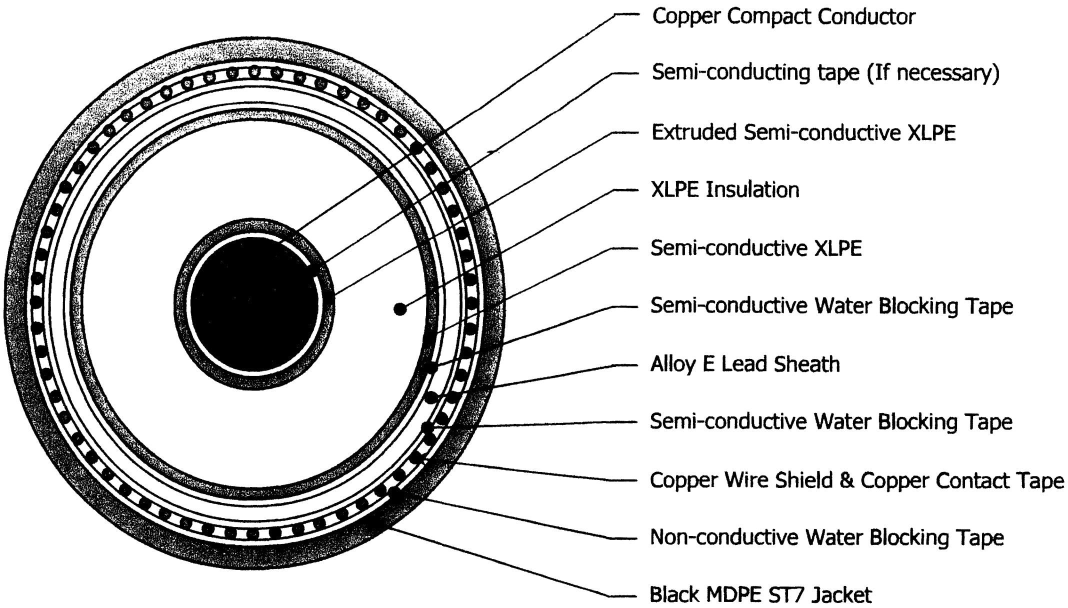
115 kV CU/XLPE/LS/CWS/MDPE

Per Spec. IEC 60840 where applicable

PHELPS DODGE INTERNATIONAL (THAILAND) LIMITED



Cable Dimension and Construction

Description		unit	CU 800 mm2
Diameter of Conductor	(Approx.)	mm	34.0
S/C Conductor screen thickness	(Approx.)	mm	1.50
Insulation thickness	(Min. Avg.)	mm	16.00
Diameter over Insulation	(Approx.)	mm	70.2
S/C Insulation screen thickness	(Approx.)	mm	1.50
Lead alloy E sheath thickness	(Min. Avg.)	mm	2.1
Diameter over Lead aloy E sheath	(Approx.)	mm	78.9
No. of Cu wires / Dia.of each wire	(Approx.)	- / mm	62 / 2.03
Outer sheath thickness	(Min. Avg.)	mm	4.0
Overall diameter	(Approx.)	mm	95
Total cable weight	(Approx.)	kg/km	19,100
Maximum Rdc of conductor at 20°C		Ω/km	0.0211
Maximum Rac of conductor at 90°C		Ω/km	0.0303
Minimum Insulation Resistance at 20°C		MΩ/km	985
Conductor Short Circuit Current 1 sec		kA	114
Screen fault current carrying capacity for 1 sec		kA	40

Permissible short-circuit current calculation for shield

$$I_{sc} = \frac{n\varepsilon}{1000}\sqrt{\frac{K^2 S^2}{t}\ln\left(\frac{\theta_f + \beta}{\theta_i + \beta}\right)}$$

Where **I_{SC}** : Permissible fault current (kA)

S : Cross-sectional area of the current carrying component (mm^2)

n : Number of shield

K : Constant depending on the material of the current carrying component ($As^{1/2}/mm^2$)

t : Duration of fault current (seconds)

ε : Factor to allow for heat loss into the asjacent components

θ_i : Initial temperature (°C)

θ_f : Final temperature (°C)

