Fire Performance Cables

Draka

Draka Cableteq | Australasia

Contents

Company Profile

Draka Holdings N.V. was first established in 1910 as Draka Kabel B.V.. Currently, our company has 67 operating companies spread out across three continents: Europe, North and South America, and Asia, in 29 countries, providing employment for more than 8,800 people worldwide.

Draka Holdings N.V. consists of two groups namely Draka Comteq, which specializes in communication cables; and Draka Cableteq, which specializes in low-voltage and special purpose cables.

Draka Cableteq

The Draka Cableteq group specializes in developing, producing and marketing a range of low-voltage and special-purpose cables for application in premises and for OEM application.

The group consists of six divisions:
Low-Voltage Cable, Elevator Cable, Marine, Oil & Gas, Rubber Cable, Mobile Network Cable and Transport.

Our main clientele for these products include electrical wholesalers, construction and installation companies, engineering and procurement companies, lift manufacturers, harness makers for car manufacturers and aerospace industry, shipbuilding, oil and gas industry, domestic and industrial appliance manufacturers and telecommunication companies engaged in mobile telecommunications.

Draka Cableteq Asia Pacific (DCAP)

Draka Cableteq | Australasia

Our regional headquarters for Australasia, Draka Cableteq's Australasian operations, reaches out to regional markets in Australia, Brunei, Indonesia, Malaysia, Myanmar, New Zealand, Thailand, and Vietnam.

Currently, Draka Australasia has three manufacturing plants placed strategically in Singapore, Malaysia and Thailand; a sales office in Australia, as well as representative offices in Indonesia and Vietnam.

Singapore Cables Manufacturers Pte Ltd

Singapore Cables Manufacturers Pte Ltd (SCM) is a subsidiary of Draka Cableteq Asia Pacific Holdings. SCM first started operations in 1975, and has since grown to be a market leader in Specialty Low-Voltage (Fire Resistant & Flame Retardant, and Instrumentation & Control) and Marine, Oil & Gas cables. Having served numerous companies in Singapore for over three decades, SCM established a strong market presence through a good track record of excellent customer service, reliability, and consistency in delivering products of sterling quality.

INTRODUCTION

Major accidents which have resulted in the deaths of many innocent people, have taught us that the safety of the occupants and users in public, commercial and industrial environments is of paramount importance. Every possible safety feature designed to prevent and protect against loss of life and damage to property should be specified and installed.

One such safety feature is the use of fire performance cables for critical safety systems, including fire alarms, emergency lighting, PA systems, CCTV systems, emergency power supplies and smoke & fire shutters.

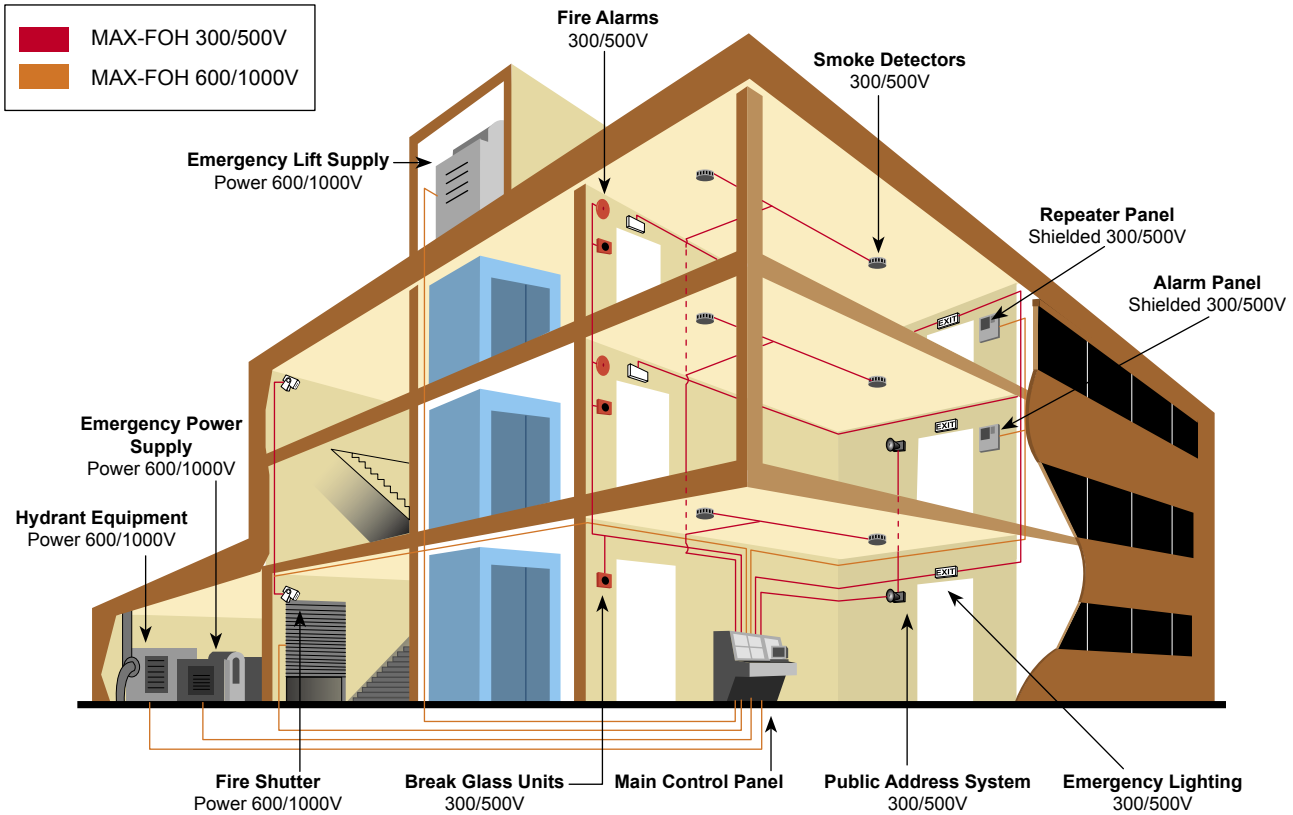
The correct selection and installation of these “life saving” cables helps ensure that in the event of an emergency, vital safety systems will continue to operate to assist an orderly evacuation of the premises and to aid the emergency services in gaining quick and effective entry to deal with the hazard.

Today’s modern architect is constantly aiming to build higher and larger structures, incorporating complex interiors within which we can both live and work. The construction of these new “super” structures inevitably means accommodating more people, with the added responsibility for their safety and well being resting with the specifiers and consultants responsible for the project.

At Draka, we understand what is required from a fire performance cable and we appreciate the pressures faced by specifiers and consultants in selecting the correct cable form the range available. For nearly twenty years, Draka special cables have been servicing the needs of the market by designing and manufacturing the widest range of fire performance cables available today.

APPLICATION

Draka fire performance cables are specifically designed to facilitate the quick and orderly evacuation of the buildings occupants in the events of an emergency. Purpose designed to maintain circuit integrity to a host of critical safety systems, including fire alarms, emergency lights, CCTV systems and emergency power supplies, MAX-FOH cables form a vital component of any safety system. The special characteristics of the MAX-FOH range make it suitable for an almost infinite number of applications and environments. The diagram below illustrates the main safety systems which should be fitted with either 300/500V or 600/1000V MAX-FOH cables.



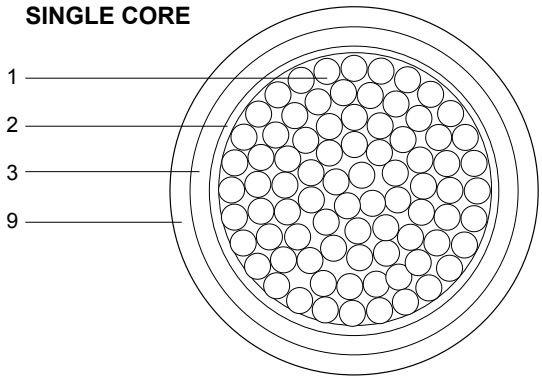
MAX-FOH

CONSTRUCTION OF CABLE

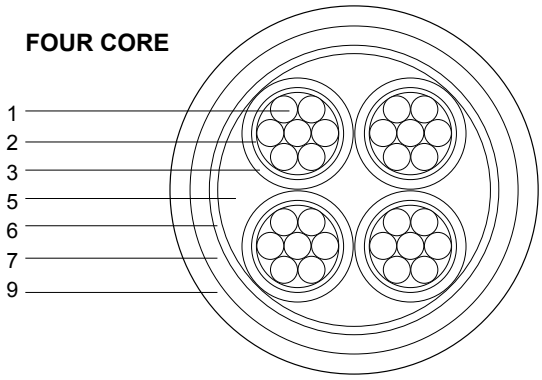
Construction	MAX-FOH	MAX-FOH-EVA
1 - Conductor	Stranded annealed copper	Stranded annealed copper
2 - Fire Barrier	Mica tape	Mica tape
3 - Insulation	Cross-linked polyethylene (XLPE)	Cross-linked EVA ** (XLEVA)
4 - Shield*	Aluminium foil with tinned copper drain wire	Aluminium foil with tinned copper drain wire
5 - Filler*	LSF filler or polypropylene split yarn	LSF filler or polypropylene split yarn
6 - Binder Tape*	Polyester tape	Polyester tape
7 - Bedding*	Low smoke halogen free (LSF) compound (Orange)	Low smoke halogen free (LSF) compound (Orange)
8 - Armour*/#	Galvanised steel wire (aluminium or copper wire for single core)	Galvanised steel wire (aluminium or copper wire for single core)
9 - Sheath	Low smoke halogen free (LSF) compound (Orange)	Low smoke halogen free (LSF) compound (Orange)

* Optional: Depending on requirement
\# Braided armour also available on request
** XLEVA material used are suitable for operating temperature of up to 125°C

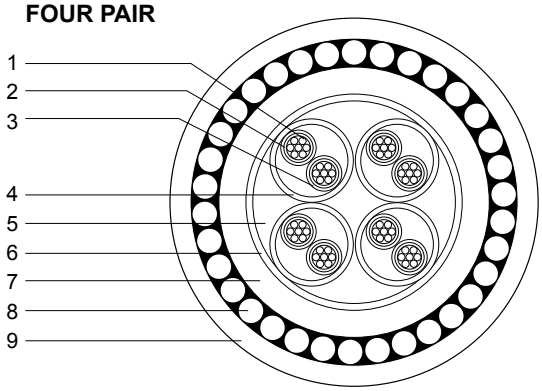
SINGLE CORE



FOUR CORE



FOUR PAIR



Identification of cores:

No. of cores	Single	Two	Three	Four	Five & above	Pairs
Colour	Natural or other colour on request	Red and Black	Red, Yellow and Blue	Red, Yellow, Blue and Black	Black with white numbering (others on request)	Black with white numbering

Note: Special construction and design to customers' specification can be provided upon request.

Applicable Standards

IEC 60502 **AS 3198**	Extruded solid dielectric insulated power cables for rated voltage of 1 kV up to 30 kV
IEC 60228 **BS 6360** **AS 1125**	Conductors of insulated cables
IEC 60754-1 **BS 6425-1** **AS 1660.5**	Test on gases evolved during combustion of electric cables - Determination of the amount of halogen acid gases
IEC 60754-2 **BS 6425-2** **AS 1660.5.4**	Test on gases evolved during combustion of electric cables - Determination of degree of acidity of gases evolved by measuring pH and conductivity
IEC 60331 **AS 1660.5.5**	Fire resistant characteristics of electric cable (750°C for 3 hours)
IEC 60332 Part 1 **BS 4066 Part 1**	Test on electric cables under fire conditions - Test on a single vertical insulated wire or cable
IEC 60332 Part 3 **BS 4066 Part 3** **Category A,B,C/AS 1660.5.1**	Test on electric cables under fire conditions - Test on bunched wires or cables
IEC 61034 **BS 7622** **AS1660.5.2**	Measurement of smoke density of electric cables burning under defined conditions
BS 6378 **SS 299 Part 1**	Performance requirements for cables required to maintain circuit integrity under fire conditions - Category C tested at 950°C for 3 hours Category W: fire with water Category Z: fire with mechanical shock
BS 6724	Armoured cables for electricity supply having thermosetting insulation with low emission of smoke and corrosive gases when affected by fire
BS 7211	Thermosetting insulated cables (non-armoured) for electric power and lighting with low emission of smoke and corrosive gases when affected by fire
BS 7846	600/1000V armoured fire-resistant electric cables having low emission of smoke and corrosive gases when affected by fire
AS 3013	Electrical installations - Classification of the fire and mechanical performance of wiring systems

* Standards applied will vary depending on cable construction.

