

Remarks, notes

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Prepared by: TK Flemming Krogh			
Approved by: TK Kenneth Johannesson	Title: ITP xxxxx		Language: E
Take over departments: PVT, TM, Q, CC	FXCTV 3x500/17 36 kV		No of sh.: 4
Manufacturer: **ABB Power Technologies High Voltage Cables**	Document No.: **Draft**	Date: **2005-10-04**	Sheet: 3

Inspection and Test Plan

OBJECT: FXCTV 3x500/17 36 kV

Voltages and Cable Dimensions

U =	34	kV Rated voltage
U_m=	36	kV Highest voltage for equipment (between conductors)
U_0=	18	kV Value of U_0 for determination of test voltages
d =	26,2	mm Nominal diameter of conductor
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t_n=	2,0	mm Nominal thickness of cable oversheath
D =	140	mm Nominal diameter of cable
C_n=	0,33	µF/km Nominal capacitance of cable core
R_c=	0,0366	ohm/km Conductor resistance DC 20 °C
R_s=	1,2	ohm/km Screen/sheath resistance DC 20 °C

Contents

No.	Name of item. Characteristics, method or type of inspection	Specifying documents ; Clause	Requirements	Code 1, 2, 3
	Tests on fiber optical cable	IEC 60793-1-C1C		
	The following tests will be performed on completed cable			
3.1	OTDR Test on all fibres (Measurements must be performed from both ends)			
	Attenuation at 1310 nm.		≤ 0.35 dB/km	M-C
	Attenuation at 1550 nm.		≤ 0.25 dB/km	M-C
	Attenuation at 1625 nm.		≤ 0.25 dB/km	M-C
	Minimum number of approved fibres		16 pcs	M-C
	The following tests will be performed as a part of the routine test.			
	The test will be repeated after loading			
3.2	OTDR Test on all fibres (Measurements must be performed from both ends)			
	Attenuation at 1310 nm.		≤ 0.35 dB/km	A-C
	Attenuation at 1550 nm.		≤ 0.25 dB/km	A-C
	Attenuation at 1625 nm.		≤ 0.25 dB/km	A-C
	Minimum number of approved fibres		12 pcs	A-C
	The following tests will be performed as a part of the commissioning test.			
3.2	OTDR Test on all fibres (Measurements must be performed from both ends)			
	Attenuation at 1310 nm.		≤ 0.35 dB/km	E-C
	Attenuation at 1550 nm.		≤ 0.25 dB/km	E-C
	Attenuation at 1625 nm.		≤ 0.25 dB/km	E-C
	Minimum number of approved fibres		12 pcs	E-C

Code 1. Place of inspection	*Code 2.Inspector*	*Code 3. Distribution of report*
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Remarks, notes

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Prepared by: TK Flemming Krogh			
Approved by: TK Kenneth Johannesson	Title: ITP xxxxx		Language: E
Take over departments: PVT, TM, Q, CC	FXCTV 3x500/17 36 kV		No of sh.: 4
Manufacturer: **ABB Power Technologies High Voltage Cables**	Document No.: **Draft**	Date: **2005-10-04**	Sheet: 4

Inspection and Test Plan

OBJECT: FXCTV 3x95/12 36 kV

Voltages and Cable Dimensions

U_0 =	34	kV	Rated voltage
U_m=	36	kV	Highest voltage for equipment (between conductors)
U_0=	18	kV	Value of U_0 for determination of test voltages
d =	11	mm	Nominal diameter of conductor
t_n=	8,0	mm	Nominal thickness of insulation
t_n=	3	mm	Nominal thickness of cable oversheath
d_n=	4,0	mm	Nominal diameter armour wires
D =	106	mm	Nominal diameter of cable
C_n=	0,17	µF/km	Nominal capacitance of cable core
R_c=	0,193	ohm/km	Conductor resistance DC 20 °C
R_s=	1,5	ohm/km	Screen/sheath resistance DC 20 °C

Contents

No.	Name of item Characteristics, method or type of inspection	Specifying documents ; Clause	Requirements	Code 1, 2, 3
1.	**Routine test** Routine test shall be carried out on each manufactured length of cable			
1.1	Measurement of electrical resistance of conductor	IEC 60502-2 16.2	20°C R_{DC}≤ 0,193 ohm/km	A-C
1.2	Measurement of electrical resistance of screen	IEC 60502-2 16.2	20°C R_{DC}≤ 1,5 ohm/km	A-C
1.3	Partial Discharge Test	IEC 60502-2 16.3	Test voltage raised to 36 kV held 10 s. ≤ 10 pC at U = 31 kV	A-C
1.4	Voltage Test	IEC 60502-2 16.4	5 minutes at U= 63 kV	A-C
1.5	Test on fiber optical cable		Please see page 4 in this document	

