



TRUSTED NOT TO COMPROMISE





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## FOREWORD

*The Cables and Tables publication has a long history, first being published by Pakistan Cables in 1954 and subsequent versions in 1967, 1970, 1985, 1992, 1999 and 2005. A booklet that has been widely used as a preferred document of reference over the years by engineers, consultants, students and various technical persons, it is with this background, that we are pleased to present the most updated version of **Cables and Tables** on the 65th year anniversary of Pakistan Cables Limited.*

*The current version addresses a variety of topics, including fundamentals of electricity, a focus on cable construction, materials and specifications, performance of cables under fire and best practices with respect to cable installation. The current version does not include current rating and voltage drop tables, which are now part of the general product catalogues. Furthermore, there is an emphasis on safety, which is one of the critical elements with respect not only to our product offering but also in our endeavors as an organization to embrace best practices with respect to health, safety and environment.*



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**FAHD K. CHINOY**  
DEPUTY CHIEF EXECUTIVE



## ABOUT PAKISTAN CABLES LIMITED

## SINCE 1953 WE ARE TRUSTED NOT TO COMPROMISE

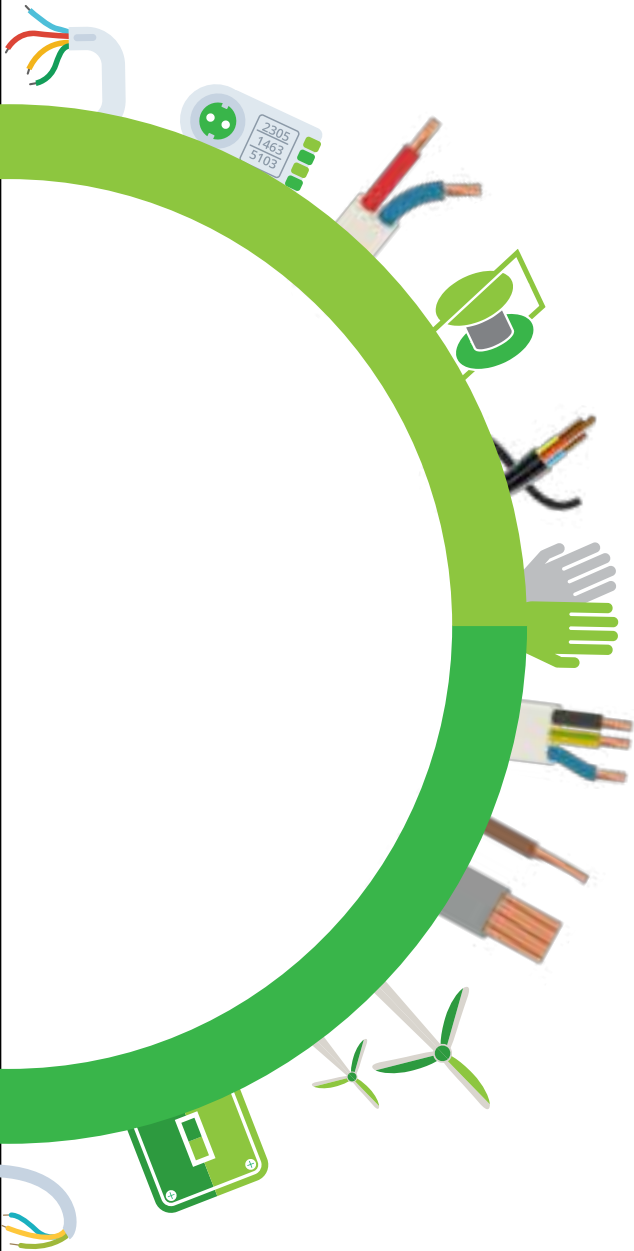
**Pakistan Cables Limited**, is regarded as the pioneer within the cable industry owing to its rich heritage, expertise and commitment to deliver world class products and services to its valued customers both at home and abroad.

Pakistan Cables, the country's oldest and most reputable cable manufacturer, was established in 1953 as a joint venture with British Insulated Callender's Cables (BICC). In the subsequent six decades, the company earned a reputation as a market leader and premier cable manufacturer in the country. As the only wires and cable manufacturer in Pakistan listed on the Pakistan Stock Exchange, the company is renowned for its commitment to ethics and business excellence. Between 2010 and 2017, the company was affiliated with General Cable, a world leader in the cable industry and a Fortune 500 Company headquartered in the United States.

The company is ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007 certified and has had several of its cables type tested by the world renowned KEMA Laboratory in Netherlands. With the latest award of KEMA Gold Type-test certificates, the company now holds eight KEMA certificates in total.

Through its foreign affiliations with leading international cable, manufacturers the company has been able to enhance its technical support, introduce innovative technology in the industry, leverage on management best practices, identify procurement advantages and develop export opportunities.

Today, Pakistan Cables is regarded as the pioneer within the industry owing to its rich heritage, expertise and commitment to consistently deliver world-class products and services to its valued customers.



**CHAPTER 1**  
**Introduction to Electricity**



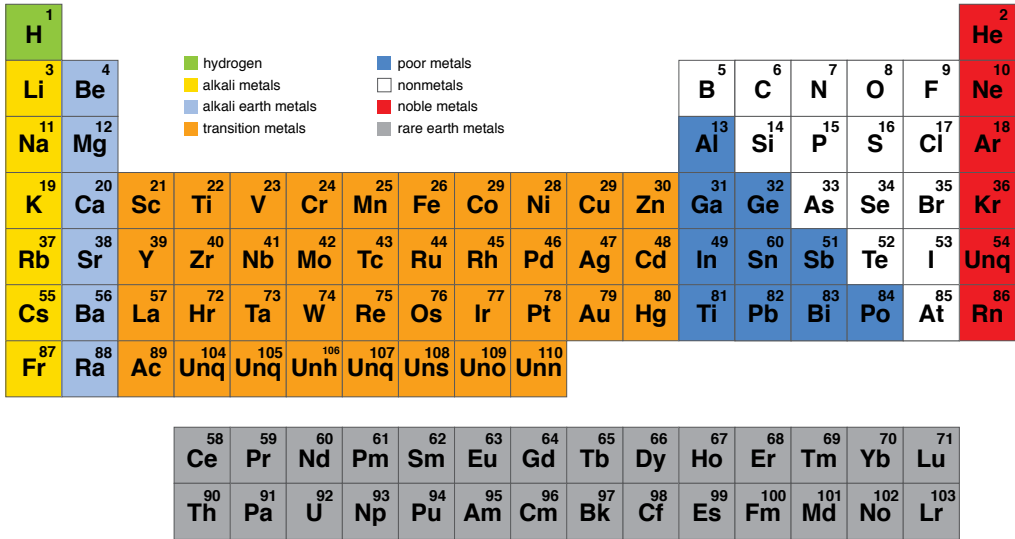
## Introduction to Electricity

Electricity is indeed miraculous. It gives us light, starts our cars, refrigerates our food. Its applications are innumerable. Truth is that we cannot survive without electricity.

# What is Electricity?

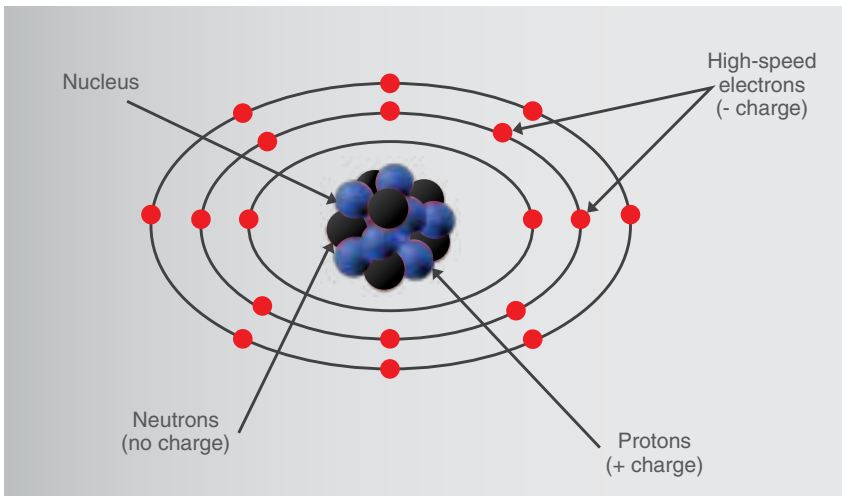
The entire universe is composed of matter. All matter consists of a combination of 118 elements.

Figure 1: The Modern Periodic Table



The smallest unit of an element is called an atom. It is so small that it takes one million of them to make up the diameter of human hair.