Comparision between test standards IEC 60331 & SS 299 Part 1

Ref	Description of tests	IEC 60331	0.6/1kV cables	Data Cables	Optical fibre cables	SS 299 Part 1	0.6/1kV cables	Data Cables	Optical fibre cables
1	**Resistance to FIRE alone**	Part 21							
	Flame temperature / Duration	750°C/90 min	✓	✓	✓	Cat A- 650°C/3hr Cat B- 750°C/3hr Cat C- 950°C/3hr Cat S - 650°C/20min	✓ ✓ ✓ ✓		
2	**Resistance to FIRE with mechanical shock**	Part 12							
	Flame temperature / Duration	830°C/120 min	✓			Cat X- 650°C/3hr Cat Y- 650°C/3hr Cat Z- 650°C/3hr	✓ ✓ ✓		
	Mechanical shock	Every 5 min	✓			Every 30 sec	✓		
3	**Resistance to FIRE with water spray**								
	Flame temperature / Duration	Not available				Cat W- 650°C/15min	✓		
4	**Other tests**								
	Electrical requirements for completed cables	Not available				Available	✓		
	Bending characteristics	Not available				Available	✓		
	Resistance of cable to impact	Not available				Available	✓		

STANDARDS AND APPROVALS

BS 6387/SS 299: 1994 - Fire, FIre with Water & Fire with Mechanical Shock Tests

The following test is the nationally recognised United Kingdom and Singapore test used to determine if a cable is capable of maintaining circuit integrity under fire conditions, fire with water and fire with mechanical shock. These tests use a number of alternative time and temperature parameters and depending on the level achieved by the cable, a corresponding letter is assigned to denote the category the cable passed.

Resistance to fire:	Symbol
650°C for 3 hours	A
750°C for 3 hours	B
950°C for 3 hours	C
950°C for 20 minutes	S

Resistance to fire and water:	Symbol
650°C for 15 minutes, then for 15 minutes with fire and water	W

Resistance to fire with mechanical shock:	Symbol
650°C for 15 minutes, with 30 second hammer blows	X
750°C for 15 minutes, with 30 second hammer blows	Y
950°C for 15 minutes, with 30 second hammer blows	Z

During the tests the cables are energised at their rated voltage.

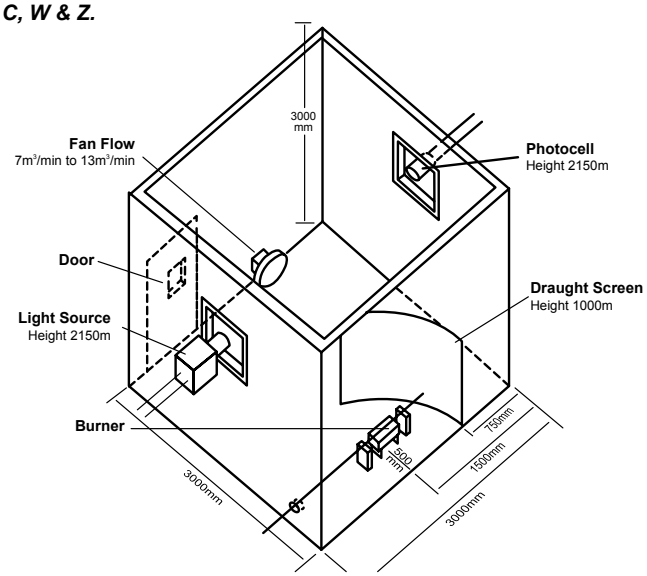
MAX-FOH cables meet the highest categories of BS 6387 i.e. C, W & Z.

IEC 61034 - Smoke Density Test

This test measures the smoke emission from electric cables during fire. The test is carried out in a 3m cubed chamber where a cable sample is subjected to fire.

The smoke emission and density are measured by transmitting a beam of light across the inside of the chambers to a photo electric cell which measures the amount of light received.

All MAX-FOH cables comply to IEC 61034 requirements.



IEC 60754 - Acid Gas Emission Test

Due to the concern regarding the amount of acid gas which could be produced when cables are burnt, this international test was developed to determine the amount of gas evolved by burning cables.

The recommended values of the test state that the weighted pH value should not be less than 4.3, when related to 1 litre of water. The weighted value of conductivity should not exceed 10us/mm.

MAX-FOH cables meet the above requirements.

IEC 60331 - Fire Test

This international fire test is designed to establish whether a cable can maintain circuit integrity during and after exposure to fire.

A sample of cable is exposed to fire for 3 hours at a temperature of between 750°C and 800°C, after 3 hours the fire is extinguished and the current is turned off. After a further 12 hours, the sample of cable is re-energised and must maintain its circuit integrity.

MAX-FOH cables meet the requirements of IEC 60331.

IEC 60332 Part 3 - Flame Propagation Test

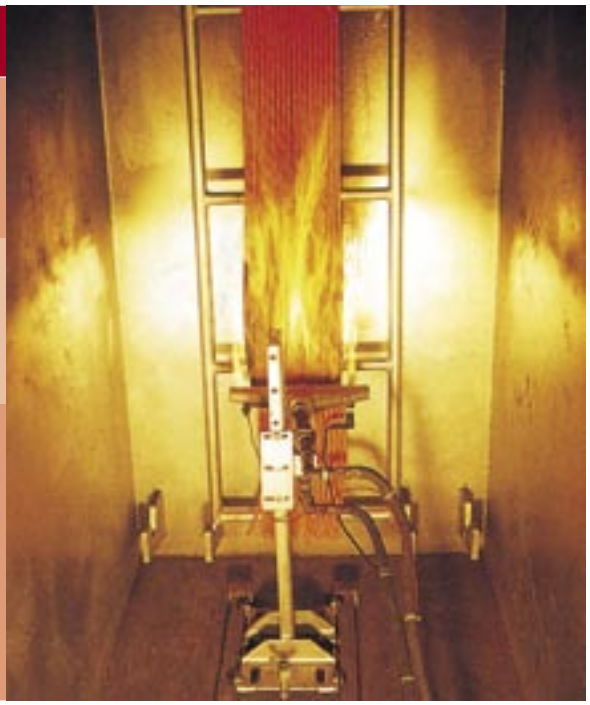
This test defines the ability of bunched cables to restrict vertical flame propagation when laid in trunking, cable trays or conduit. The test comprises of 3 categories each determined by the amount of combustible material in a 1 metre sample, as shown in the table below.

Category	A	B	C	D
No. of litres of combustible material in a 1 metre sample.	7	3.5	1.5	0.5
Exposure (mins)	40	40	20	20

The cable samples are placed vertically next to one another on a vertical ladder where they are exposed to fire from a ribbon gas burner for the pre-arranged times.

After burning, the samples are wiped clean to examine for char (the crumbling) fo the cable surface. The charring should not have reached a height exceeding 2.5m above the bottom edge of the burner.

MAX-FOH cables meet the requirement of IEC 60332 part 3



Additional Considerations

As well as the requirements written into International and British cable standards, there are other essential criteria which designers and consultants need to consider - Is the cable able to withstand voltage spikes, transmit data and prevent flame propagation?

All MAX-FOH cables do comply with these additional benefits, including the added advantage that MAX-FOH requires fewer joints in a cable run compare to mineral, reducing the risk of weak links in the chain. MAX-FOH does not require complicated terminations and is therefore quicker and easier to install.

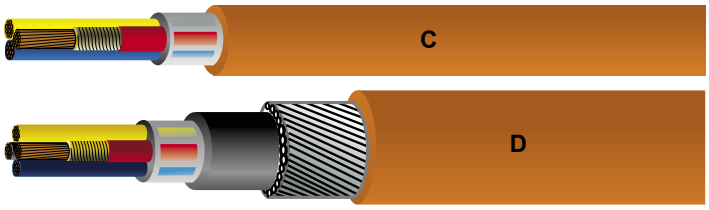
TABLE OF CONSTRUCTION

600/1000V, Unarmoured and Armoured Fire Resistant Cables

Table 1

	(A) Unarmoured Cables								(B) Armoured Cables				
		Insulated, non-sheathed			Insulated and Sheathed				Insulated and Sheathed				
	Nominal area of conductor	Insulation Thickness	Approx. diameter overall	Approx. weight	Insulation Thickness	Sheath Thickness	Approx. diameter overall	Approx. weight	Bedding Thickness	Armour wire diameter	Sheath Thickness	Approx. diameter overall	Approx. weight
	mm^2	mm	mm	kg/km	mm	mm	mm	kg/km	mm	mm	mm	mm	kg/km
Single Core	1.5	0.7	3.9	32	0.7	1.4	6.4	55	-	-	-	-	-
	2.5	0.8	4.6	43	0.7	1.4	6.8	70	-	-	-	-	-
	4	0.8	5.1	55	0.7	1.4	7.4	90	-	-	-	-	-
	6	0.8	5.6	85	0.7	1.4	7.9	110	-	-	-	-	-
	10	1.0	7.1	146	0.7	1.4	8.9	160	-	-	-	-	-
	16	1.0	8.1	198	0.7	1.4	9.9	220	-	-	-	-	-
	25	1.2	9.8	320	0.9	1.4	12.2	330	-	-	-	-	-
	35	1.2	10.9	410	0.9	1.4	13.5	430	-	-	-	-	-
	50	1.4	13.4	549	1.0	1.4	15.0	560	1.0	0.90	1.8	2.0	800
	70	1.4	15.2	770	1.1	1.4	17.0	770	1.0	1.25	1.8	22.5	1000
	95	1.6	17.6	1140	1.1	1.5	19.0	1040	1.0	1.25	1.8	24.0	1400
	120	1.6	19.3	1425	1.2	1.5	20.8	1290	1.0	1.60	1.8	27.0	1700
	150	1.8	21.3	1720	1.4	1.6	23.0	1580	1.0	1.60	1.8	29.0	2000
	185	2.0	23.7	2155	1.6	1.6	25.3	1950	1.0	1.60	1.9	31.3	2400
	240	2.2	26.8	2900	1.7	1.7	28.3	2530	1.0	1.60	2.0	35.0	3300
	300	2.4	29.7	3540	1.8	1.8	31.0	3140	1.0	1.60	2.1	37.0	3800
	400	2.6	33.3	4410	2.0	1.9	34.7	3970	1.2	2.00	2.3	42.0	4800
	500	2.8	37.2	5660	2.2	2.0	38.5	4970	1.2	2.00	2.4	46.0	5900
	630	2.8	41.3	7140	2.4	2.2	43.5	6400	1.2	2.00	2.5	51.0	7400
	800	-	-	-	2.6	2.3	48.0	8000	1.4	2.50	2.8	57.0	9400
	1000	-	-	-	2.8	2.4	53.2	10200	1.4	2.50	2.9	62.0	11000
Two Cores	1.5	-	-	-	0.7	1.8	10.4	150	1.0	0.90	1.8	15.0	400
	2.5	-	-	-	0.7	1.8	11.2	180	1.0	0.90	1.8	16.0	450
	4	-	-	-	0.7	1.8	12.3	240	1.0	0.90	1.8	17.0	530
	6	-	-	-	0.7	1.8	13.5	300	1.0	0.90	1.8	18.0	620
	10	-	-	-	0.7	1.8	15.7	420	1.0	1.25	1.8	20.0	900
	16	-	-	-	0.7	1.8	17.8	590	1.0	1.25	1.8	22.0	1050
	25	-	-	-	0.9	1.8	21.2	860	1.0	1.60	1.8	26.5	1600
	35	-	-	-	0.9	1.8	23.7	1120	1.0	1.60	1.9	29.0	1964