β : Reciprocal of temperature coefficient of resistance at 0 °C

Parameters	Cu Wire Shield	Tape Shield	Armour	Lead Sheath
K	226	-	-	41
S	3.24	-	-	499.42
n	62	-	-	-
t	1	-	-	1
θi	75	-	-	75
θf	200	-	-	200
β	234.5	-	-	230
ε	1.00	-	-	1.11
ISC	26.4	0	0	13.4
Total I_{sc}	**40 kA Time duration = 1 second**			

Reference : IEC Standard Publication No. 949: Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects.

a General Cable company

APPENDIX 2: TECHNICAL SCHEDULES

1.	**115kV Power Cables**		**800 mm^2**
1	Tender		
2	Manufacturer		Phelps Dodge International(Thailand)
3.	Manufacturer 's type designation		HXLP/LS/CWS/PE
4.	Numbers of cores		1
5.	Rated Voltage Uo/U	(kV)	66/115
6.	Highest operating voltage under normal conditions	(kV)	123
7.	Lightning impulse withstand voltage	(kV)	550
8.	Rated frequency	(Hz)	50
9.	Ambient air temperature range		
	- Minimum installation temperature	(°C)	10
10.	Nominal cross-sectional area of conductor	(mm^2)	800
11.	Continuous current rating		
	- In air at +30°C (flat formation, cross bond)	(A)	1035
	- Under conditions in item 44 (Direct buried)	(A)	800
12.	Maximum thermal short circuit current of the conductor (1sec), cable loaded as in item 11 Before short circuit	(kA)	113.6
	- Final conductor temperature	(°C)	250
13.	Maximum dynamic short circuit current (see item 44)	(kA)	177.5
14.	Maximum thermal short circuit current of the metallic shield (1sec), cable loaded as in item 11		
	- Before short circuit (Cu.wire shield + Lead sheath)	(kA)	40

15	Conductor			
	- Material			Uncoated Copper
	- Design			Circular Compact
	- Nominal diameter	(Approx.)	(mm)	33.9
16.	Conductor screen			
	- Material			Semi-conductive XLPE
	- Minimum thickness	(Min.Avg.)	(mm)	1.5
17.	Maximum dielectric stress at conductor screen (Assumed smooth)		(MV/m)	5.71
18.	Insulation			
	- Material			XLPE
	- Minimum average thickness (excluding semi-conductive layer)	(MIn. Avg.)	(mm)	16.0
	- Minimum thickness at any place (excluding semi-conductive layer)	(Min. Spot)	(mm)	14.4
19.	Insulation screen			
	- Material			Semi-conductive XLPE
	- Minimum thickness	(Min. Avg.)	(mm)	1.5
20.	Vulcanization method			
	- Medium in curing process			N_2
	- Medium in cooling process			N_2
	- Is water used in any phase of process?			No
21	Metallic sheath			
	- Material and type			Alloy E Lead
	- Additive in lead sheath (if such) to improve			

	vibration resistance			Antimony (sb)
	- Minimum ~~radial~~ thickness	(Min. Spot)	(mm)	1.9
	- Nominal thickness	(Min. Avg.)	(mm)	2.1
22	Nominal diameter over metallic sheath	(Approx.)	(mm)	78.5
23	Armour (if any)			
	- Bedding; material and type			N/A
	- Armouring; material and type			N/A
	- Minimum thickness		(mm)	N/A
	- Nominal diameter over armour		(mm)	N/A
	- Tensile strength		(kN)	N/A
24	Outer sheath			
	- Material			MDPE
	- Nominal thickness	(Min. Avg.)	(mm)	4.0
	- Minimum thickness	(Min. Spot)	(mm)	3.3

25. Additional constructional parts

- Material: Cu.Wire &Cu. contact tape, S/C W/B tape, N/C W/B tape
- Cause for usage: Cu.wire&Cu.contact tape fulfil the requirement of phase to earth current rating
  S/C W/B tape&N/C W/B tape provide a continuous longitudinal watertight barrier