Code 1. Place of inspection	*Code 2.Inspector*	*Code 3. Distribution of report*
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Remarks, notes

In order to avoid inaccuracy (due to temperature variations) all resistance measurement will be performed prior to assembling

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Prepared by TK Flemming Krogh			
Approved by TK Kenneth Johannesson	Title ITP xxxxx		Language E
Take over departments PVT, TM, Q, CC	FXCTV 3x95/12 36 kV		No of sh. 4
Manufacturer **ABB Power Technologies High Voltage Cables**	Document No. **Draft**	Date **2005-10-04**	Sheet 1

Inspection and Test Plan

OBJECT: FXCTV 3x95/12 36 kV

Voltages and Cable Dimensions

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Contents

No.	Name of item. Characteristics, method or type of inspection	Specifying documents ; Clause	Requirements	Code 1, 2, 3
2.	**Sample test**			
	The sample tests 2.1- 2.4 will be performed on samples taken from beginning and end from each extrusion serie			
	The sample test 2.5 will be performed on a sample taken from first and last completed cable length.			
2.1	Conductor examination	IEC 60502-2 17.4	Solid conductor	A-C
2.2	Measurement of thickness of insulation and non-metallic sheath			
2.2.1	Measurement of insulation	IEC 60502-2 17.5.2	$t_{min} \geq$ 7,1 mm $t_{max}-t_{min}/t_{max} <$ 0,15 mm	A-C
2.2.2	Measurement of cable oversheath	IEC 60502-2 17.5.3	$t_{min} \geq$ 2,20 mm	A-C
2.3	Hot Set Test for XLPE-Insulation	IEC 60502-2 17.5.10	IEC60502-2 Table 22 XLPE	A-C
2.4	Measurement of diameter of armour wires	IEC 60502-2 17.7.7	$d_{min} \geq$ 3,8 mm	A-C

Code 1. Place of inspection
A at manufacturer (ABB company)
M at manufacturer outside ABB
S at a subcontractor of the manufacturer
E at erection site
X other, specified under "Remarks"

Code 2.Inspector
B customer/owner representative, mandatory hold point
C customer/owner representative
N representative of responsible ABB company
D representative of the manufacturers design function
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Q representative of the manufacturers quality function
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Code 3. Distribution of report
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Remarks, notes

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Take over departments: PVT, TM, Q, CC	FXCTV 3x95/12 36 kV		No of sh.: 4
Manufacturer: **ABB Power Technologies High Voltage Cables**	Document No.: **Draft**	Date: **2005-10-04**	Sheet: 2

Inspection and Test Plan

OBJECT: FXCTV 3x95/12 36 kV

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D =	140	mm Nominal diameter of cable
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R_c=	0,0366	ohm/km Conductor resistance DC 20 °C
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Contents

No.	Name of item Characteristics, method or type of inspection	Specifying documents ; Clause	Requirements	Code 1, 2, 3
3.	**Electrical tests after installation** After installation test shall be carried out on installed cable			
3.1	AC or DC test	IEC 60502-2 20)	(to be decided)	ECC
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Manufacturer **ABB Power Technologies High Voltage Cables**	Document No. **Draft**	Date **2005-10-04**	Sheet 3

Inspection and Test Plan

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	The following tests will be performed on completed cable			
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	Attenuation at 1550 nm.		≤ 0.25 dB/km	M-C
	Attenuation at 1625 nm.		≤ 0.25 dB/km	M-C
	Minimum number of approved fibres		16 pcs	M-C
	The following tests will be performed as a part of the routine test.			
	The test will be repeated after loading			
3.2	OTDR Test on all fibres (Measurements must be performed from both ends)			
	Attenuation at 1310 nm.		≤ 0.35 dB/km	A-C
	Attenuation at 1550 nm.		≤ 0.25 dB/km	A-C
	Attenuation at 1625 nm.		≤ 0.25 dB/km	A-C
	Minimum number of approved fibres		12 pcs	A-C
	The following tests will be performed as a part of the commissioning test.			
3.2	OTDR Test on all fibres (Measurements must be performed from both ends)			
	Attenuation at 1310 nm.		≤ 0.35 dB/km	E-C
	Attenuation at 1550 nm.		≤ 0.25 dB/km	E-C
	Attenuation at 1625 nm.		≤ 0.25 dB/km	E-C
	Minimum number of approved fibres		12 pcs	E-C

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Remarks, notes

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Manufacturer: **ABB Power Technologies High Voltage Cables**	Document No.: **Draft**	Date: **2005-10-04**	Sheet: 4