A Unarmoured cables
B Armoured cables

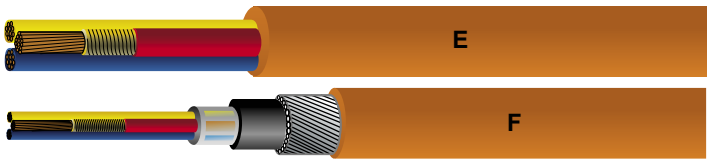


600/1000V, Unarmoured and Armoured Fire Resistant Cables

Table 2

	(C) Unarmoured Cables					(D) Armoured Cables				
	Nominal area of conductor	Insulation Thickness	Sheath Thickness	Approx. diameter overall	Approx. weight	Bedding Thickness	Armour wire diameter	Sheath Thickness	Approx. diameter overall	Approx. weight
	mm^2	mm	mm	mm	kg/km	mm	mm	mm	mm	kg/km
Three Cores	1.5	0.7	1.8	11.4	170	1.0	0.90	1.8	15.9	450
	2.5	0.7	1.8	12.3	215	1.0	0.90	1.8	16.8	510
	4	0.7	1.8	13.44	280	1.0	0.90	1.8	18.0	610
	6	0.7	1.8	14.7	360	1.0	1.25	1.8	20.0	820
	10	0.7	1.8	16.7	510	1.0	1.25	1.8	21.6	1000
	16	0.7	1.8	18.5	740	1.0	1.25	1.8	23.8	1300
	25	0.9	1.8	22.0	1100	1.0	1.60	1.8	28.0	1900
	35	0.9	1.8	25.0	140	1.0	1.60	1.8	31.0	2400
	50	1.0	1.8	28.0	1900	1.0	1.60	1.9	34.5	3000
	70	1.1	1.9	32.0	2600	1.2	2.00	2.1	40.5	4300
	95	1.1	2.0	37.0	3500	1.2	2.00	2.2	45.0	5400
	120	1.2	2.1	42.0	4400	1.2	2.00	2.3	49.0	6600
	150	1.4	2.4	47.0	5500	1.4	2.50	2.5	55.0	8300
	185	1.6	2.4	52.0	6800	1.4	2.50	2.7	60.0	10000
	240	1.7	2.6	58.0	8800	1.4	2.50	2.9	67.0	12000
	300	1.8	2.7	64.0	10000	1.6	2.50	3.0	74.0	15000
Four Cores	1.5	-	1.8	12.3	200	1.0	0.90	1.8	16.6	500
	2.5	-	1.8	13.3	255	1.0	0.90	1.8	17.7	580
	4	-	1.8	14.6	335	1.0	1.25	1.8	19.5	800
	6	-	1.8	16.0	440	1.0	1.25	1.8	21.0	950
	10	-	1.8	18.2	640	1.0	1.25	1.8	23.0	1200
	16	-	1.8	21.0	915	1.0	1.60	1.8	26.4	1700
	25	-	1.8	25.6	1410	1.0	1.60	1.8	30.5	2300
	35	0.9	1.8	28.6	1500	1.0	1.60	1.9	34.2	2900
	50	1.0	1.8	32.1	1950	1.0	2.00	2.0	39.0	3900
	70	1.1	2.0	37.0	3100	1.2	2.00	2.2	44.0	4900
	95	1.1	2.1	42.0	3600	1.2	2.00	2.3	49.0	6600
	120	1.2	2.3	47.0	5700	1.4	2.50	2.5	45.0	8500
	150	1.4	2.4	51.7	7000	1.4	2.50	2.7	60.0	9900
	185	1.6	2.6	57.7	8700	1.4	2.50	2.8	66.0	12000
	240	1.7	2.8	65.0	11000	1.6	3.15	3.1	75.0	16000
	300	1.8	3.0	71.6	14000	1.6	3.15	3.2	82.0	19000

C Unarmoured cables
D Armoured cables
* Multicore unarmoured and armoured fire resistant cables are available upon request

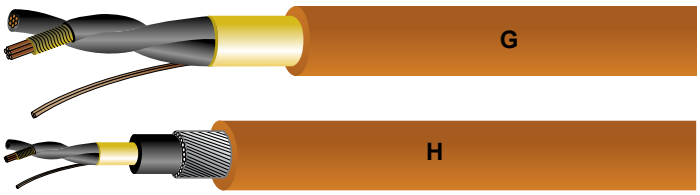


300/500V, Unarmoured and Armoured Fire Resistant Cables

Table 3

	(E) Unarmoured Cables						(F) Armoured Cables				
	Nominal area of conductor	No. & Diameter of wires	Insulation Thickness	Sheath Thickness	Approx. diameter overall	Approx. weight	Bedding Thickness	Armour wire diameter	Sheath Thickness	Approx. diameter overall	Approx. weight
	mm^2	No./mm	mm	mm	mm	kg/km	mm	mm	mm	mm	kg/km
Single core	0.75	7/0.37	0.55	0.5	4.1	22	0.5	0.9	1.4	8.9	155
	1	7/0.44	0.55	0.5	4.3	26	0.5	0.9	1.4	9.1	165
	1.5	7/0.53	0.55	0.5	4.6	32	0.5	0.9	1.4	9.4	180
	2.5	7/0.67	0.55	0.5	5.0	43	0.5	0.9	1.4	9.8	200
	4	7/0.85	0.55	0.5	5.6	60	0.5	0.9	1.4	10.4	240
Two cores	0.75	7/0.37	0.55	0.5	7.0	64	0.5	0.9	1.4	11.8	285
	1	7/0.44	0.55	0.5	7.4	74	0.5	0.9	1.4	12.2	310
	1.5	7/0.53	0.55	0.5	8.0	92	0.5	0.9	1.4	12.8	345
	2.5	7/0.67	0.55	0.5	8.8	120	0.5	0.9	1.4	13.6	400
	4	7/0.85	0.55	0.5	9.9	165	0.5	0.9	1.4	14.7	475
Three cores	0.75	7/0.37	0.55	0.5	7.5	75	0.5	0.9	1.4	12.3	310
	1	7/0.44	0.55	0.5	7.9	88	0.5	0.9	1.4	12.7	355
	1.5	7/0.53	0.55	0.5	8.5	110	0.5	0.9	1.4	13.3	375
	2.5	7/0.67	0.55	0.5	9.4	150	0.5	0.9	1.4	14.2	445
	4	7/0.85	0.55	0.5	10.6	205	0.5	0.9	1.4	15.4	535
Four cores	0.75	7/0.37	0.55	0.5	8.3	90	0.5	0.9	1.4	13.1	360
	1	7/0.44	0.55	0.5	8.7	105	0.5	0.9	1.4	13.5	380
	1.5	7/0.53	0.55	0.5	9.4	135	0.5	0.9	1.4	14.2	430
	2.5	7/0.67	0.55	0.5	10.4	180	0.5	0.9	1.4	15.2	500
	4	7/0.85	0.55	0.5	11.7	255	0.5	0.9	1.5	16.7	620

E Unarmoured fire resistant cables
F Armoured fire resistant cables
* Multicore unarmoured and armoured fire resistant cables are available upon request



300/500V, Unarmoured and Armoured Shielded Fire Resistant Cables

Table 4

	(E) Unarmoured Cables						(F) Armoured Cables				
	Nominal area of conductor	No. & Diameter of wires	Insulation Thickness	Sheath Thickness	Approx. diameter overall	Approx. weight	Bedding Thickness	Armour wire diameter	Sheath Thickness	Approx. diameter overall	Approx. weight
	mm^2	No./mm	mm	mm	mm	kg/km	mm	mm	mm	mm	kg/km
Single pair	0.75	7/0.37	0.5	0.8	7.9	65	0.8	0.9	1.4	12.7	300
	1	7/0.43	0.6	0.8	8.5	75	0.8	0.9	1.4	13.3	340
	1.5	7/0.53	0.6	0.8	9.1	90	0.8	0.9	1.4	13.9	370
	2.5	7/0.67	0.6	0.8	9.9	110	0.8	0.9	1.4	14.7	420
Two pairs	0.75	7/0.37	0.5	0.8	10.0	100	0.8	0.9	1.4	14.8	410
	1	7/0.43	0.6	0.9	11.0	125	0.9	0.9	1.4	15.8	460
	1.5	7/0.53	0.6	0.9	11.8	150	0.9	0.9	1.5	16.8	520
	2.5	7/0.67	0.6	1.0	13.1	205	1.0	0.9	1.5	18.1	605
Three pairs	0.75	7/0.37	0.5	1.0	12.2	145	1.0	0.9	1.5	17.2	565
	1	7/0.43	0.6	1.0	13.1	170	1.0	0.9	1.5	18.1	600
	1.5	7/0.53	0.6	1.0	14.1	215	1.0	0.9	1.6	19.3	655
	2.5	7/0.67	0.6	1.1	15.7	290	1.1	1.25	1.6	21.6	920
Four pairs	0.75	7/0.37	0.5	1.0	13.7	180	1.0	0.9	1.5	18.7	600
	1	7/0.43	0.6	1.0	14.7	215	1.0	1.25	1.6	20.6	820
	1.5	7/0.53	0.6	1.1	16.1	280	1.1	1.25	1.6	22.0	920
	2.5	7/0.67	0.6	1.1	17.7	370	1.1	1.25	1.6	23.8	1090

G Unarmoured fire resistant cables
H Armoured fire resistant cables
* Multipairs unarmoured and armoured shielded fire resistant cables are available upon request

SELECTION OF CROSS-SECTIONAL AREA OF CONDUCTOR

In order to choose the right power cable, one has to consider:

- the current
- the voltage drop
- the short circuit rating
- the installation methods
- the ambient temperature
- the frequency and harmonic current
- maximum safe length at short circuit

Current Rating

When electric current flows through the conductor of a cable, the electrical resistance of the conductor generates heat. When a temperature greater than that allowed is reached by the cable due to heat generation, a larger conductor size (with lower electrical resistance) has to be selected. Other important considerations are methods of installation of the cable and ambient temperature. Calculation which takes into account all criteria are described in IEC 60287 and are rather complex. In general, preferences is given to standard current rating tables which are issued by national standardization bureaus.

The current rating given in Table 4 to 14 are based on the following standard conditions of the installation.

1. Maximum operating temperature of conductor = 90°C
2. Ambient air temperature = 30°C
3. Ground temperature = 15°C
4. Soil thermal resistivity = 1.2°C m/w
5. Depth of laying (For cable laid direct in the ground) = 0.5m

Voltage Drop

Another important factor for the determination of the conductor size is the voltage drop. The voltage drop of the cable at a given current is caused by losses in the cable. In case of a too high voltage drop, it is necessary to choose a bigger conductor size. The voltage drop in a cable demotes the difference in voltage at the beginning and at the end of the cable. It depends on:

- the current carried
- the power factor
- the length of the cable
- the resistance of the cable
- reactance of the cable

The permissible voltage drop is usually stated as a percentage of the circuit voltage.

According to CP5:1998 regulation 525-01-01, it is stipulated that the total voltage drop for any particular cable run must be such that the voltage drop in the circuit of which the cable forms a part does not exceed 4% of the nominal voltage of the supply.

Selection of Cable based on Voltage Drop and Current using Tables

Since the actual power factor of the load is usually not known, the most practical approach to the question of the voltage drop is to assume the worst conditions, i.e. power factor equal to one and the conductor is at maximum operating temperature. The voltage drop values given in the tables are based on these assumptions.

The values of the voltage drop (Vd) are tabulated for a current of one Ampere for a 1 metre run, the value of voltage drop needs to be multiplied by the length of the run, in metre, and by the current, in Ampere that the cables are to carry.

V=Vd x I x L

Where V = Voltage
Vd = Approximate Voltage drop/Ampere/metre
I = Current in Ampere per phase
L = Route length in metres

Example:
Given that the supply voltage is 415V, 3 phase 50Hz and that the cable used is a 4C Cu/mica/XLPE/SWA/PVC fire resistant cable. Required cable is to be installed in ground and to carry a 250 Amp load per phase over a route length of 100m. Cable installation is to be in compliance with CP5: 1998 Regulation 522.08 regulation.

V=Vd x I x L

Maximum permissible voltage drop
Vmax = 4% of 415V
Vmax = 16.6V

Voltage drop/ampere/metre

$$Vd = \frac{Vmax}{I \times L} = \frac{16.6V}{250 \times 100} = \mathbf{0.66mV}$$

Select from Table 10 (pg 32) such that the Vd value is equal to, or less than the calculated 0.66mV, at the same time ensuring that it will carry the current. It will be seen that this value is 0.61 giving a cable size of 70mm^2.