Figure 2: Atomic Structure

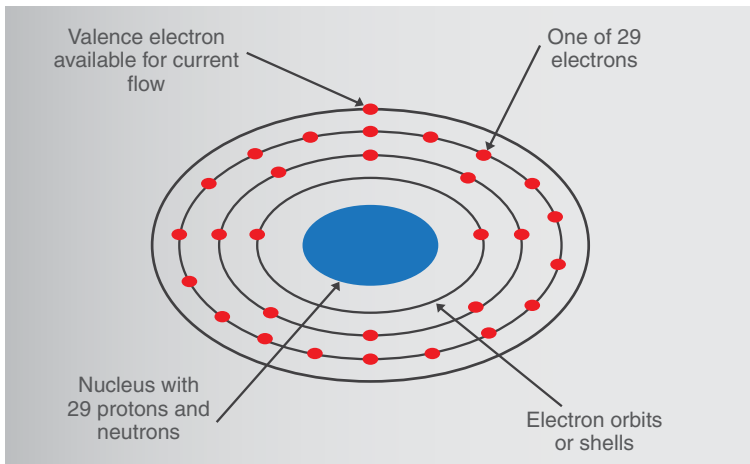


An atom has the nucleus in its center, comprising of positively charged protons and neutrally charged neutrons. Neutrons and protons are identical in mass. Around the nucleus is a cloud of electrons which are negatively charged. Electrons are 1837 times lighter than proton. The attraction between negatively charged electron and positively charged nucleus keeps the electrons near the nucleus.

**For Example:**

Copper atom which has 29 protons in its nucleus and therefore 29 electrons orbiting around the nucleus.

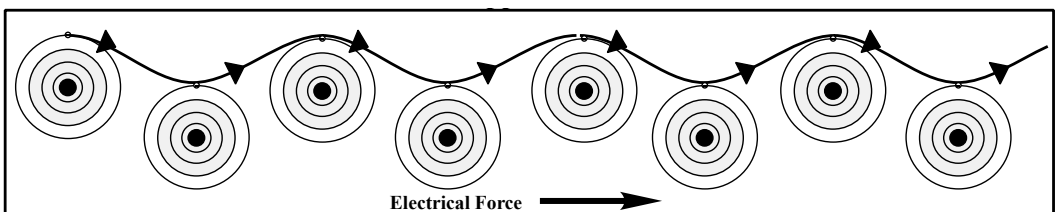
**Figure 3:** Atomic Structure of Copper Atom



The maximum number of electrons that can occupy a specific energy level (Shell) can be found by the formula  $2n^2$ . Thus, copper has only one electron orbiting in its outermost shell ( $2+8+18+1$ ) which is also called the Valence shell.

The closer to the nucleus, the more tightly bound the electrons are to the atom. Electrons in the outer shell can be forced out of the atom by applying external force such as magnetic field or chemical reaction. Free electrons forced from atom leave a void which can be filled by an electron forced out by another atom.

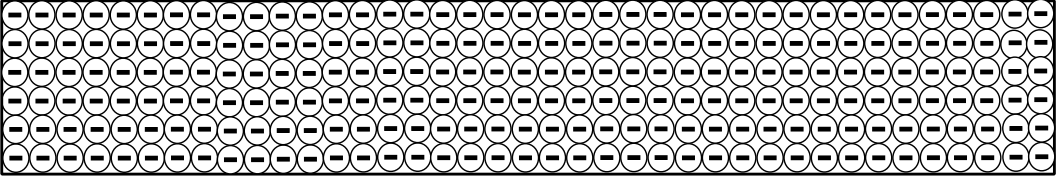
**Figure 4:** Copper Wire



## Conductors and Insulators

An electric current flows when free electrons move from atom to atom in a material. Materials that permit many electrons to move freely, are called conductors. Copper, silver, gold, aluminium and iron are conductors. Copper and aluminium are mostly used as conductors in cables.

Figure 5: Conductor

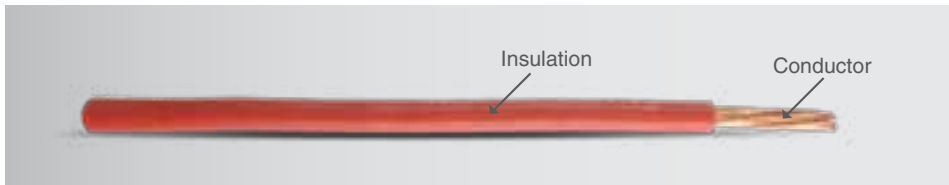


Within an insulator, all outermost electrons in an atomic structure are bound together and unable to move freely. That is each outermost electron is attracted to both its own nucleus and simultaneously its nearest neighboring nucleus, it is thus unable to move freely.

In electric cables, electrons flow along copper or aluminium conductor to provide power to electrical devices such as a lamp or a motor.

The insulation over the conductor is provided to keep electrons within the conductor.

Figure 6:



## Current

The flow of free electrons in a material from one atom to the next atom in the same direction is referred to as current ( $I$ ). The amount of current flowing is determined by the number of electrons that pass through the conductor in one second. The unit of current is ampere (A).  $6.24 \times 10^{18}$  electrons moving through a conductor per second is equal to one amp. Electron flows from negative to positive.

## Voltage

The force required to make electricity flow through a conductor is called electromotive force (emf), a difference in potential. The unit of voltage is volt (V).

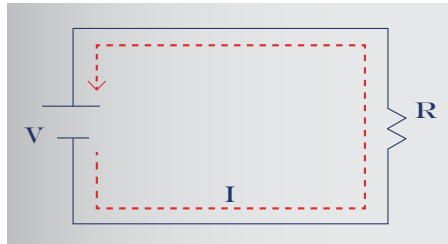
## Resistance

Resistance opposes the current flow in a circuit. The larger the wire, lesser the resistance to current flow & the unit of resistance is ohm ( $\Omega$ ). The amount of resistance ( $R$ ) depends upon the composition, length, cross section and temperature of the material. Resistance of a conductor increases with an increase in length or decrease in cross sectional area.

## Ohm's Law

A simple electric circuit consist of a voltage source, load and conductor to allow flow of electron from voltage source to load and back to source.

Figure 7:



Ohm's Law states that current varies directly with voltage and inversely with resistance.

$$I = V/R$$

Where,

Current (I) = ampere

Voltage (V) = volts

Resistance (R) = ohms

When the circuit is in operation, it transmits power (watts) from source (battery) to the load (fan or light bulb). So the amps, volts, ohms and watts are related as follows:

1. amps = volts/ohms
2. volts = ohms x amp
3. ohms = volts/amps
4. watts = volts x amps

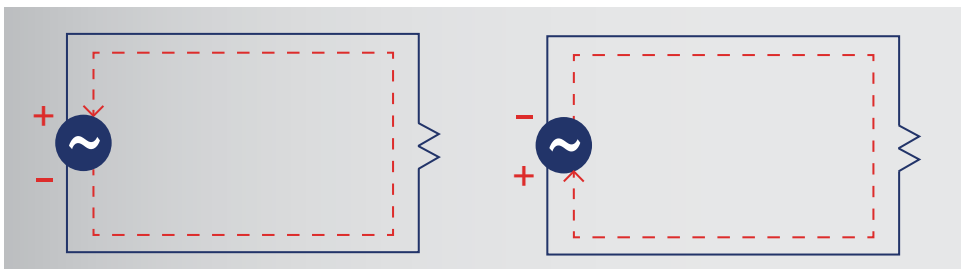
## Direct Current (DC)

Batteries supply current in one direction only. There is one path of current that flows from the negative terminal and returns to positive terminal.

## Alternate Current (AC)

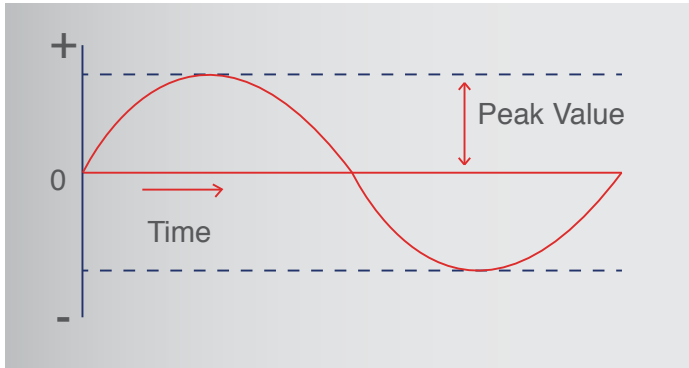
An AC generator makes electrons flow first in one direction then in another .The generator works on the principle of electromagnetic induction.

Figure 8:



Alternating voltage and current vary continuously like a sine wave. The vertical axis represents the direction and magnitude of current and voltage. The horizontal axis represents time. When the wave is above the time axis, current is flowing in one direction i.e. +VE direction, when it is below the time axis current is flowing in the opposite direction i.e. -VE direction. The sine wave moves through a complete rotation of  $360^\circ$  which is called one cycle.