26	Nominal overall diameter of complete cable	(Approx.)	(mm)	95
27	Nominal weight of complete cable	(Approx.)	(kg/m)	19.1
28	Installation minimum bending radius			
	- Laid direct in ground or in air		(m)	1.62
	- Laid in ducts		(m)	1.62
	- Cable placed into position adjacent to joint or terminations		(m)	1.62

29	Norminal internal diameter of ducts	(mm)	- Direct buried per item 44)
30	Maximum DC resistance of conductor at 20 °C	(Ω/km)	0.0221
31	Maximum AC resistance of conductor at 90°C (see conditions in Item 44)	(Ω/km)	0.0321
32	Reactance per phase of three phase circuit at 50 Hz (see conditions in Item 44)	(Ω/km)	0.123
33	Maximum DC resistance of metallic sheath at 20 °C (Lead sheath parallel with Cu. wire)	(Ω/km)	0.075
34	Maximum DC resistance of armour at 20°C	(Ω/km)	N/A
35	Maximum capacitance	(μF/km)	0.243
36	Maximum charging current at nominal voltage	(mA/m)	5.04
37	Maximum value of tangent of dielectric loss angle of cable when laid direct in the ground at nominal voltage and 50 Hz at the conductor temperture of As item 41 at 2 kV and 50Hz at the conductor temperature of		
	- +20 °C		-
	- +90 °C		10×10^{-4}
38	Maximum value of tangent of dielectric loss angle of cable at 50Hz at a conductor temperature of +20 °C		
	- not more than 50% of nominal voltage		-
	- at 100% of nominal voltage		40×10^{-4}
	- at 200% of nominal voltage		-
39	Maximum change in the value of tangent of dielectric loss angle between 60% of nominal voltage and 200% of nominal voltage at 20 °C		20×10^{-4}
40	Maximum dielectric loss of cable of three phase circuit when laid direct in the ground at nominal voltage and 50 Hz at the conductor temperature	(W/m/phase)	0.308

41	Metallic shield dielectric loss of cable of three phase circuit at nominal voltage, 50 Hz and current rating given in item 11	(W/m)	20.36
42	Induced voltage in the metallic shield which is boned by single point system (V/km)	~~(V/A/m)~~	86.3
43	Zero-sequence reactance in three phase circuit, installed cables as item 44 (Ω/km)		0.0344
44	Installation and operation conditions on which current carrying capacity and maximum dynamic short circuit current are based		
	- Maximum ambient temperature in air	(^{o}C)	45
	- Maximum temperature in ground	(^{o}C)	30
	- Maximum conductor temperature in ground	(^{o}C)	90
	- Maximum conductor temperature in trough	(^{o}C)	90
	- Are cables laid direct in ground?		Yes
	- Installation depth in ground	(mm)	1000
	- Recommended method of protection of cables		-
	- Are cables laid in trough?		Yes
	- Minimum diameter of the trough	(mm)	-
	- Installation depth of the trough	(mm)	-
	- Installation formation (trefoil, flat)		Trefoil
	- Distance between phase		Touching
	- Distance between circuits		-
	- Is metallic shield bonded at cross bond?		Yes
	- Other installation conditions		-
45	Maximum permissible tensile force in pulling	(kN)	35.1
46	Dimension of cable trench	(mm)	-

47 Water tree problems

How are the cables protected against water trees?

- During the insulating process we utilize crosslinked compounds of extra clean quality and the process utilizes nitrogen curing and nitrogen cooling. This eliminates the presences of water during this critical process.

- After insulating the cable is wrapped with a water blocking tape and a lead sheath is extruded over the conductor to provide an impermeable barrier for moisture during the life of the cable. This lead sheath protects the cable from physical and chemical deterioration.

- The splicing and terminating kits are designed to insure that moisture will not be allowed to enter the cable.

Is water tree retardation tested or studied anyway in the cables? How?

- The water tree retardation has been studied by the manufactures of the compounds.

- We do an inspection on every length of cable for voids and contaminates per IEC and AEIC standards to insure the quality of cable and stability of the process.

Are there any guarantees that there shall be no water trees in the cables?

Every process in the manufacturing of the cable is designed to eliminate water treeing. By using the latest state of the art equipment and materials. This is the best guarantee for the service life to the cable.