Handling and installation of FR cable

Minimum bending radius

Type of cable	Unarmoured		Armoured
Number of cores	Single core	Multicore	
300/500V and 600/1000V cable	8D	6D	10D

where D: diameter of cable

Side wall pressure to cable

Permissable maximum side wall pressure to the cable at bending point during installattion is 500kgf/m.

$$\text{Side wall pressure to cable} = \frac{\text{Pulling tension (kgf)}}{\text{Bending radius (m)}}$$

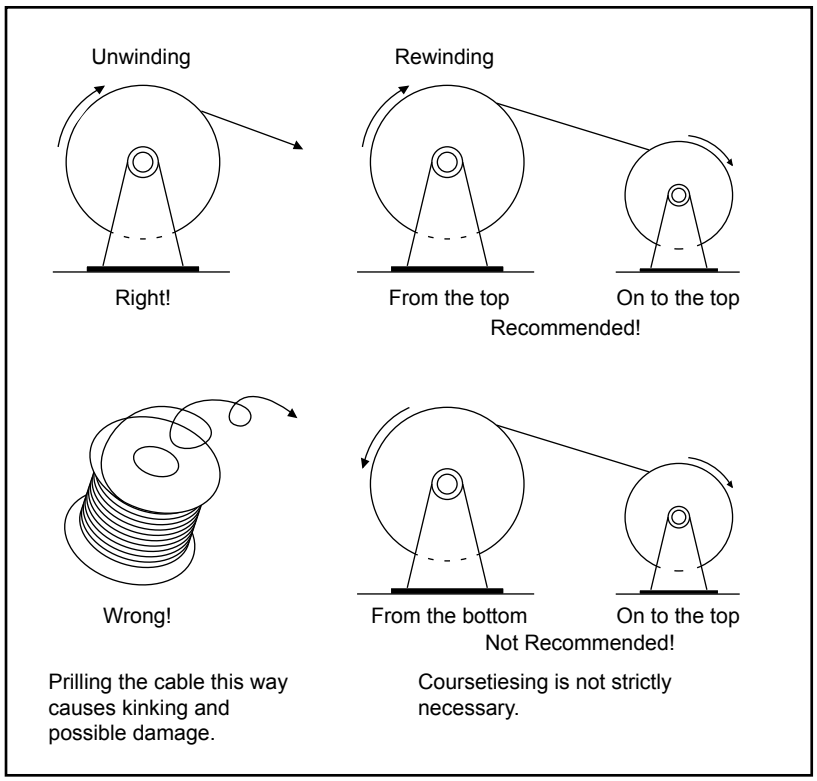
$$= \frac{T}{R}$$

Permissable maximum pulling tension (T)

Conductor	(Tension kgf)
Copper	7 x (No. of cores) x (cross-sectional area of conductor)

Drum handling

Handle the drums with care! It is always recommended and a must with heavy drums - to lift drums with a fork-lift truck or a crane when removing them from the vehicle. Always take care to lower the drums into an upright position on their flanges.



LSF

LOW SMOKE
HALOGEN FREE
CABLES

DRAKA SCM LOW SMOKE HALOGEN FREE CABLES

In certain applications, cables under fire conditions have become a major concern. When conventional cables burn, they may emit smoke, halogen and toxic gases that may obscure vision and may be harmful to both equipment and human beings.

After years of research and development, SCM is manufacturing and supplying Low Smoke Halogen Free Cables which meets the severe requirements of cables under fire condition.

Unlike conventional cables, Low Smoke Halogen Free Cables have the following characteristics:-

1. **Low Smoke**: When the cable is on fire, it does not liberate large volume of dense black smoke. These cables when ignited will only produce a limited amount of smoke. This property helps to improve safety in areas where there are limited means to escape in the event of an emergency, or where large crowds are regularly in attendance.

2. **Halogen Free**: When the cable is on fire, it does not emit any halogen gases. These are acidic and will attack equipment and human beings. The property helps to protect computer, electronic/ communication equipment and reduces thee toxicity of thee gases emitted from the fire. This reduces the risk of personnel engaged in vital operations being incapacitated and the safe escape of people in an emergency.

With the superior fire performance, these range of cables are recommended for use in the following areas:

1. Underground tunnels, lifts, power stations
2. Mass Rapid Transit System
3. Airports
4. Large buildings/Multi Story Buildings
5. Critical areas of an installations e.g. escape route of an installation
6. Oil Platforms/Ships
7. Areas where masses of people gather and areas with limited means of escape in the event of a fire
8. Military installations/equipment/machines
9. Critical circuits that must continue to operate in case of a fire. e.g. Fire alarms, emergency lifts, pumps circuits etc.

CHARACTERISTICS OF LOW SMOKE HALOGEN FREE CABLES

Applicable test methods/standards for Low Smoke Halogen Free Property

Performance in Fire Tests

Fire Propagation

IEC 60332 PART 3	(International)
BS 4066 PART 3	(UK)
CEI 20-22	(Italy)
VDE 804C	(Germany)
NF C 32-070 CAT. C1	(France)
IEEE 383	(USA)
UL 1581	(USA)
UL 1666	(USA)
FT4	(Canada)
AS 1660.5.1	(Australia)

Cables jacketed with polyethylene or certain types of PVC compounds have the potential to spread or propagate a fire along a cable run. Many international bodies have devised tests designed to assess this property. SCM LSF Cables are flame retardant and hence both hard to ignite and only burn with difficulty. Cables jacketed with LSF compounds have consistently been found to comply with most of these needs.

Acid Gas

IEC 60754 PART 1	(International)
IEC 60754 PART 2	(International)
CEI 20-37 PART 1	(Italy)
VDE 0472 PART 813	(Germany)
NF C 20-453	(France)
AS 1660.5.4	(Australia)

Many flame retardant compounds are based on halogen containing chemicals. Halogen can be present as part of the polymer e.g. PVC or may be a component of a flame retardant additive. When burnt, these materials liberate acidic gases such as hydrochloric gas which, when in contact with electrical or electronic components, can cause very expensive corrosion damage. The cost of thee secondary damage can far exceed those attributed to flame damage, particularly when associated with computer and communication equipment. SCM LSF Cables are designed not to release acidic gases.

Smoke

IEC 61034	(International)
UITP E4	(International)
BS 7622	(UK)
UTE C 20-452	(France)
CEI 20-37 PART 3 - METHOD	(Italy)
ASTM E662	(USA)
AS 1660.5.2	(Australia)

Several materials used in the manufacture of electric wires and cables can liberate large volumes of dense black smoke when ignited. SCM LSF Cables however, are designed to produce only limited amounts of smoke when they are exposed to fire. This property helps to improve safety in areas where there are limited means of escape in the event of an emergency, or where large crowds are regularly in attendance.

Toxicity

Naval Engineering Standard 713	(UK)
CEI 20-37 PART 2	(Italy)
NF C 20-454	(France)

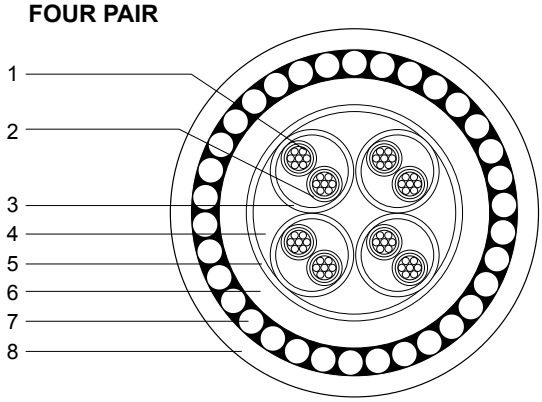
The evolution of toxic fumes from burning materials has been of concern to a variety of industries. In the case of electric wires and cables, toxic gases are of particular importance where they may hamper the safe escape of people in an emergency, or incapacitate personnel engaged in vital operations. SCM LSF Cables do not liberate the highly toxic species generated by some other cable materials as in the case of SCM LSF Cables the main products of combustion are water and carbon dioxide. SCM LSF Cables comply with most military toxic gas evolution specifications.

CONSTRUCTION OF CABLE

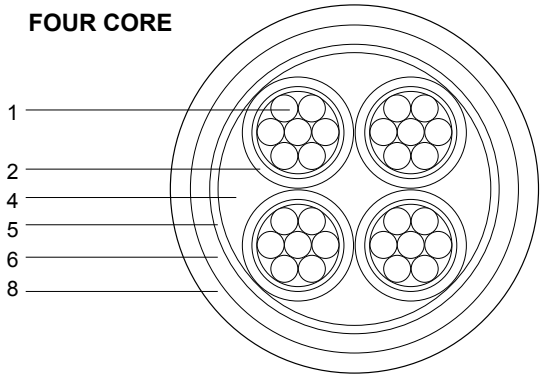
Construction	
1 - Conductor	Stranded annealed copper
2 - Insulation	XLPE or Low smoke halogen free (LSF) compound
3 - Shield*	Aluminium foil with tinned copper drain wire
4 - Filler*	LSF filler or polypropylene split yarn
5 - Binder Tape*	Polyester tape
6 - Bedding*	Low smoke halogen free (LSF) compound
7 - Armour*/#	Galvanised steel wire (aluminium or copper wire for single core)
8 - Sheath	Low smoke halogen free (LSF) compound

* Optional: Depending on requirement
\# Braided armour also available on request

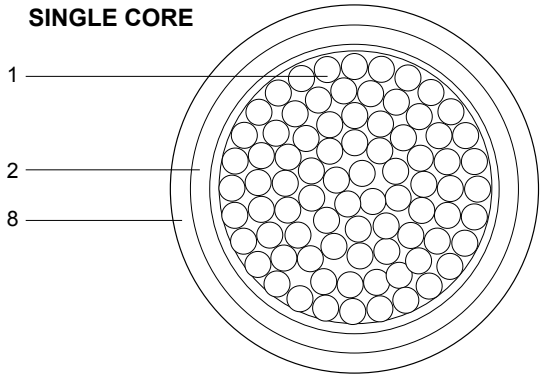
FOUR PAIR



FOUR CORE



SINGLE CORE



Identification of cores:

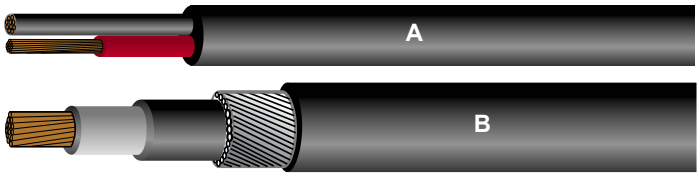
No. of cores	Single	Two	Three	Four	Five & above	Pairs
Colour	Natural or other colour on request	Red and Black	Red, Yellow and Blue	Red, Yellow, Blue and Black	Black with white numbering (others on request)	Black with white numbering

Note: Special construction and design to customers' specification can be provided upon request.

Applicable Standards

IEC 60502-1	Extruded solid dielectric insulated power cables for rated voltage of 1 kV up to 30 kV
IEC 60228/BS 6360	Conductors of insulated cables
IEC 60754-1/BS 6425-1	Test on gases evolved during combustion of electric cables - Determination of the amount of halogen acid gases
IEC 60754-2/BS 6425-2	Test on gases evolved during combustion of electric cables - Determination of degree of acidity of gases evolved by measuring PH and conductivity
IEC 61034/BS 7622	Measurement of smoke density of electric cables burning under defined conditions
BS 6724	Armoured cables for electricity supply having thermosetting insulation with low emission of smoke and corrosive gases when affected by fire
BS 7211	Thermosetting insulated cables (non-armoured) for electric power and lighting with low emission of smoke and corrosive gases when affected by fire
BS 7846	600/1000V armoured fire-resistant electric cables having low emission of smoke and corrosive gases when affected by fire