Figure 9:

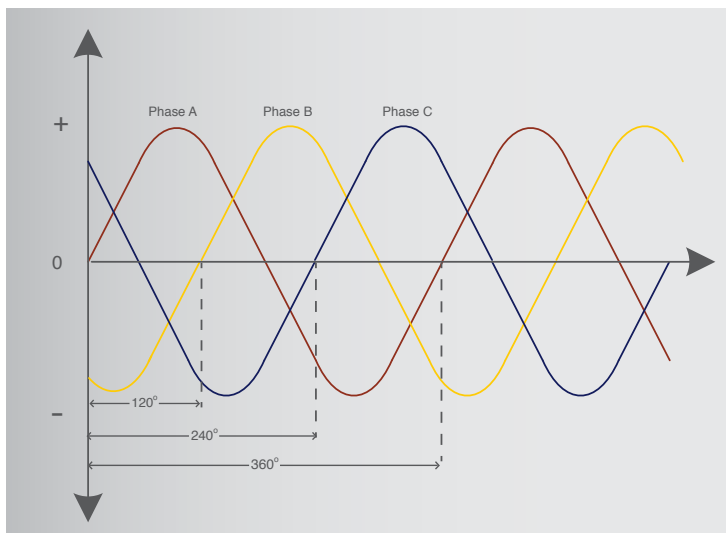


To the best of our knowledge, WAPDA /KESC generate and distribute electricity at a standard rate of 50 cycles per second .The effective value of AC is defined in terms of equivalent heating effect when compared to DC. The effective value or rms (root mean square) value of AC or current is  $0.707 \times$  peak value.

## Single phase and Three phase AC:

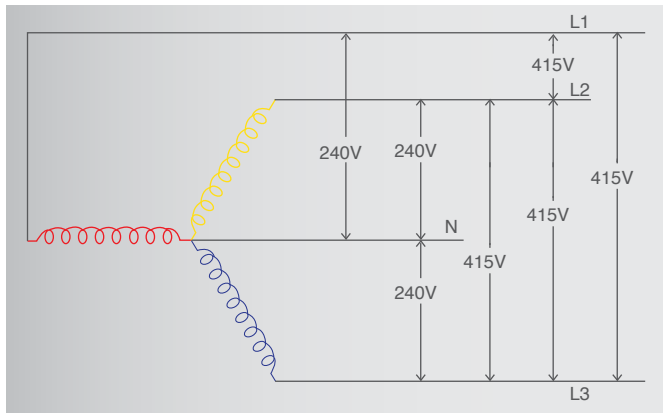
Single phase AC power is commonly used in homes and offices. Power companies generate, transmit and distribute three phase AC power. Three phase power is used in commercial and industrial applications. Three phase power is a continuous series of overlapping AC cycles. Each wave represents a phase and is offset by  $120^\circ$  electrical degrees for each of the two other phases.

Figure 10:



The distribution transformers step down the voltage from 11kV to 3 phase 415 V and single phase 240V for use at industrial, commercial and residential premises.

Figure 11:



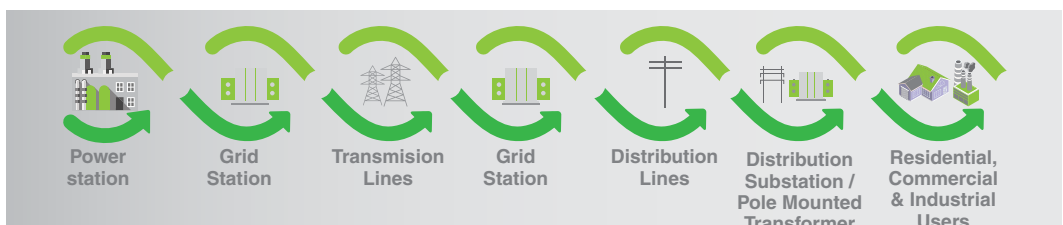
## Transmission and Distribution of Electrical Energy:

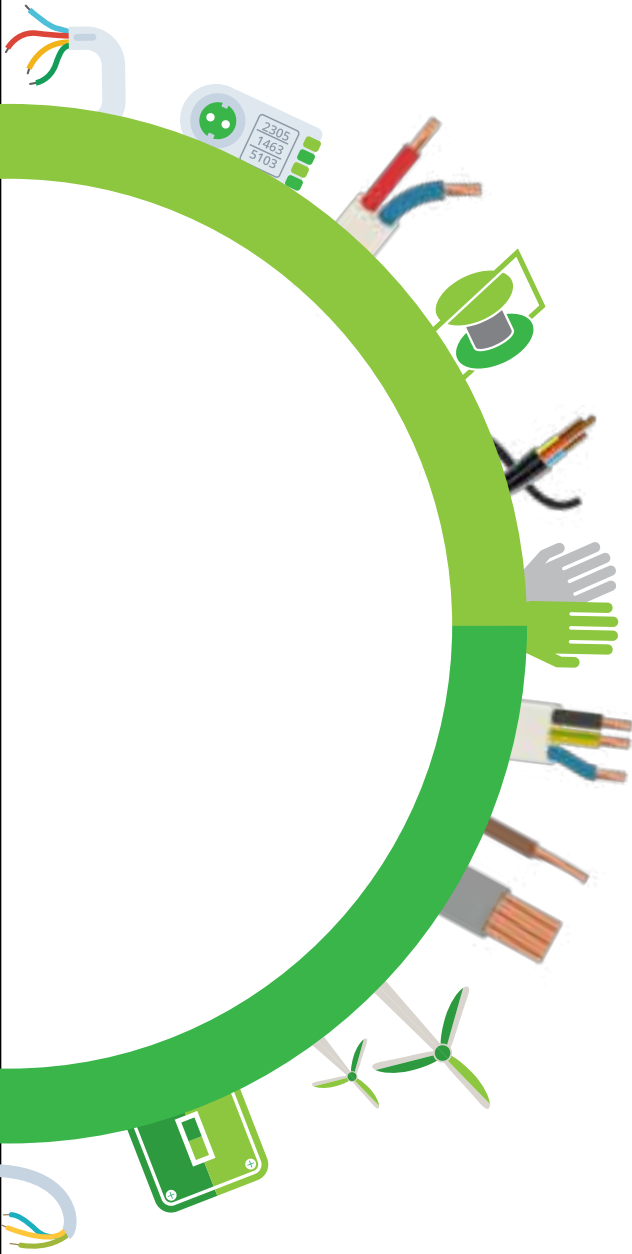
Most economical, technical and practical aspects are kept in mind in order to have optimum solution. Therefore, overhead lines are made for transmission and distribution of electrical energy in rural areas while insulated cables are buried underground in urban areas. In Pakistan bulk power is transmitted through overhead transmission lines at 500 KV, 220 KV and 132 KV from Power Generating Station to grid stations near the energy utilization centers. Power transformers at grid stations step down the voltage to 11 KV for distribution of power to Industrial and Commercial consumers through overhead lines or insulated cables. The distribution transformer then steps down 11 KV to 3 phase 415 KV or single phase 240 KV for domestic consumers

Alternating current has many advantages and three phase AC is used globally for transmission and distribution of power. The voltage for electrical cables are expressed as  $U_o/U$ .  $U_o$  is the voltage between conductor and earth while  $U$  is the voltage between phase conductors for which the cable is designed.

As per BS and IEC standards general wiring cables are designated as 300/500V and 450/750V while power cables as 600/1000V, 1900/3300V, 3800/6600V, 6350/11000V and 8700/15000V. These grades of cables are manufactured by Pakistan Cables.

For electrical power transmission, only the value of  $U$  is quoted such as 66KV, 132 KV, 220KV and 500 KV. Pakistan Cables manufactures Aluminium Conductor Steel Reinforced (ACSR), All Aluminium Alloy Conductors (AAAC) and Aluminium Conductor with Composite Core (ACCC) for overhead power transmission.



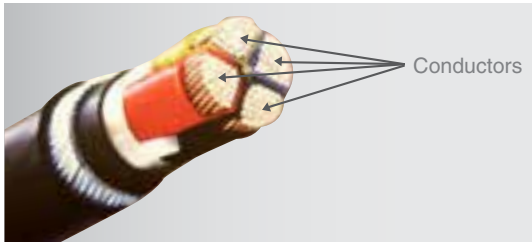


## CHAPTER 2

# Cable Construction and Cable making Materials



## Conductors



Conductors are the paths along which a current flows. For most applications the prime requirement of cable is that it should carry a specified electrical current between two points in the most economical way. We look for a material that offers minimum resistance to the flow of electricity to minimize energy loss along the cable length. Silver is the best conductor but remains very expensive.

## Copper and Aluminium

Copper and Aluminium are used as conductors in cables. Copper is the most widely used conductor material. Aluminium conductors are mostly confined to applications in overhead transmission lines and large sizes of cables for fixed installations. It is found unsuitable for use in house wiring installations due to its lower resistance to fatigue and corrosion when compared with Copper. Conductors are categorized by cross sectional areas in relation to their electrical resistance.