TABLE OF CONSTRUCTION

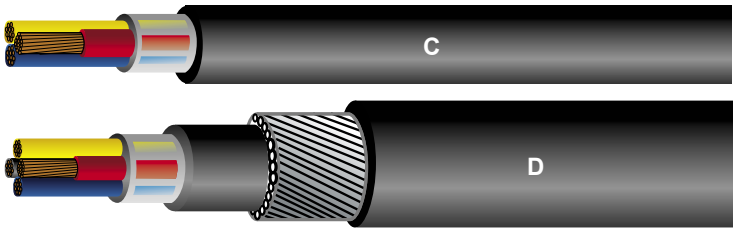


600/1000V, Unarmoured and Armoured LSF Cables

Table 1

	(A) Unarmoured Cables								(B) Armoured Cables				
		Insulated, non-sheathed			Insulated and Sheathed				Insulated and Sheathed				
	Nominal area of conductor	Insulation Thickness	Approx. diameter overall	Approx. weight	Insulation Thickness	Sheath Thickness	Approx. diameter overall	Approx. weight	Bedding Thickness	Armour wire diameter	Sheath Thickness	Approx. diameter overall	Approx. weight
	mm^2	mm	mm	kg/km	mm	mm	mm	kg/km	mm	mm	mm	mm	kg/km
Single Core	1.5	0.7	3.9	32	0.7	1.4	6.4	55	-	-	-	-	-
	2.5	0.8	4.6	43	0.7	1.4	6.8	70	-	-	-	-	-
	4	0.8	5.1	55	0.7	1.4	7.4	90	-	-	-	-	-
	6	0.8	5.6	85	0.7	1.4	7.9	110	-	-	-	-	-
	10	1.0	7.1	146	0.7	1.4	8.9	160	-	-	-	-	-
	16	1.0	8.1	198	0.7	1.4	9.9	220	-	-	-	-	-
	25	1.2	9.8	320	0.9	1.4	12.2	330	-	-	-	-	-
	35	1.2	10.9	410	0.9	1.4	13.5	430	-	-	-	-	-
	50	1.4	13.4	549	1.0	1.4	15.0	560	1.0	0.90	1.8	2.0	800
	70	1.4	15.2	770	1.1	1.4	17.0	770	1.0	1.25	1.8	22.5	1000
	95	1.6	17.6	1140	1.1	1.5	19.0	1040	1.0	1.25	1.8	24.0	1400
	120	1.6	19.3	1425	1.2	1.5	20.8	1290	1.0	1.60	1.8	27.0	1700
	150	1.8	21.3	1720	1.4	1.6	23.0	1580	1.0	1.60	1.8	29.0	2000
	185	2.0	23.7	2155	1.6	1.6	25.3	1950	1.0	1.60	1.9	31.3	2400
	240	2.2	26.8	2900	1.7	1.7	28.3	2530	1.0	1.60	2.0	35.0	3300
	300	2.4	29.7	3540	1.8	1.8	31.0	3140	1.0	1.60	2.1	37.0	3800
	400	2.6	33.3	4410	2.0	1.9	34.7	3970	1.2	2.00	2.3	42.0	4800
	500	2.8	37.2	5660	2.2	2.0	38.5	4970	1.2	2.00	2.4	46.0	5900
	630	2.8	41.3	7140	2.4	2.2	43.5	6400	1.2	2.00	2.5	51.0	7400
	800	2.8	-	-	2.6	2.3	48.0	8000	1.4	2.00	2.8	57.0	9400
	1000	3.0	-	-	2.8	2.4	53.2	10200	1.4	2.00	2.9	62.0	11000
Two Cores	1.5	-	-	-	0.7	1.8	10.4	150	1.0	0.90	1.8	15.0	400
	2.5	-	-	-	0.7	1.8	11.2	180	1.0	0.90	1.8	16.0	450
	4	-	-	-	0.7	1.8	12.3	240	1.0	0.90	1.8	17.0	530
	6	-	-	-	0.7	1.8	13.5	300	1.0	0.90	1.8	18.0	620
	10	-	-	-	0.7	1.8	15.7	420	1.0	1.25	1.8	20.0	900
	16	-	-	-	0.7	1.8	17.8	590	1.0	1.25	1.8	22.0	1050
	25	-	-	-	0.9	1.8	21.2	860	1.0	1.60	1.8	26.5	1600
	35	-	-	-	0.9	1.8	23.7	1120	1.0	1.60	1.9	29.0	1964

A Unarmoured cables
B Armoured cables

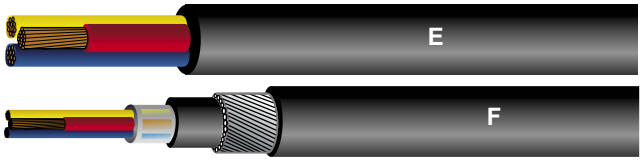


600/1000V, Unarmoured and Armoured LSF Cables

Table 2

	(C) Unarmoured Cables					(D) Armoured Cables				
	Nominal area of conductor	Insulation Thickness	Sheath Thickness	Approx. diameter overall	Approx. weight	Bedding Thickness	Armour wire diameter	Sheath Thickness	Approx. diameter overall	Approx. weight
	mm^2	mm	mm	mm	kg/km	mm	mm	mm	mm	kg/km
Three Cores	1.5	0.7	1.8	11.4	170	1.0	0.90	1.8	15.9	450
	2.5	0.7	1.8	12.3	215	1.0	0.90	1.8	16.8	510
	4	0.7	1.8	13.44	280	1.0	0.90	1.8	18.0	610
	6	0.7	1.8	14.7	360	1.0	1.25	1.8	20.0	820
	10	0.7	1.8	16.7	510	1.0	1.25	1.8	21.6	1000
	16	0.7	1.8	18.5	740	1.0	1.25	1.8	23.8	1300
	25	0.9	1.8	22.0	1100	1.0	1.60	1.8	28.0	1900
	35	0.9	1.8	25.0	140	1.0	1.60	1.8	31.0	2400
	50	1.0	1.8	28.0	1900	1.0	1.60	1.9	34.5	3000
	70	1.1	1.9	32.0	2600	1.2	2.00	2.1	40.5	4300
	95	1.1	2.0	37.0	3500	1.2	2.00	2.0	45.0	5400
	120	1.2	2.1	42.0	4400	1.2	2.00	2.3	49.0	6600
	150	1.4	2.4	47.0	5500	1.4	2.50	2.5	55.0	8300
	185	1.6	2.4	52.0	6800	1.4	2.50	2.7	60.0	10000
	240	1.7	2.6	58.0	8800	1.4	2.50	2.9	67.0	12000
	300	1.8	2.7	64.0	10000	1.6	2.50	3.0	74.0	15000
Four Cores	1.5	0.7	1.8	11.4	170	0.90	0.90	1.8	15.9	450
	2.5	0.7	1.8	12.3	215	0.90	0.90	1.8	16.8	510
	4	0.7	1.8	13.44	280	0.90	1.25	1.8	18.0	610
	6	0.7	1.8	14.7	360	1.25	1.25	1.8	20.0	820
	10	0.7	1.8	16.7	510	1.25	1.25	1.8	21.6	1000
	16	0.7	1.8	18.5	740	1.25	1.60	1.8	23.8	1300
	25	0.9	1.8	22.0	1100	1.60	1.60	1.8	28.0	1900
	35	0.9	1.8	25.0	1400	1.60	1.60	1.8	31.0	2400
	50	1.0	1.8	28.0	1900	1.60	2.00	1.9	34.5	3000
	70	1.1	2.0	32.0	2600	2.00	2.00	2.1	40.5	4300
	95	1.1	2.1	37.0	3500	2.00	2.00	2.0	45.0	5400
	120	1.2	2.3	42.0	4400	2.00	2.50	2.3	49.0	6600
	150	1.4	2.4	47.0	5500	2.50	2.50	2.5	55.0	8300
	185	1.6	2.6	52.0	6800	2.50	2.50	2.7	60.0	10000
	240	1.7	2.8	58.0	8800	2.50	3.15	2.9	67.0	12000
	300	1.8	3.0	64.0	10000	2.50	3.15	3.0	74.0	15000

C Unarmoured cables
D Armoured cables
* Multicore unarmoured and armoured fire resistant cables are available upon request

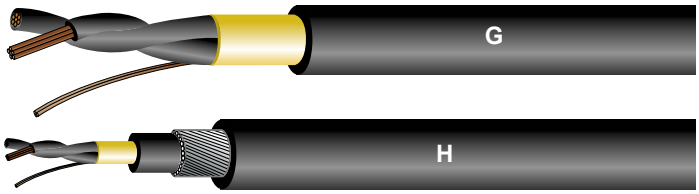


300/500V, Unarmoured and Armoured LSF Cables

Table 3

	(E) Unarmoured Cables						(F) Armoured Cables				
	Nominal area of conductor	No. & Diameter of wires	Insulation Thickness	Sheath Thickness	Approx. diameter overall	Approx. weight	Bedding Thickness	Armour wire diameter	Sheath Thickness	Approx. diameter overall	Approx. weight
	mm^2	No./mm	mm	mm	mm	kg/km	mm	mm	mm	mm	kg/km
Single Core	0.75	7/0.37	0.55	0.5	4.1	22	0.5	0.9	1.4	8.9	155
	1	7/0.44	0.55	0.5	4.3	26	0.5	0.9	1.4	9.1	165
	1.5	7/0.53	0.55	0.5	4.6	32	0.5	0.9	1.4	9.4	180
	2.5	7/0.67	0.55	0.5	5.0	43	0.5	0.9	1.4	9.8	200
	4	7/0.85	0.55	0.5	5.6	60	0.5	0.9	1.4	10.4	240
Two Cores	0.75	7/0.37	0.55	0.5	7.0	64	0.5	0.9	1.4	11.8	285
	1	7/0.44	0.55	0.5	7.4	74	0.5	0.9	1.4	12.2	310
	1.5	7/0.53	0.55	0.5	8.0	92	0.5	0.9	1.4	12.8	345
	2.5	7/0.67	0.55	0.5	8.8	120	0.5	0.9	1.4	13.6	400
	4	7/0.85	0.55	0.5	9.9	165	0.5	0.9	1.4	14.7	475
Three Cores	0.75	7/0.37	0.55	0.5	7.5	75	0.5	0.9	1.4	12.3	310
	1	7/0.44	0.55	0.5	7.9	88	0.5	0.9	1.4	12.7	355
	1.5	7/0.53	0.55	0.5	8.5	110	0.5	0.9	1.4	13.3	375
	2.5	7/0.67	0.55	0.5	9.4	150	0.5	0.9	1.4	14.2	445
	4	7/0.85	0.55	0.5	10.6	205	0.5	0.9	1.4	15.4	535
Four Cores	0.75	7/0.37	0.55	0.5	8.3	90	0.5	0.9	1.4	13.1	360
	1	7/0.44	0.55	0.5	8.7	105	0.5	0.9	1.4	13.5	380
	1.5	7/0.53	0.55	0.5	9.4	135	0.5	0.9	1.4	14.2	430
	2.5	7/0.67	0.55	0.5	10.4	180	0.5	0.9	1.4	15.2	500
	4	7/0.85	0.55	0.5	11.7	255	0.5	0.9	1.4	16.7	620

E Unarmoured fire resistant cable
F Armoured fire resistant cable
* Multicore unarmoured and armoured fire resistant cables are available upon request



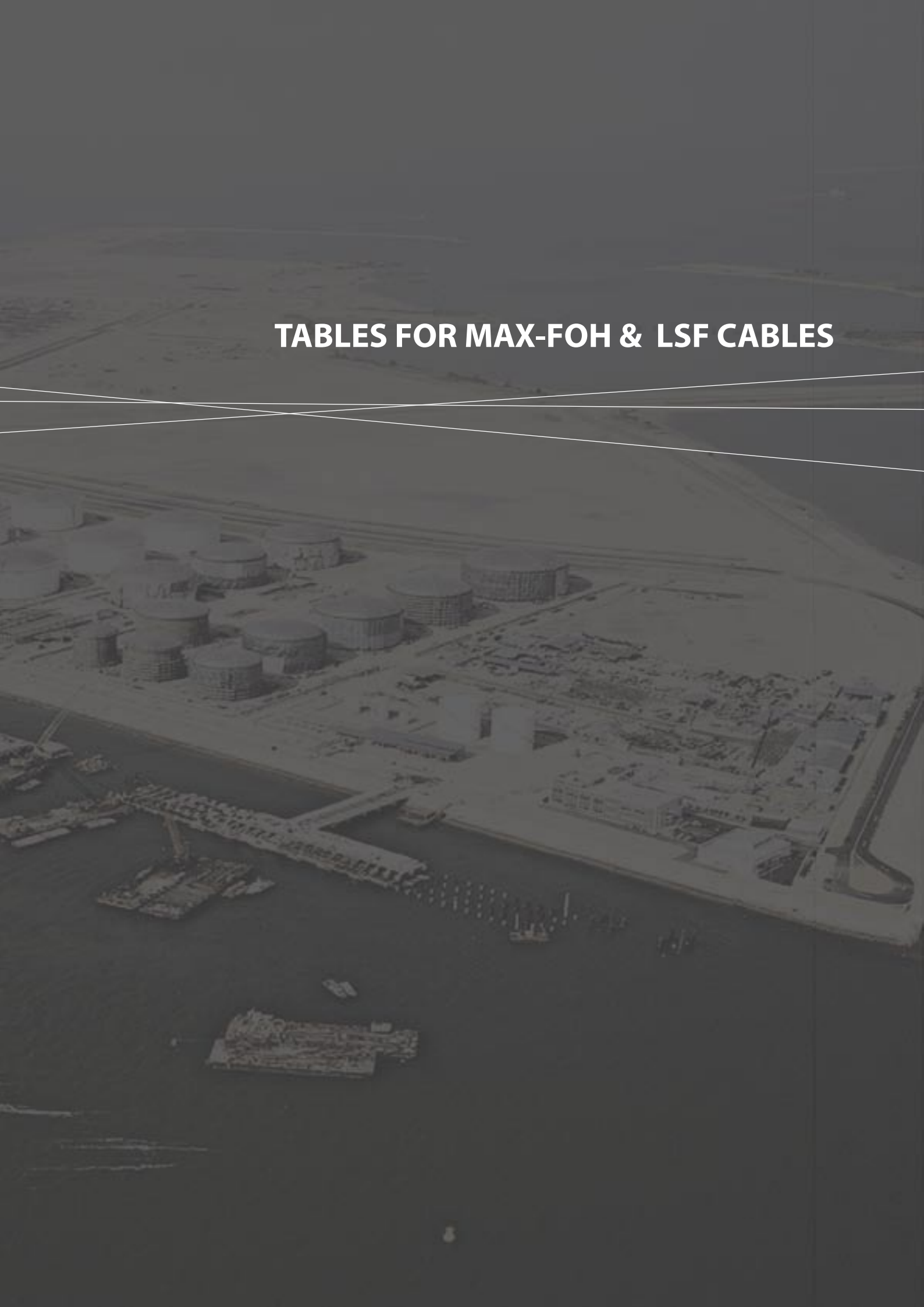
300/500V, Unarmoured and Armoured Shielded LSF Cables

Table 4

	(E) Unarmoured Cables						(F) Armoured Cables				
	Nominal area of conductor	No. & Diameter of wires	Insulation Thickness	Sheath Thickness	Approx. diameter overall	Approx. weight	Bedding Thickness	Armour wire diameter	Sheath Thickness	Approx. diameter overall	Approx. weight
	mm^2	No./mm	mm	mm	mm	kg/km	mm	mm	mm	mm	kg/km
One pair	0.75	7/0.37	0.5	0.8	7.9	65	0.8	0.9	1.4	12.7	300
	1	7/0.43	0.6	0.8	8.5	75	0.8	0.9	1.4	13.3	340
	1.5	7/0.53	0.5	0.8	9.1	90	0.8	0.9	1.4	13.9	370
	2.5	7/0.67	0.6	0.8	9.9	110	0.8	0.9	1.4	14.7	420
Two pair	0.75	7/0.37	0.5	0.8	10.0	100	0.8	0.9	1.4	14.8	410
	1	7/0.43	0.6	0.9	11.0	125	0.9	0.9	1.4	15.8	460
	1.5	7/0.53	0.6	0.9	11.8	150	0.9	0.9	1.5	16.8	520
	2.5	7/0.67	0.6	1.0	13.1	205	1.0	0.9	1.5	18.1	605
Three pair	0.75	7/0.37	0.5	1.0	12.2	145	1.0	0.9	1.5	17.2	565
	1	7/0.43	0.6	1.0	13.1	170	1.0	0.9	1.5	18.1	600
	1.5	7/0.53	0.6	1.0	14.1	215	1.0	0.9	1.6	19.3	655
	2.5	7/0.67	0.6	1.1	15.7	290	1.1	1.25	1.6	21.6	920
Four pair	0.75	7/0.37	0.5	1.0	13.7	180	1.0	0.9	1.5	18.7	600
	1	7/0.43	0.6	1.0	14.7	215	1.0	1.25	1.6	20.6	820
	1.5	7/0.53	0.6	1.1	16.1	280	1.1	1.25	1.6	22.0	920
	2.5	7/0.67	0.6	1.1	17.7	370	1.1	1.25	1.6	23.8	1090

G Unarmoured fire resistant cable
H Armoured fire resistant cable
* Multi-pairs unarmoured and armoured shielded fire resistant cables are available upon request

TABLES FOR MAX-FOH & LSF CABLES



CURRENT RATINGS AND VOLTAGE DROP TABLE (Unarmoured Cable)

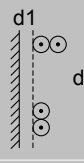
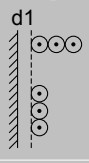
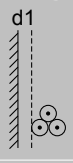
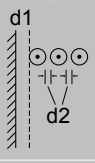
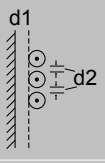
Cables installed in free air

Plain annealed stranded conductor, mica tape lapping, XLPE insulated, LSF cables, 600/1000V

Conditions of installation:

Ambient temperature : 30°C
Maximum Conductor temperature : 90°C

Table 1

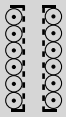
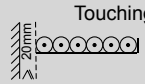
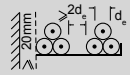
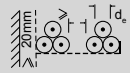
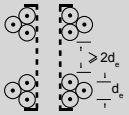
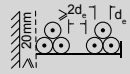
Nominal area of conductor mm²	INSTALLATION METHODS						
	Single Core Cable					Multicore Cable	
	2-Single Cores Touching	2-Single Cores Touching	3-Single Cores Trefoil	3-Single Cores Spaced Horizontal	3-Single Cores Spaced Vertical	2 Loaded Conductor	3 Loaded Conductor
	A 	B 	C 	D 	E 	F 	G 
1.5	27	23	22	27	23	26	23
2.5	35	31	30	37	31	36	32
4	49	42	40	52	44	49	42
6	63	54	52	67	55	63	54
10	88	76	73	95	76	86	75
16	137	100	96	150	112	115	100
25	161	141	135	182	161	149	127
35	200	176	169	226	201	185	157
50	242	215	207	275	246	225	192
70	310	279	268	353	318	289	246
95	377	341	328	430	389	352	298
120	437	399	382	500	454	410	346
150	504	462	443	577	527	473	399
185	575	531	509	661	605	542	456
240	679	631	604	781	719	641	538
300	783	731	699	902	833	741	620
400	940	880	839	1085	1008	-	-
500	1083	1006	958	1253	1169	-	-
630	1254	1117	1077	1454	1362	-	-
800	1460	1262	1152	1696	1595	-	-
1000	1683	1432	1240	1958	1847	-	-

Group installation correction factor for methods A to E, please refer to Table 2
Group installation correction factor for methods F to G, please refer to Table 3
Correction factors for ambient air temperature other than 30 °C, please refer to Table 6
d1: Clearance to wall not less than one cable diameter
d2: Minimum 0.3 times the diameter of cable

Correction factors for groups of more than one circuit of single core cables

To be used in conjunction with current ratings in Table 4 for single core cables in free air for installation methods A to G.

Table 2

Installation method (See Note 1)			Number of three-phase circuits (Note 4)				Use as a multiplier to rating for
			Numbers of trays	1	2	3	
Unperforated trays (Note 2)	H	Touching 	1 2 3	0.95 0.92 0.90	0.90 0.85 0.80	0.85 0.80 0.75	Three cables in horizontal formation
Perforated trays (Note 2)	J	Touching 	1 2 3	0.95 0.95 0.90	0.90 0.85 0.85	0.85 0.80 0.80	
Vertical perforated trays (Note 3)	K	Touching 	1 2	0.95 0.90	0.85 0.85	- -	Three cables in vertical formation
Ladder supports, cleats, etc (Note 2)	L	Touching 	1 2 3	1.00 0.95 0.95	0.95 0.90 0.90	0.95 0.90 0.85	Three cables in horizontal formation
Unperforated trays (Note 2)	H		1 2 3	1.00 0.95 0.95	0.95 0.90 0.90	0.95 0.85 0.85	Three cables in trefoil formation
Perforated trays (Note 2)	J		1 2 3	1.00 0.95 0.95	1.00 0.95 0.90	0.95 0.90 0.85	
Vertical perforated trays (Note 3)	K		1 2	1.00 1.00	0.90 0.90	0.90 0.85	
Ladder supports, cleats, etc (Note 2)	L		1 2 3	1.00 0.95 0.95	1.00 0.95 0.95	1.00 0.95 0.90	

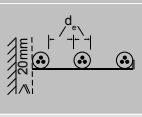
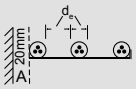
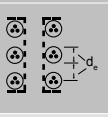
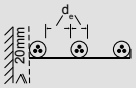
Notes:

1. Factors are given for single layers of cables (for trefoil groups) as shown in the tables and DO NOT apply when cables are installed in more than one layer touching each other. Values for such installations may be significantly lower and must be determined by an appropriate method.
2. Values are given for a vertical spacing between trays of 300mm. For closer spacing the factors should be reduced.
3. Values are given for a horizontal spacing between trays of 225mm with tray mounted back to back. For closer spacing the factors should be reduced.
4. For circuits having more than one cable in parallel per phase, each set of three conductors should be considered as a circuit for the purposes of this table.

Correction factors for groups of more than one multicore cable

To be used in conjunction with current ratings in Table 1 for multicore cables in free air for installation methods F to G.

Table 3

Installation method			Number of trays	Number of cables					
				1	2	3	4	6	9
Unperforated trays (Note 2)	M	Touching 	1 2 3	0.95 0.95 0.95	0.85 0.85 0.85	0.80 0.75 0.75	0.75 0.75 0.70	0.70 0.70 0.65	0.70 0.65 0.60
		Spaced 	1 2 3	1.00 0.95 0.95	0.95 0.95 0.95	0.95 0.90 0.90	0.95 0.90 0.90	0.90 0.85 0.85	- - -
Perforated trays (Note 2)	N	Touching 	1 2 3	1.00 1.00 1.00	0.90 0.85 0.85	0.80 0.80 0.80	0.80 0.75 0.75	0.75 0.75 0.70	0.75 0.70 0.65
		Spaced 	1 2 3	1.00 1.00 1.00	1.00 1.00 1.00	100 0.95 0.95	0.95 0.90 0.90	0.90 0.85 0.85	- - -
Vertical perforated trays (Note 3)	O	Touching 	1 2	1.00 1.00	0.90 0.90	0.80 0.80	0.75 0.75	0.75 0.70	0.70 0.70
		Spaced 	1 2	1.00 1.00	0.90 0.90	0.90 0.90	0.90 0.85	0.85 0.85	- -
Ladder supports cleats, etc. (Note 2)	P	Touching 	1 2 3	1.00 1.00 1.00	0.85 0.85 0.85	0.80 0.80 0.80	0.80 0.80 0.75	0.80 0.75 0.75	0.80 0.75 0.70
		Spaced 	1 2 3	1.00 1.00 1.00	1.00 1.00 1.00	1.00 1.00 0.95	1.00 0.95 0.95	1.00 0.95 0.95	- - -

Notes:

1. Factors apply to single layer groups of cables as shown above and do NOT apply when cables are installed in more than one layer touching each other. Values for such installations may be significantly lower and must be determined by an appropriate method.
2. Values are given for a vertical spacing between trays of 300mm . For closer vertical spacing the factors should be reduced.
3. Values are given for a horizontal spacing between trays of 225mm with trays mounted back to back. For closer spacing the factors should be reduced.