The conductors are also classified according to their shape and formation. Such conductors are listed below along with application:

- (a) Solid conductors – general wiring cables up to  $4\text{mm}^2$
- (b) Circular Stranded conductors – for overhead use and underground cables
- (c) Compacted circular – for Low Voltage and Medium Voltage cables
- (d) Sector shaped with perspiral lay – for low voltage Power cables
- (e) Flexible conductors – in areas demanding flexibility like cords, flexible cables, battery leads for automobiles, etc.



Solid  
Conductor



Circular Stranded  
Conductor



Compacted  
Circular



Sector  
Shaped



Flexible  
Conductors

### Solid Conductors:

Solid conductors comprise of single wire and are used in domestic wiring cables up to  $4.0\text{mm}^2$ . Use in higher sizes is restricted due to their inability to be pulled around sharp bends where stranded conductors are used.

### Stranded Conductors:

Stranded conductors comprise of suitable number of wires. These are circular, compacted circular and sector shaped having concentric layers of wires with lays of opposite direction in each layer.

- Circular conductors are compacted by pulling through a die resulting in smoother surface and reduced overall diameter
- Sector shaped conductors are stranded in the same way but passed through shaping rolls after application of wires in each layer. Rolls used for shaping and compacting rotate around the conductor to produce pre-spiral lay. The spiral lay in the sectoral shaped conductor is helpful while laying up the insulated core for multicore cables and prevents the stress in insulation.
- Flexible conductors comprise of large number of small diameter wires. The smaller the diameter of wires, the higher would be the flexibility for a particular cross sectional area.

## Electrical and Physical Properties

Taking cost into consideration copper and aluminium are mostly used as conductors.

Table 1: Electrical Properties

Metal	Relative conductivity (Copper = 100)	Electrical resistivity at 20°C $\times 10^{-8} \Omega\text{m}$
Copper (HC, annealed)	100	1.724
Copper (HC, hard drawn)	97	1.777
Copper (HC, Oxygen free, annealed)	100	1.724
Alum (EC grade Semi Hard)	61.5	2.803
Alum (EC grade Hard)	61.4	2.808

Table 2: Physical Properties

Parameters	Unit	Copper	Aluminium
Density at 20°C	Kg/m <sup>3</sup>	8890	2703
Coefficient of thermal expansion per °C	$\times 10^{-6}$	17	23
Melting Point	°C	1083	659
Thermal conductivity	W/cm °C	3.8	2.4
Ultimate Tensile Stress Soft	MN/m <sup>2</sup>	225	70 - 90
Ultimate Tensile Stress Hard	MN/m <sup>2</sup>	385	125 - 205
Elastic Modulus	MN/m <sup>2</sup>	26	14

Copper wires in cables are normally used in annealed condition, but stranded Aluminium conductor for cables and overhead conductors consists of wires in hard condition.

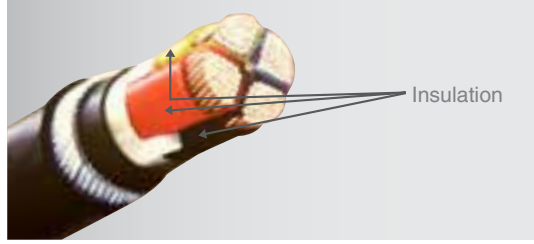
## Copper vs. Aluminium

When crimping Aluminium ferrule, deep indent crimping is preferred in order to break the Aluminium oxide layer on the surface of the Aluminium conductor. Corrosion of Aluminium conductor is a major problem in damp outdoor installations. Exposed Aluminium conductors have to be kept dry by sealing them with a heat shrink tubing.

Factors to be considered:

Most accessories (lugs, ferrule, connectors) and electrical equipment (circuit breakers, switches) are designed for use with copper conductors. When using Aluminum conductor, bimetallic accessories must be used to avoid the connection becoming loose, resulting in high resistance connection (hot connection). This is due to different temperature coefficients of expansion between copper and aluminum. On cooling, Aluminum conductor in copper ferrule will contract more than copper thus becoming loose. This would result in short circuiting and fire.

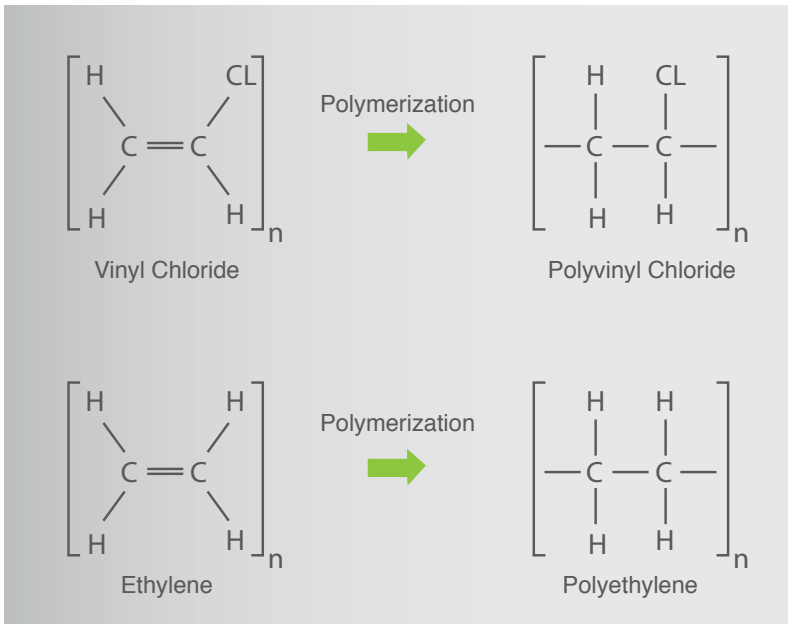
## Insulation



As mentioned in Chapter 1, electrical insulation is the material whose internal electrical charges do not flow freely and therefore make it nearly impossible to conduct electric current under the influence of electric field. Thus avoiding short circuit between conductors after application around each.

Synthetic polymers are plastics and rubbers used as insulating materials such as PVC, Polyethylene, thermoplastic rubber.

Many monomers when combined together form polymers. Monomer is a molecule (combination of several atoms). Monomers of ethylene combined together form polyethylene and monomers of vinyl chloride form Poly Vinyl Chloride



Another category of polymers are elastomers like rubbers which are highly elastic. An elastomer is a material which undergoes substantial deformation at room temperature by a weak stress. It returns rapidly to its initial shape upon release of that stress. Rubber and elastomers are used synonymously in the cable industry.

### **Thermoplastics and Thermosets:**

Plastics can be further divided into thermoplastics and thermosets. Thermoplastic flows when it is above its melting point. The process is reversible and upon cooling the material hardens e.g. polyvinyl chloride (PVC). Thermosetting polymers do not soften sufficiently on heating to be reshaped e.g. cross linked polyethylene (XLPE). Thermoplastics are converted to thermosets by adding chemical cross linking agent or by irradiation.

### **Polyvinyl Chloride(PVC):**

PVC polymer cannot be extruded without the addition of processing aides e.g. plasticizers and lubricants. Some grades of PVC are suitable for use as insulation up to 6.0 KV. Other ingredients like fillers and stabilizers are also added to achieve desired electrical and physical properties. PVC is suitable for use as insulation for conductors having continuous operating temperature from 70°C to 85°C depending on the grade. It can sustain short circuit temperature of 160°C. PVC is a fire retardant compound i.e. it is self-extinguishing and have low flame propagation.

### **Cross linked PE(XLPE):**

Despite its excellent electrical properties, the use of polyethylene is restricted to a maximum continuous operating temperature of 70°C being a thermoplastic. By cross linking, working temperature is increased to 90°C and short circuit temperature to 250°C

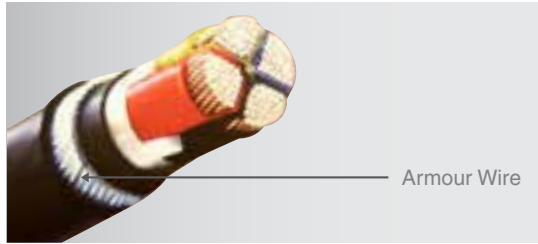
### Characteristics of PVC Insulation:

Parameters	Unit	Characteristics
<b>Maximum conductor temperature in normal operation</b>	°C	70
<b>Properties in the state as manufactured</b>		
Minimum tensile strength	N/mm <sup>2</sup>	12.5
Minimum elongation at break	%	125
<b>Properties after aging in air oven</b>		
Temperature	°C	80±2
Duration	h	7x24
Minimum tensile strength	N/mm <sup>2</sup>	12.5
Maximum Variation	%	±20
Minimum elongation at break	%	125
Maximum Variation	%	±20
<b>Bending at low temperature</b>		
Temperature	°C	-15±2
Requirement		no cracks
<b>Elongation at low temperature</b>		
Temperature	°C	-15±2
Minimum elongation without break	%	30
<b>Pressure at high temperature</b>		
Temperature	°C	80±2
Maximum indentation	%	50
<b>Resistance to cracking</b>		
Temperature	°C	150±2
Requirement		no cracks
<b>Loss of mass</b>		
Temperature	°C	80±2
Duration	h	7x24
Maximum loss of mass	mg/cm <sup>2</sup>	2.0
<b>Insulation resistance</b>		
Temperature	°C	70±2
Minimum K value	Mohm-km	0.037