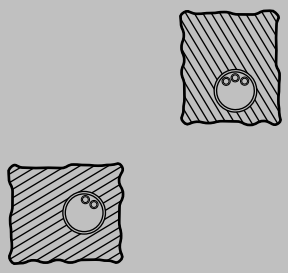
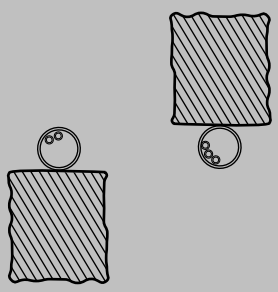
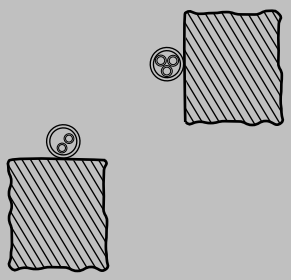
Cables in conduit and trunking, and bunched cables on a surface

Plain annealed stranded conductor, mica tape lapping, XLPE insulated, LSF cables, 600/1000V

Conditions of Installation:

Ambient temperature : 30°C
Maximum conductor temperature : 90°C

Table 4

Nominal area of conductor	Insulated conductors in R		Insulated conductors in S		Multicore cable on a wall T	
	2 loaded Conductor	3 loaded Conductor	2 loaded Conductor	3 loaded Conductor	2 loaded Conductor	3 loaded Conductor
						
mm²	Amp		Amp		Amp	
1.5	19	17	23	20	24	22
2.5	26	23	31	27	33	30
4	35	31	42	37	45	40
6	45	40	54	48	58	52
10	61	54	74	66	80	71
16	81	73	100	89	107	96
25	106	95	133	117	138	119
35	131	117	164	144	171	147
50	158	141	198	175	210	179
70	200	179	254	222	269	229
95	241	216	306	269	328	278
120	278	249	354	312	382	322
150	318	285	-	-	441	371
185	362	324	-	-	506	424
240	424	380	-	-	599	500
300	486	435	-	-	693	576
400	579	519	-	-	860	692
500	664	595	-	-	994	797
630	765	685	-	-	1155	923
800	885	792	-	-	1349	1074
1000	1014	908	-	-	1560	1237

For group correction factors, please refer to Table 5
Correction factors for ambient temperatures other than 30°C, refer to Table 6

Correction factors for cables in conduit and trunking, and bunched cables on a surface

Correction factors for groups of more than one circuit or more then one multicore cable.
To be used in conjunction with ratings for cables in Table 4.

Table 5

Item	Arrangement of Cables		Correction factors													
			Number of circuits or multicore cables													
			1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
1	Bunched on a surface or enclosed in conduit or trunking		1.00	0.80	0.70	0.65	0.60	0.55	0.55	0.50	0.50	0.50	0.45	0.45	0.40	0.40	0.40
2	Single-layer wall or floor	Touching	1.00	0.85	0.80	0.75	0.75	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.65	0.65	0.65
3		Spaced	1.00	0.95	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
4	Single-layer under ceiling	Touching	0.95	0.80	0.70	0.70	0.65	0.65	0.65	0.60	0.60	0.60	0.60	0.60	0.55	0.55	0.55
5		Spaced	0.95	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85

Notes:
1. These factors are applicable to uniform groups of cables, equally loaded.
2. Where horizontal clearance between adjacent cables exceeds twice their overall diameter, no reduction factor need be applied.
3. “Spaced” cables means a clearance between adjacent surfaces of one cable diameter.
4. The same correction factors are applied to:
   - groups of two or three single-core cables;
   - multicore cables.
5. If a system consists of both two and three core cables, the total number of cables is taken as the number of circuits, and the corresponding correction factor is applied to the tables for two loaded conductors for the two-core cables, and to the tables for three loaded conductors for the three-core cables.
6. If a group consists of **n** loaded single-core cables it may either be considered as **n/2** circcuits of two loaded conductors or **n/3** circuits of three loaded conductors.

Correction factors for ambient air temperature other than 30°C

Table 6

Ambient temperature ^{0}C	10	15	20	25	35	40	45	50	55	60	65	70	75	80
Correction factors	1.15	1.12	1.08	1.04	0.96	0.91	0.87	0.82	0.76	0.71	0.65	0.58	0.50	0.41

Voltage drop table (Unarmoured Cables)

Voltage drop for single core cables per amp per metre

Table 7

Nominal area of conductor (mm²)	For ⊙⊙		For ⊙⊙⊙ (mV)	For ⊙⊙⊙ (mV)	For ⊙⊙⊙ (mV)
	AC (mV)	DC (mV)			
1.5	30.86	30.86	26.73	26.73	26.73
2.5	18.90	18.90	16.37	16.37	16.37
4	11.76	11.76	10.19	10.19	10.19
6	7.86	7.86	6.81	6.81	6.81
10	4.67	4.66	4.04	4.04	4.05
16	2.95	2.94	2.55	2.55	2.56
25	1.87	1.85	1.62	1.62	1.63
35	1.35	1.34	1.17	1.17	1.19
50	1.01	0.99	0.87	0.88	0.90
70	0.71	0.68	0.61	0.62	0.65
95	0.52	0.49	0.45	0.45	0.50
120	0.43	0.39	0.37	0.38	0.42
150	0.36	0.32	0.32	0.33	0.37
185	0.30	0.25	0.26	0.28	0.33
240	0.25	0.19	0.22	0.24	0.29
300	0.22	0.15	0.20	0.21	0.28
400	0.20	0.12	0.17	0.20	0.26
500	0.19	0.093	0.16	0.18	0.25
630	0.18	0.072	0.15	0.17	0.25
800	0.17	0.056	0.15	0.17	0.24
1000	0.16	0.045	0.14	0.16	0.24

Voltage drop for multi-core cables per amp per metre

Table 8

Nominal area of conductor (mm²)	For twin-core		For 3 and 4 cores (mV)
	AC (mV)	DC (mV)	
16	2.90	2.90	2.60
25	1.90	1.90	1.60
35	1.30	1.30	1.20
50	1.00	0.99	0.87
70	0.70	0.68	0.61
95	0.52	0.49	0.45
120	0.42	0.39	0.36
150	0.35	0.32	0.30
185	0.29	0.25	0.25
240	0.24	0.19	0.21
300	0.21	0.15	0.19

CURRENT RATINGS AND VOLTAGE DROP TABLE (Armoured Cable)

Cables laid direct in ground

Single Core

Plain annealed stranded copper conductor, mica tape lapping, XLPE insulated, Aluminium or copper wire armoured, LSF cables, 600/1000V

Table 9

Nominal Area of Conductor	Single Core (Aluminium wire armoured)					
	Two cables touching				Three cables trefoil (touching) 3-phase	
	Single-phase (ac)		dc			
mm²	Current rating Amp	Approx volt drop per Amp per metre mV	Current rating Amp	Approx voltdrop per Amp per metre mV	Current rating Amp	Approx volt drop per Amp per metre mV
50	275	0.99	275	0.99	235	0.86
70	340	0.70	340	0.68	290	0.61
95	405	0.53	410	0.49	345	0.46
120	460	0.43	470	0.39	390	0.37
150	510	0.37	530	0.32	435	0.32
185	580	0.31	600	0.25	490	0.27
240	670	0.26	690	0.19	560	0.23
300	750	0.24	790	0.15	630	0.21
400	830	0.21	910	0.12	700	0.19
500	910	0.20	1030	0.093	770	0.18
630	1000	0.19	1200	0.072	840	0.17
800	1117	0.18	1422	0.056	931	0.16
1000	1254	0.17	1683	0.045	1038	0.15

Twin and Multi Core

Plain annealed stranded copper conductor, mica tape lapping, XLPE insulated LSF bedded, Galvanised steel wire armoured, LSF sheathed cables, 600/1000V

Table 10

Nominal Area of Conductor	Direct in ground					
	Two-Core cable				Three or Four Core Cable	
	Single-phase (ac)		dc			
mm²	Current rating Amp	Approx volt drop per Amp per metre mV	Current rating Amp	Approx volt drop per Amp per metre mV	Current rating Amp	Approx volt drop per Amp per metre mV
16	140	2.90	140	2.90	115	2.60
25	180	1.90	180	1.90	150	1.60
35	215	1.30	215	1.30	180	1.20
50	255	1.00	255	0.99	215	0.87
70	315	0.70	315	0.68	265	0.61
95	380	0.52	380	0.49	315	0.45
120	430	0.42	435	0.39	360	0.36
150	480	0.35	490	0.32	405	0.30
185	540	0.29	560	0.25	460	0.25
240	630	0.24	650	0.19	530	0.21
300	700	0.21	740	0.15	590	0.19

For group correction factors, please refer to Table 12. Correction factors for ground temperatures other than 15°C, refer to Table 14

Conditions of installation (for Table 9 & 10):

Ground temperature : 15°C
Depth of laying : 0.5m
Soil thermal resistivity : 1.2°C m/w
Maximum conductor operating temperature at rated current : 90°C

Note:
Ratings given are for single circuits installed thermally independent of any other heat source.

Cables run in single way ducts

Plain annealed stranded copper conductor, mica tape lapping, XLPE insulated, armoured, LSF cables, 600/1000V

Table 11

Nominal area of conductor	Single Core				Two-Core		Three or Four Core	
	Two cables ducts touching		Three cables ducts touching,trefoil					
	Current rating	Approx volt drop per Amp per metre	Current rating	Approx volt drop per Amp per metre	Current rating	Approx volt drop per Amp per metre	Current rating	Approx volt drop per Amp per metre
mm^2	Amp	mV	Amp	mV	Amp	mV	Amp	mV
16	-	-	-	-	115	2.90	94	2.6
25	-	-	-	-	145	1.90	125	1.6
35	-	-	-	-	175	1.30	150	1.2
50	255	1.10	235	0.93	210	1.00	175	0.87
70	310	0.80	280	0.70	260	0.70	215	0.61
95	365	0.65	330	0.56	310	0.52	260	0.45
120	410	0.55	370	0.48	355	0.42	300	0.36
150	445	0.50	405	0.43	400	0.35	335	0.30
185	485	0.45	440	0.39	455	0.29	380	0.25
240	550	0.40	500	0.35	520	0.24	440	0.21
300	610	0.37	550	0.32	590	0.21	495	0.19
400	640	0.35	580	0.30	-	-	-	-
500	690	0.33	620	0.28	-	-	-	-
630	750	0.30	670	0.26	-	-	-	-
800	828	0.28	735	0.24	-	-	-	-
1000	919	0.26	811	0.22	-	-	-	-

For group correction factors, please refer to Table 13
Correction factors for ground temperatures other than 15°C, refer to Table 14

Conditions of installation:

Ground temperature	: 15°C
Depth of laying	: 0.5m
Soil thermal resistivity	: 1.2°C m/w
Maximum conductor operating temperature at rated current	: 90°C
Ambient air temperature	: 25°C

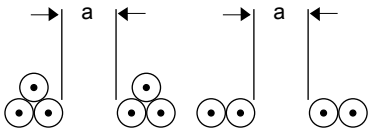
Note:
* Single core cables are aluminium wire armoured for a.c. systems.
Ratings given are for single circuits installed thermally independent of any other heat source.

Correction factors for more than one circuit, cables laid directly in the ground

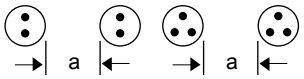
Table 12

Number of circuits	Cable to cables clearance (a)				
	Nil (cables touch-ing)	One cable diameter	0.215m	0.25m	0.5m
2	0.75	0.80	0.85	0.90	0.90
3	0.65	0.70	0.15	0.80	0.85
4	0.60	0.60	0.70	0.75	0.80
5	0.55	0.55	0.65	0.70	0.80
6	0.50	0.55	0.60	0.70	0.80

Single-core cables



Multicore cables



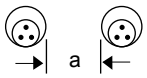
Correction factors for more than one circuit, cables laid directly in ducts in the ground

A - Multicore cables in single-way ducts

Table 13

Number of cables	Duct to duct clearance (a)			
	Nil (ducts touching)	0.25m	0.5m	1.0m
2	0.85	0.90	0.95	0.95
3	0.75	0.85	0.90	0.95
4	0.70	0.80	0.85	0.90
5	0.65	0.80	0.85	0.90
6	0.60	0.80	0.80	0.90

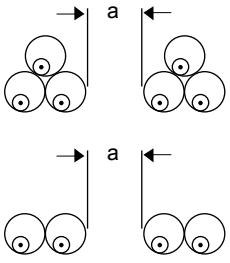
Multicore cables



B - Single-core cables in single-way ducts

Number of single-core circuits of two or three cables	Duct to duct clearance (a)			
	Nil (ducts touching)	0.25m	0.5m	1.0m
2	0.80	0.90	0.90	0.95
3	0.70	0.80	0.85	0.90
4	0.65	0.75	0.80	0.90
5	0.60	0.70	0.80	0.90
6	0.60	0.70	0.80	0.90

Single-core cables



Correction factors for ground temperatures other than 15°C

Table 14

Ground temperature °C	10	15	20	25	30	35	40	45	50
Correction factor	1.03	1.00	0.97	0.93	0.89	0.86	0.82	0.76	0.72

SHORT CIRCUIT RATINGS

Another important factor for the determination of the conductor size is the maximum allowable current during a short circuit when the maximum allowable conductor temperature is higher than during normal operation.