### Characteristics of XLPE Insulation:

Parameters	Unit	Characteristics
<b>Maximum conductor temperature in normal operation</b>	°C	90
<b>Without Ageing</b>		
Tensile Strength (min)	N/mm <sup>2</sup>	12.5
Elongation at break (min)	%	200
<b>After aging in an air oven after ageing without conductor treatment:</b>		
Temperature	°C	135
Tolerance	°C	±3
Duration	h	168
<b>Tensile Strength</b>		
Variation (max)	%	±25
Elongation at break:		
Variation (max)	%	±25
<b>Hot Set:</b>		
Treatment:		
Air temperature (tolerance±3°C)	°C	200
Time under load	min	15
Mechanical stress	N/cm <sup>2</sup>	20
Maximum elongation underload	%	175
Maximum permanent elongation after cooling	%	15
<b>Water Absorption:</b>		
Treatment:		
Temperature (tolerance±2°C)	°C	85
Duration	hrs	336
Maximum increase of mass	mg/cm <sup>2</sup>	1
<b>Shrinkage:</b>		
Distance between marks	mm	200
Treatment:		
Temperature (tolerance±3°C)	°C	130
Duration	hrs	1
Maximum Shrinkage	%	4

## Armour



Armour comprises of a single layer of steel or aluminum wires applied over a layer of PVC extruded over insulated conductors, which act as a bedding for the armour preventing damage to the insulation. The armour provides mechanical strength to the cable against external damage, and longitudinal reinforcement enabling cable to withstand high pulling loads during installation. It also functions as a carrier for earth fault current.

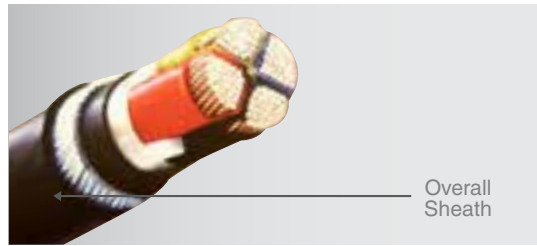
Aluminium wires are used in single core cables instead of steel wire. A magnetic field exists due to the current flowing within a single core cable. Steel wire being magnetic, this magnetic field induces current, resulting in the cable's overheating. This will not happen in case of non magnetic aluminium wires.

### Characteristics of Steel Armour Wire:

Parameters	Unit	Characteristics
Torsion	number of turns to fracture	depends upon the diameter of wire
Tensile strength	N/mm <sup>2</sup>	340-500
Elongation after fracture	%	10
Electrical resistivity at 20°C	Ohms-m	13.8 X 10 <sup>-8</sup>
Mass of zinc coating	gm/m <sup>2</sup>	depends upon the diameter of wire
Adherence of zinc coating	-	zinc coating should not flake off from wire surface



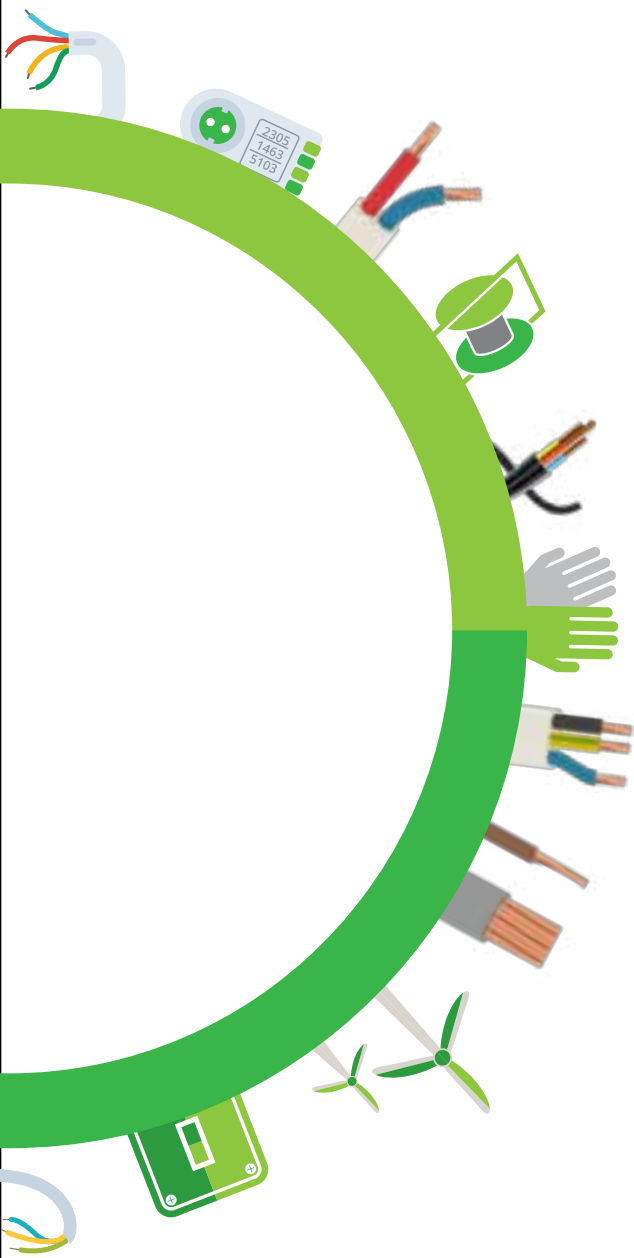
## Overall Sheath



PVC sheath provides protective finish for cables and also prevents corrosion of the armour. PVC provides toughness and resistance to deformation during and after installation. Medium density PE is also used where more toughness is required. Protection against ants, termites and vermins are also provided by including suitable additives during the extrusion process.

### Characteristics of PVC Sheath:

Parameters	Unit	Characteristics	
<b>Maximum conductor temperature on normal operation</b>	°C	70°C	90°C
<b>Properties in the state as manufactured</b>			
Minimum tensile strength	N/mm <sup>2</sup>	12.5	12.5
Minimum elongation at break	%	125	150
<b>Properties after aging in air oven</b>			
Temperature	°C	80±2	100±2
Duration	h	168	168
Minimum tensile strength	N/mm <sup>2</sup>	12.5	12.5
Maximum Variation	%	±20	±25
Minimum elongation at break	%	125	150
Maximum Variation	%	±20	±25
<b>Bending at low temperature</b>			
Temperature	°C	-15±2	-15±2
Requirement		no cracks	no cracks
<b>Elongation at low temperature</b>			
Temperature	°C	-15±2	-15±2
Minimum elongation without break	%	30	20
<b>Maximum conductor temperature on normal operation</b>	°C	70°C	90°C
<b>Impact at low temperature</b>			
Temperature	°C	-	-15±2
Requirement	-	-	no cracks
<b>Pressure at high temperature</b>			
Temperature	°C	80±2	90±2
Maximum indentation	%	50	50
<b>Resistance to cracking</b>			
Temperature	°C	150±2	150±2
Requirement		no cracks	no cracks
<b>Loss of mass</b>			
Temperature	°C	80±2	100±2
Duration	h	168	168
Maximum loss of mass	mg/cm <sup>2</sup>	2	1.5



### CHAPTER 3

## Performance of Cables Under Fire

## Performance of Cables Under Fire

Although cables seldom cause fire, they may be subjected to fire due to other causes being an integral part of property and equipment. When PVC burns, it produces poisonous gases, mainly hydrogen chloride (HCL). When HCL combines with moisture, it forms hydrochloric acid, which is a threat to life, electronic equipment, metal surface and even buildings. It also gives off a thick black smoke preventing people to find their way to exits and makes it difficult for others to evacuate them from the areas affected by fire. It is therefore, recommended to use Low Smoke Halogen Free cables for certain public places like airports, mass transit transport, shopping malls etc. Cables manufactured with such materials have acid gas evolution of less than 0.5 percent in comparison 25 to 30 percent for PVC compounds.

This chapter mentions technical terms relating to performance of such cables under fire, their characteristics and standards. There are different abbreviations used for such cables having similar characteristics, such as LSF (Low Smoke and Fume), LSZH (Low Smoke Zero Halogen), HFFR (Halogen Free and Fire Retardant).

## Fire Retardant

Fire Retardant cables are designed for use in fire situations where the spread of flames along a cable route needs to be retarded. Due to its relatively low cost, fire retardant cables are widely used as fire survival cables. During a fire, the flame spread will be retarded and the fire is confined to a small area, thus reducing the fire hazard due to fire propagation. The LV and MV cables with PVC sheathing manufactured by Pakistan Cables, are fire retardant.

## Low Smoke and Fume Fire Retardant Cables (LSF)

- All those cables releasing low smoke and fume during fire are called LSF cables. Halogen Free cables fall under the category of LSF cables.
- PVC Compounds after inclusion of smoke suppressant and flame retardant additives, reduce smoke generation. Thus, they have reduced flame propagating characteristics in the event of fire, but these are not Halogen Free.

## Low Smoke Zero Halogen Fire Retardant (LSZH)

LSZH cables are not only characterized by the fire retardant performance but also by the halogen free properties. Thus, offering low corrosivity and toxicity. During a fire, such cables will emit less smoke and acid gases which severely affect respiratory system of human beings leading to death and at the same time damage expensive equipment. Compared with PVC cables, LSZH cables outperform by their fire retardancy, low corrosivity and low smoke emission properties.

## Halogen Free Advantages

Low Smoke	Low Corrosivity/Toxicity	Safer Choice
<ul style="list-style-type: none"> <li>• Improve visibility</li> <li>• Increased time to exit the fire area</li> </ul>	<ul style="list-style-type: none"> <li>• Low acid gases from halogens prevent corrosion and damage to equipment</li> <li>• Less harmful emissions</li> <li>• Increased time to exit the fire area</li> </ul>	<ul style="list-style-type: none"> <li>• Reduced chance of loss of life due to less harmful emissions.</li> <li>• Environmental friendly than PVC compound.</li> </ul>

## Testing for Performance Under Fire

Pakistan Cables is the only manufacturer in Pakistan to have state of the art testing equipment to verify performance of cables under fire as required by the International standards for such types of cables.

## Testing for Fire Retardance

**IEC / BSEN 60332-1-2 - Single Cable**



**IEC / BSEN 60332-3 - Bunched Cables**



## Testing for Smoke Density, Corrosivity/Toxicity

**SMOKE DENSITY**  
IEC / BSEN 61034



**CORROSIVITY/TOXICITY**  
IEC / BSEN 60754-1 (HCL Emission)  
IEC / BSEN 60754-2 (PH and Conductivity)



Pakistan Cables is the first wire and cable manufacturer in Pakistan to attain KEMA Gold certification for its Low Smoke Zero Halogen (LSZH) power cables by KEMA laboratories, Netherlands.

## Applications

HOTELS, COMMERCIAL BUILDINGS, HOSPITALS, SHOPPING MALLS, CINEMAS, AIRPORTS, MASS TRANSIT, SHIPS, DATA CENTERS AND SIMILAR PUBLIC PLACES.



## Cable Construction and Standards

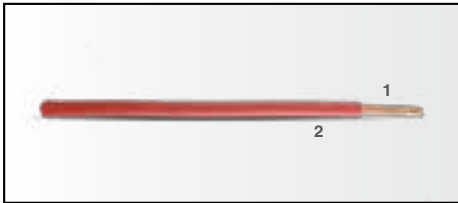
### SINGLE CORE, LSZH INSULATED CABLES, WITHOUT SHEATH 450/750V



1. Copper Conductor
2. LSZH Insulation

<b>BS EN 50525:</b>	Electric cables- low voltage energy cables of rated voltage upto and including 450 / 750 V ( $U_0 / U$ )
<b>Part 3-31:</b>	Cables with special fire performance-single core non-sheathed cables with halogen-free thermoplastic insulation, and low emission of smoke.
<b>Conductor:</b>	COPPER
<b>Maximum Continuous Conductor Operating Temperature:</b>	70°C
<b>Construction:</b>	INSULATION: LSZH POLYMER (Red, Yellow, Blue, Black, Green)
<b>Performance:</b>	HCL Emission : 0.5% (Max) Corrosivity pH : 4.3(Min) Conductivity: 10 $\mu$ S/mm (Max) Smoke Emission: Light Transmittance 60% (Min) Fire Propagation: On single vertical cables

Note: Technical data mentioned in the Annexure

**SINGLE CORE, XL-HFFR INSULATED CABLES, WITHOUT SHEATH 450/750V**

1. Copper Conductor
2. Cross-linked XL-HFFR Insulation

<b>BS EN 50525:</b>	Electric cables- low voltage energy cables of rated voltage upto and including 450 / 750 V ( $U_o / U$ )
<b>Part 3-41:</b>	Cables with special fire performance-single core non-sheathed cables with halogen-free Cross-linked insulation, and low emission of smoke.
<b>Conductor:</b>	COPPER
<b>Maximum Continuous Conductor Operating Temperature:</b>	90°C
<b>Construction:</b>	INSULATION: XL-HFFR Hologen Free Cross-linked Insulation with low emission of smoke.
<b>Performance:</b>	HCL Emission : 0.5% (Max) Corrosivity pH : 4.3(Min) Conductivity: 10 $\mu$ S/mm (Max) Smoke Emission: Light Transmittance 60% (Min) Fire Propagation: On single vertical cables

Note: Technical data mentioned in the Annexure



## SINGLE CORE AND MULTICORE, XLPE INSULATED, UNARMoured AND ARMoured, LSZH SHEATHED, 600/1000V:



1. Copper / Aluminium Conductor
2. XLPE Insulation
3. Polypropylene Filler
4. LSZH Bedding
5. Armour Wire
6. LSZH Oversheath

<b>IEC 60502-1:</b>	Power cables with extruded insulation and their accessories for rated voltages from 1 kV ( $U_m = 1.2$ kV) upto 30 kV ( $U_m = 36$ kV)
<b>Part 1:</b>	Cables for rated voltages of 1 kV ( $U_m = 1.2$ kV) and 3 kV ( $U_m = 3.6$ kV)
<b>Conductor:</b>	COPPER and ALUMINIUM
<b>Maximum Continuous Conductor Operating Temperature:</b>	90°C
<b>Construction:</b>	Insulation: XLPE (Red, Yellow, Blue, Black) Bedding: LSZH POLYMER (Black) Sheath: LSZH POLYMER (Black)
<b>Performance:</b>	HCL Emission: 0.5% (Max) Corrosivity : pH: 4.3(Min) Conductivity: 10 $\mu$ S/mm (Max) Smoke Emission: Light Transmittance 60%(Min) Fire Propagation: On single vertical cables On bunched cables

Note: Technical data mentioned in the Annexure

## Precautions for Handling and Storing LSZH Cables

- Cables should not be exposed to sun.
- Avoid any contact of cables with hot surface.
- It is preferable to lay cables in the morning hours.
- Rough terrain or sharp edges of the tray should be avoided while pulling the cables, as it may damage LSZH sheath.
- Rollers and bends should be smooth.
- There should be a cushion between the clamp and cable surface. Clamps should not be applied directly over the sheath.

# Technical Data

Title of Tables.		
<b>CONDUCTOR DATA:</b>		
1	Class 2 conductors stranded for Single-core and Multi core cables	35
2	Diameters of stranded circular compacted copper and aluminium conductors	11
<b>DIMENSIONS &amp; WEIGHTS:</b>		
3	450 / 750 V. LSZH/ <b>XL-HFFR</b> Insulated Cables, Non Armoured Without Sheath	12
4	600 / 1000 V Unarmoured and single wire armoured, LSZH over - sheathed cables. Single Core and Two Core	13
5	600 / 1000 V Unarmoured and single wire armoured, LSZH over - sheathed cables. Three Core and Four Core	14
6	600 / 1000 V Unarmoured and single wire armoured, LSZH over - sheathed cables. Four Core With Reduced Neutral Conductor	15

**Note:**

For Current carrying capacity, Voltage drop and Short Circuit Ratings, please refer to the LSZH Catalogue.

**URL:** <http://www.pakistancables.com/media/20678/pcl-lszh.pdf>

## Conductor Data

### Class 2 Stranded Conductors for Single-core and Multi-core cables

Table 1

Nominal cross-sectional area mm <sup>2</sup>	Minimum number of wires in the conductor						Maximum resistance of conductor at 20°C	
	Circular Conductor		Circular Compacted Conductor		Shaped Conductor		Annealed Copper Conductor	Plain aluminium Conductor
	Cu	Al	Cu	Al	Cu	Al	Plain wires	
1.5	7	-	6	-	-	-	12.1	-
2.5	7	-	6	-	-	-	7.41	-
4	7	-	6	-	-	-	4.61	-
6	7	-	6	-	-	-	3.08	-
10	7	7	6	-	-	-	1.83	3.08
16	7	7	6	6	-	-	1.15	1.91
25	7	7	6	6	6	6	0.727	1.20
35	7	7	6	6	6	6	0.524	0.868
50	19	19	6	6	6	6	0.387	0.641
70	19	19	12	12	12	12	0.268	0.443
95	19	19	15	15	15	15	0.193	0.320
120	37	37	18	15	18	15	0.153	0.253
150	37	37	18	15	18	15	0.124	0.206
185	37	37	30	30	30	30	0.0991	0.164
240	37	37	34	30	34	30	0.0754	0.125
300	61	61	34	30	34	30	0.0601	0.100
400	61	61	53	53	53	53	0.0470	0.778
500	61	61	53	53	-	-	0.0366	0.0605
630	91	91	53	53	-	-	0.0283	0.0469
800	91	91	-	-	-	-	0.0221	0.0367
1000	91	91	-	-	-	-	0.0176	0.0291