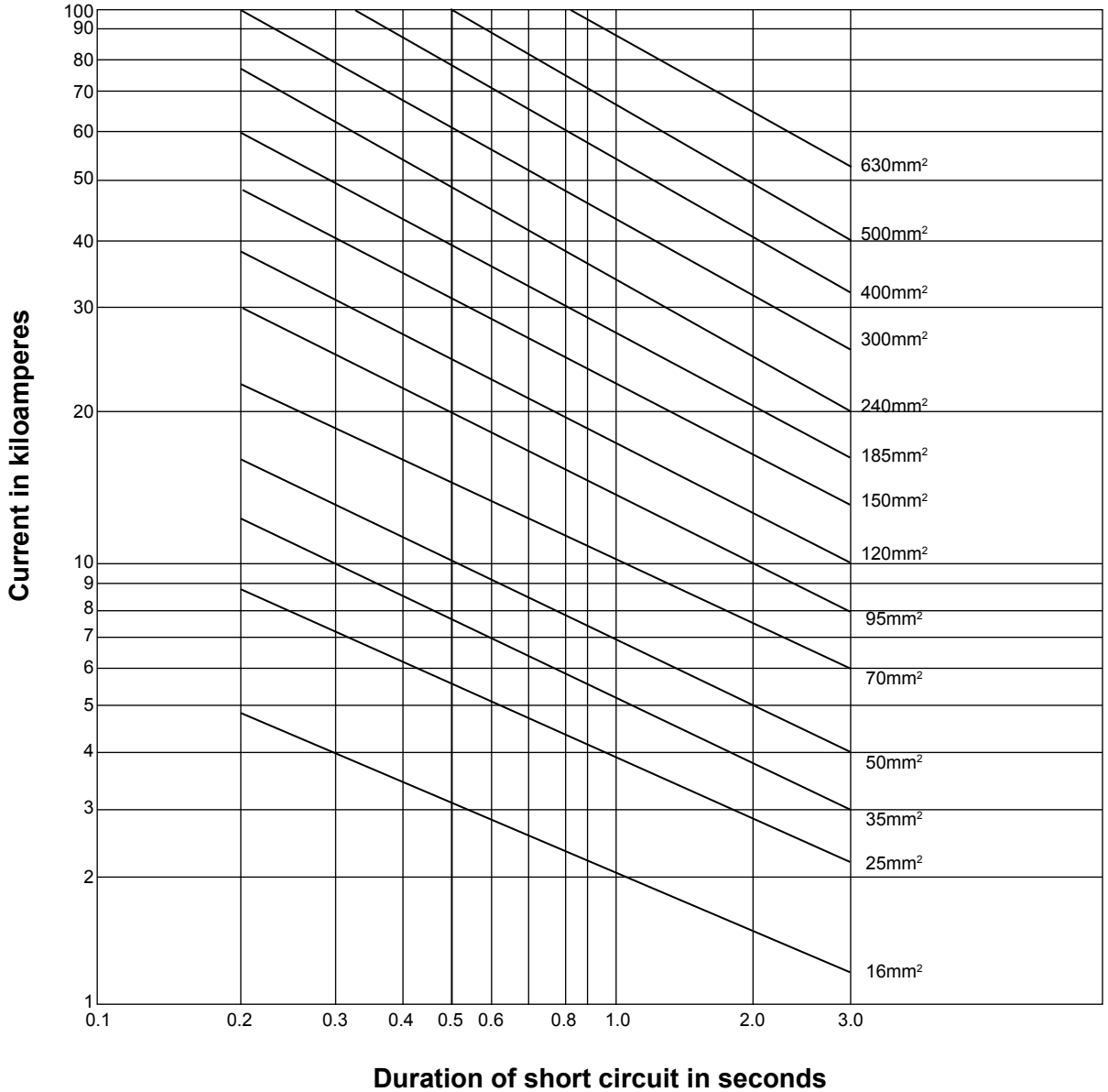
The maximum permissible short circuit current of XLPE cables up to 1 kV with copper conductors can be calculated with following formula:

$$1k = \frac{S}{\sqrt{t}} \cdot K$$

Where 1k = Maximum permissible short circuit current in Ampere
S = Conductor area in mm^2
t = Duration of short circuit process in seconds. Maximum value for t = 5 seconds
K = Constant of 143 for copper conductors and temperature rising 90 degree C to 250 degree C

Copper Conductors

The values of fault current given in the graph are based on the cable being fully loaded at the start of the short circuit (conductor temperature 90°C) and a final conductor temperature of 250°C, and it should be ensured that the accessories associated with the cable are also capable of operation at these values of fault current.



Maximum conductor resistance

Table 15

Cross Section Area (S) mm²	Conductor for fixed wiring Class 1 (solid) Class 2 (stranded) ohm/km at 20°C
0.50	36.0
0.75	24.5
1.00	18.1
1.50	12.1
2.50	7.41
4	4.61
6	3.08
10	1.83
16	1.15
25	0.727
35	0.524
50	0.387
70	0.268
95	0.193
120	0.153
150	0.124
185	0.0991
240	0.0754
300	0.0601
400	0.0470
500	0.0366
630	0.0283
800	0.0221
1000	0.0176

Electrical Characteristics

Table 16

Conductor Resistance Temperature Correction Factors			
Temp°C	Factor	Temp°C	Factor
10	0.961	25	1.020
11	0.965	30	1.039
12	0.969	35	1.059
13	0.972	40	1.079
14	0.976	45	1.098
15	0.980	50	1.118
16	0.984	55	1.138
17	0.988	60	1.157
18	0.992	65	1.177
19	0.996	70	1.196
20	1.000	75	1.216
21	1.004	80	1.236
22	1.008	80	1.255
23	1.012	90	1.275
24	1.016		

Project references:

SCM has supplied to a vast number of major projects regionally. Here are some projects, which have utilised Draka cables:

Building & Construction Projects Government / Infrastructure

Central Ministries Building
Changi Airport Terminals 1, 2 & 3
Changi Water Reclamation Plant (CWRP)
Expressways (CTE/KPE & Tuas Tunnel)
ICA Woodlands Checkpoint
Jurong Island Checkpoint
Ministry of Foreign Affairs Building
Ministry of Information & The Arts Building
Ministry of Home Affairs Building
Ministry of Nat'l Development Building
Pasir Panjang Terminal
Seletar Sewage Treatment Works
Tanah Merah Prison
Treasury Building
Supreme Court
Parliament House
Singapore Police Force HQ
Revenue House

Commercial

Ceba Vision Manufacturing Plant
Asahi Television Tube Plant
Beaufort Hotel
Bugis Junction
Changi Business Park
Conrad Hotel
CPF Building
Four Seasons Hotel
Glaxochem Pharmaceutical Plant
HDB Hub (Toa Payoh)
Hewlett Packard Building
Keppel Digihub
Ngee Ann City
OCBC Building
One Raffles Quay
Ritz Carlton Hotel
SATS Building
Singapore Conference Hall
Singapore Post Building
Singapore Turf Club (Kranji)
SSMC Wafer Fabrication Plant
The Concourse
The Esplanade
Trade Hub 21

Power Stations

Tuas Power Station
Senoko Power Station
Tuas Incineration Plant
Pulau Seraya Power Station

Education

Anglo-Chinese School (Dover)
Chinese High School
Institute of Technical Education (Simei)
La-selle School of Arts
Nanyang Polytechnic
Nanyang Technological University
Ngee Ann Polytechnic
Singapore Sports School
SMU City Campus

Transport

LRT Bukit Panjang
LRT Punggol / Sengkang
MRT Bishan Depot
MRT Circle Line
MRT North East Line

Hospitals

Alexandra Hospital
Gleneagles Hospital
Institute of Mental Health
New Changi Hospital
Raffles Hospital
Singapore General Hospital

Overseas Projects

Eastern Distributor Tunnel (NSW/Australia)
M5 Motorway (NSW Australia)
Lane Cove Tunnel (NSW Australia)
Cross City Tunnel (NSW Australia)
Inner City Bypass (QLD Australia)
Suncorp Stadium (QLD Australia)
Park Hyatt Saigon (HCMC Vietnam)
RMIT Ho Chi Minh Campus
(HCMC Vietnam)
Duxton Hotel (HCMC Vietnam)
Disneyland (Hong Kong)
Shangri-la Mekati (Manila, Philippines)
Shang Tower (Manila, Philippines)
Royal Palace Hotel (Cambodia)
Capital Residences (JKT, Indonesia)
Glodok Kemayoran Mall (JKT, Indonesia)
Suvarnabhumi Airport (BKK, Thailand)
Bangkok Bank Building (BKK, Thailand)
Ratchada Tower (BKK, Thailand)
Maneeya Tower (BKK, Thailand)
Parliament House (BSB, Brunei)
Royal Naval Base (BSB, Brunei)
Riverside Residential (BSB, Brunei)

MOG Vessel Types

Jackup Rigs
Semi-Sub Accommodation Platforms
KFELS Class B & Super Class B Jackups
Anchor Handling Tug/Supply
Baker Marine Class 375 Jackup
Baker Marine Pacific Class 375 Jackup
Landing Supply Crafts
Container Vessels
2,600 TEU Containerships
Pipe Laying Vessels
Catamarans (Devil Cats)
FPSOs
Military Vessels - Patrol Boats, LSTs,
Destroyers

Marine, Oil & Gas Clients

Keppel FELS
Keppel Singmarine
Keppel Shipyard
Pan United
PPL Shipyard
Singapore Technologies Marine
Jurong Shipyard
Jaya Shipbuilding
Sembawang Shipyard
SMOE
Incat Tasmania
Upstream Petroleum
ASL Shipyard
Marineteknik
Saigon Shipyard
Vietsov Petro
PT Batamec
PT Pan U
PT Dok Surabaya
NGV
MSET
MMHE
Sime Darby Engineering
MODEC
Italthai Marine
MARSUN
ASIMAR

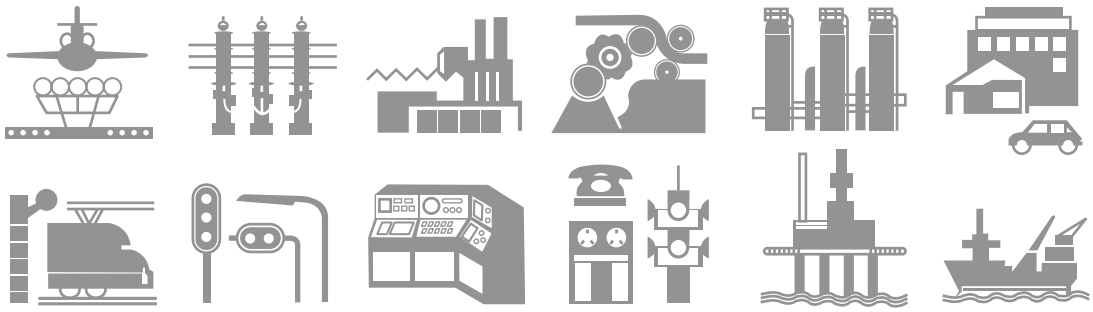
Petrochemical Clients

Emirates National Oil Company
ExxonMobil
Oiltanking
PetroVietnam
Ras Laffan
Shell Eastern
Vopak Oil Terminals

Petrochem Projects

Horizon Project
LVPS Upgrade Project
Fuel ESD Project
SPA Debottleneck Project
Phase 9 Project
Camau 1, 2 & 3
Dong Quat Refinery
Petrochem Plant Project
PSU Project
Banyan Project

Quality Cable for



Draka Group

67 plants in 29 countries. Employs 8,200 people

Draka

Draka Cableteq | Australasia

Singapore Cables Manufacturers Pte Ltd (SCM)
No. 20 Jurong Port Road Jurong Town Singapore 619094
Tel: +65 6265 0707 Fax: +65 6265 2226

Draka Cableteq | Greater China

Draka Cables (Hong Kong) Limited (DCHK)
Tel: 852-2410 9229 Fax: 852-2410 9789

Suzhou Draka Cable Co Ltd (SDC)
Tel: 86-512-6578 9888 Fax: 86-512-6578 9878

Draka Cableteq | Australasia

Sindutch Cables Manufacturer Sdn Bhd (SCMM)
Tel: 606-556-3833 Fax: 606-556-3282

Draka Cableteq Australia Pty Ltd (DCA)
Tel: 61-2-6762-5988 Fax: 61-2-6762-5788

CSC Cable Sdn Bhd (CSC)
Tel: 606-556-3833 Fax: 606-556-3670

MCI-Draka Cable Co Ltd (MDC)
Tel: 662-308-0830 Fax: 662-308-0833

2007 Version 1