### Diameters of stranded circular compacted copper and aluminium conductors

Table 2

Cross-sectional Area mm <sup>2</sup>	Stranded Compacted circular conductors [Class 2]	
	Minimum diameter mm	Maximum diameter mm
10	3.6	4
16	4.6	5.2
25	5.6	6.5
35	6.6	7.5
50	7.7	8.6
70	9.3	10.2
950	11.0	12.0
120	12.3	13.5
150	13.7	15.0
185	15.3	16.8
240	17.6	19.2
300	19.7	21.6
400	22.3	24.6
500	25.3	27.6
630	28.7	32.5

## Dimensions and Weights

Table 3

Single Core, 450/750V. LSZH Insulated Cables, Non Armoured Without Sheath  
 Single Core, 450/750V. XL-HFFR Insulated Cables, Non Armoured Without Sheath

BSEN 50525 - 3 -31

BSEN 50525 - 3 -41

1 Nominal Cross-sectional area of *conductors  mm <sup>2</sup>	2 Minimum number of wires in conductor (BS EN 60228)	3 Radial thickness on insulation specified value  mm	4 Mean overall diameter		6 Approx Weight of Cable Copper Kg / Km
			Lower Limit	Upper Limit	
			mm	mm	
1.5	6	0.7	2.7	3.4	22
2.5	6	0.8	3.3	4.1	35
4	6	0.8	3.8	4.7	50
6	6	0.8	4.3	5.4	70
10	6	1.0	5.6	7.0	120
16	6	1.0	6.4	8.0	175
25	6	1.2	8.1	10.1	270
35	6	1.2	9.0	11.3	360
50	6	1.4	10.6	13.2	490
70	12	1.4	12.1	15.1	680
95	15	1.6	14.1	17.6	950
120	18	1.6	15.6	19.4	1170
150	18	1.8	17.3	21.6	1500
185	30	2.0	19.3	24.1	1820
240	34	2.2	22.0	27.5	2360
300	34	2.4	24.5	30.6	3000
400	53	2.6	27.5	34.3	3770
500	53	2.8	30.5	38.2	4840
630	53	2.8	34.0	42.5	6180

\* Circular / Circular Compacted Copper Conductor

Note : 1 - Can also be supplied, if desired with single solid conductor size upto 6mm<sup>2</sup>

Note : 2 - Can also be supplied, if desired with flexible class - 5 conductor size upto 240mm<sup>2</sup>

## Dimensions and Weights

### XLPE Insulated Power Cables

Table 4

600 / 1000 V Unarmoured and single wire armoured, LSZH over - sheathed cables

IEC 60502-1

Nominal Area of Conductor		Nominal Thickness of Insulation	Unarmoured			Armoured			
			Approx. Cable Diameter overall	Approximate Cable weight		Armour Wire Diameter	Approx. Cable Diameter overall	Approximate Cable weight	
				Copper	Aluminium			Copper	Aluminium
mm <sup>2</sup>	mm	mm	kg / km		mm	mm	kg / km		
S I N G L E C O R E	* 1.5	0.7	7.80	50	-	-	-	-	-
	* 2.5	0.7	8.20	70	-	-	-	-	-
	* 4.0	0.7	8.70	90	-	-	-	-	-
	* 6.0	0.7	9.20	110	-	-	-	-	-
	* 10	0.7	10.10	160	-	-	-	-	-
	* 16	0.7	11.00	210	110	▲ 1.25	15.20	360	260
	* 25	0.9	12.00	320	160	▲ 1.25	16.10	480	320
	* 35	0.9	13.30	420	190	▲ 1.25	18.00	600	380
	* 50	1.0	14.30	540	240	▲ 1.25	19.20	790	490
	* 70	1.1	16.40	760	330	▲ 1.25	20.40	1030	600
	* 95	1.1	18.40	1030	430	▲ 1.25	22.60	1370	770
	* 120	1.2	20.30	1280	520	▲ 1.60	25.10	1660	900
	* 150	1.4	22.30	1560	630	▲ 1.60	26.80	1960	1030
	* 185	1.6	24.50	1940	770	▲ 1.60	29.10	2380	1210
	* 240	1.7	27.30	2460	930	▲ 1.60	32.20	3000	1470
	* 300	1.8	30.00	3150	1220	▲ 1.60	38.10	3660	1730
^ 400	2.0	34.47	4160	1700	▲ 2.00	42.00	4730	2250	
^ 500	2.2	38.00	5040	1900	▲ 2.50	47.20	5840	2700	
^ 630	2.4	43.50	6680	2680	▲ 2.50	53.00	7880	3880	
^ 800	2.6	48.70	8300	3110	▲ 2.50	57.90	9560	4360	
^ 1000	2.8	54.00	10400	3850	▲ 2.50	63.00	11800	5250	
T W O C O R E	* 1.5	0.7	11.50	-	-	0.90	14.30	280	-
	* 2.5	0.7	11.30	-	-	0.90	16.20	360	-
	* 4.0	0.7	12.00	-	-	0.90	17.00	460	-
	* 6.0	0.7	13.10	-	-	0.90	19.70	610	-
	* 10	0.7	15.00	-	-	1.25	21.50	870	-
	* 16	0.7	16.60	490	280	1.25	22.20	1110	900
	* 25	0.9	21.30	730	400	1.60	26.40	1470	1140
	# 35	0.9	21.70	960	500	1.60	25.30	1780	1320
	# 50	1.0	20.90	1120	510	1.60	26.10	1910	1300
	# 70	1.1	23.90	1550	670	1.60	29.50	2490	1610
	# 95	1.1	26.80	2100	870	2.00	33.60	3410	2180
	# 120	1.2	29.70	2630	1080	2.00	36.50	4050	2500
	# 150	1.4	33.10	3220	1320	2.00	39.70	4790	2890
	# 185	1.6	36.80	4010	1630	2.50	46.00	6190	3810
	# 240	1.7	41.30	5220	2090	2.50	50.50	7640	4510
	# 300	1.8	45.30	6480	2550	2.50	54.90	9200	5270
# 400	2.0	51.00	8320	3260	2.50	60.60	11360	6300	

\* Circular/Circular Compacted Stranded Conductors

# Shaped Stranded Conductors

▲ Aluminium Wire Armoured

^ Circular Stranded Conductor

# Dimensions and Weights

## XLPE Insulated Power Cables

Table 5

600 / 1000 V Unarmoured and single wire armoured, LSZH over - sheathed cables.

IEC 60502-1

Nominal Area of Conductor		Nominal Thickness of Insulation	Unarmoured			Armoured			
			Approx. Cable Diameter overall	Approximate Cable weight		Armour Wire Diameter	Approx. Cable Diameter overall	Approximate Cable weight	
				Copper	Aluminium			Copper	Aluminium
mm <sup>2</sup>	mm	mm	kg / km		mm	mm	kg / km		
T H R E E C O R E	* 1.5	0.7	11.10	140	-	0.90	15.90	380	-
	* 2.5	0.7	11.80	150	-	0.90	16.00	440	-
	* 4.0	0.7	12.70	240	-	0.90	17.50	530	-
	* 6.0	0.7	13.90	320	-	0.90	18.80	630	-
	* 10	0.7	15.90	460	-	1.25	21.20	940	-
	* 16	0.7	17.60	650	340	1.25	23.20	1300	990
	* 25	0.9	21.30	960	480	1.60	26.50	1720	1240
	# 35	0.9	21.40	1210	550	1.60	28.30	2000	1340
	# 50	1.0	23.30	1590	690	1.60	30.50	2450	1550
	# 70	1.1	26.80	2240	940	2.00	34.50	3250	1950
	# 95	1.1	30.50	2910	1090	2.00	39.40	4620	2800
	# 120	1.2	33.90	3790	1470	2.00	42.60	6180	3860
	# 150	1.4	38.00	4680	1840	2.50	48.00	7100	4260
	# 185	1.6	42.50	5880	2320	2.50	52.40	8780	5220
# 240	1.7	47.10	7600	2920	2.50	57.20	10680	6000	
# 300	1.8	52.50	9710	3950	2.50	62.30	11920	6160	
# 400	2.0	58.40	12390	4790	2.50	69.70	15940	8340	
F O U R C O R E	* 1.5	0.7	12.00	170	-	0.90	16.90	420	-
	* 2.5	0.7	12.90	220	-	0.90	17.80	500	-
	* 4.0	0.7	13.70	300	-	0.90	17.60	600	-
	* 6.0	0.7	15.10	390	-	1.25	20.00	840	-
	* 10	0.7	16.90	590	-	1.25	22.20	1200	-
	* 16	0.7	19.50	860	430	1.60	24.60	1650	1220
	* 25	0.9	22.90	1200	560	1.60	28.10	2460	1820
	# 35	0.9	23.80	1660	770	1.60	30.80	2540	1900
	# 50	1.0	27.10	2180	960	1.60	32.70	3100	2000
	# 70	1.1	33.10	3040	1330	2.00	41.00	4900	3190
	# 95	1.1	34.50	4160	1720	2.00	43.50	6390	3950
	# 120	1.2	38.50	5040	2150	2.50	49.00	7520	4630
	# 150	1.4	42.60	6420	2620	2.50	53.30	8600	4800
	# 185	1.6	47.40	8030	3280	2.50	58.50	10430	5680
# 240	1.7	53.70	10430	4180	2.50	63.90	13120	6870	
# 300	1.8	59.00	13010	5150	2.50	69.50	16370	8510	
# 400	2.0	66.70	16650	6520	3.15	78.70	21660	11530	

\* Circular/Circular Compacted Stranded Conductors

# Shaped Stranded Conductors

# Dimensions and Weights

## XLPE Insulated Power Cables

Table 6

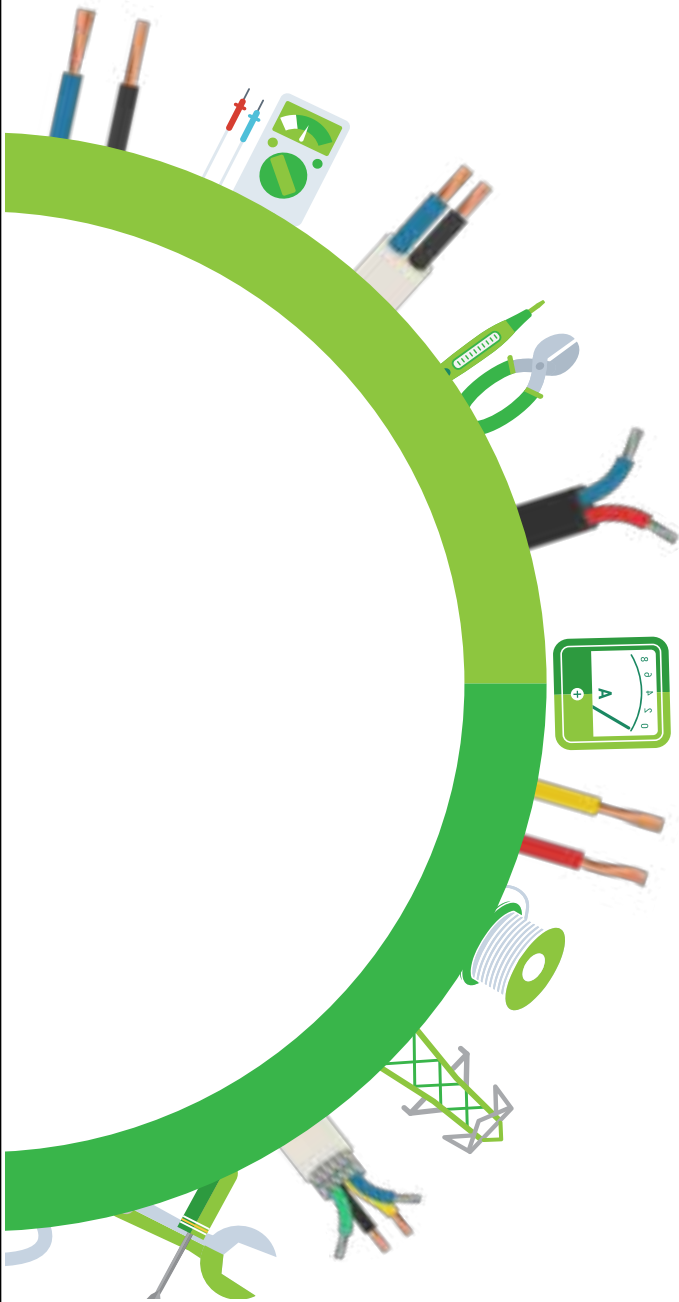
600 / 1000 V Unarmoured and single wire armoured, LSZH over - sheathed cables.

IEC 60502-1

Nominal Area of Conductor	Nominal Area of Neutral Conductor	Nominal Thickness of Insulation		Unarmoured				Armoured			
				Approx. Cable Diameter overall	Approximate Cable weight		Armour Wire Diameter	Approx. Cable Diameter overall	Approximate Cable weight		
					Copper	Aluminium			Copper	Aluminium	
mm <sup>2</sup>	mm <sup>2</sup>	Phase	Neutral	mm	kg / km		mm	mm	kg / km		
FOUR CORE WITH REDUCED NEUTRAL CONDUCTOR	* 25	* 16	0.9	0.7	23.70	1120	550	1.60	29.50	1880	1310
	# 35	* 16	0.9	0.7	24.10	1440	680	1.60	30.50	2280	1520
	# 50	* 25	1.0	0.9	27.10	1890	830	1.60	33.70	2960	1900
	# 70	* 35	1.1	0.9	31.70	2640	1110	2.00	39.50	4330	2800
	# 95	* 50	1.1	1.0	35.80	3970	1870	2.00	43.70	5950	3850
	# 120	* 70	1.2	1.1	39.90	4570	2010	2.50	48.60	6740	4180
	# 150	* 70	1.4	1.1	44.40	5470	2240	2.50	53.00	7680	440
	# 185	* 95	1.6	1.1	49.40	6890	2770	2.50	58.00	9650	5530
	# 240	* 120	1.7	1.2	55.80	9330	3990	2.50	64.50	11370	6030
	# 300	* 150	1.8	1.4	61.70	12540	4650	2.50	69.80	16020	8130
	# 400	* 185	2.0	1.6	68.80	14580	5830	2.50	79.30	19700	10950

\* Circular/Circular Compacted Stranded Conductors

# Shaped Stranded Conductors



## CHAPTER 4 Quality





## Quality Policy

At Pakistan Cables we are committed to achieve and enhance customer satisfaction by providing quality Cables, Copper Rod, Aluminium Extrusions and PVC Compounds. This is achieved by manufacturing products according to the relevant national and international standards and customer requirements.

Pakistan Cables shall continually review and improve the effectiveness of Quality Management System in line with its objectives of achieving higher productivity and quality.

In line with our quality policy, Pakistan Cables is committed to provide quality products, excellent customer service, continuous innovation and enhanced process efficiencies. The Company reiterates its commitment to consistently deliver enhanced value to its customers, through continuous improvement of its products and processes. The quality management system of the Company continues to conform to ISO 9001:2015 across all departments of the Company as certified by BVQI, UK. Pakistan Cables, being an ISO 9001 certified company, has trained personnel who are motivated and instructed to fulfill all requirements laid down in the Quality Management System.

Pakistan Cables has adequate resources that are essential to implement the quality system and to achieve its quality objectives as outlined in its Quality Policy. The maintenance of the quality management system is achieved through internal and external Quality Audits. The main purpose of Quality Audits is to take necessary corrective action to eliminate deviations and bring further improvements to the system.

## Quality Assurance

The Quality Control Programme for electrical cables at Pakistan Cables comprises of:

1. Receiving Inspection and Testing
2. In Process Inspection and Testing
3. Final Inspection and Testing

The Company has a highly advanced Quality Assurance laboratories, equipped with state of the art equipment and manned by professional and skilled personnel, engaged to check process variables at every step of the manufacturing process, ensuring that all products comply with relevant international specifications.

- **Raw Materials**
  - Grade A Copper purchased from LME approved suppliers
  - Quality raw materials are procured from pre-qualified reputable sources worldwide.
  - Each raw material has passes through stringent approval process in which both raw materials and suppliers capabilities are evaluated. A supplier not meeting the Company's standards is removed from the approved suppliers list.
- **Interstage controls during manufacturing**
  - Experienced and fully trained workforce.
  - Building quality during manufacture.
  - Checks at every stage before moving further.
  - Each meter of the insulation passes through high voltage test.
- **Finished cables and wires**
  - All lengths of cables are subjected to testing as per standard.

A considerable portion of inspection man hours are spent on the production floor where quality is built into the product. The finished cable is then subjected to tests as per standards.

## Complaint Handling

Pakistan Cables also maintains a complaint handling procedure which is overseen by the senior management of the Company. Each complaint is promptly investigated and corrective and preventive action taken.

## Testing Equipments



Profile Projector



Megger Mit 520.



LOM-510A MICRO-OHMMETER



Partial Discharge Detector



High Voltage Discharge System



D.C. High Voltage Test Set



Universal Testing Machine



Halogen Acid Gas Analyser



Digital Low Resistance Ohmmeter



Low Temperature Cabinet



50 KN Universal Testing Machine

## Certifications

Pakistan Cables manufactures medium and low voltage cables that have been accepted as world class, following the type testing and certification by KEMA high voltage laboratory in Netherlands.

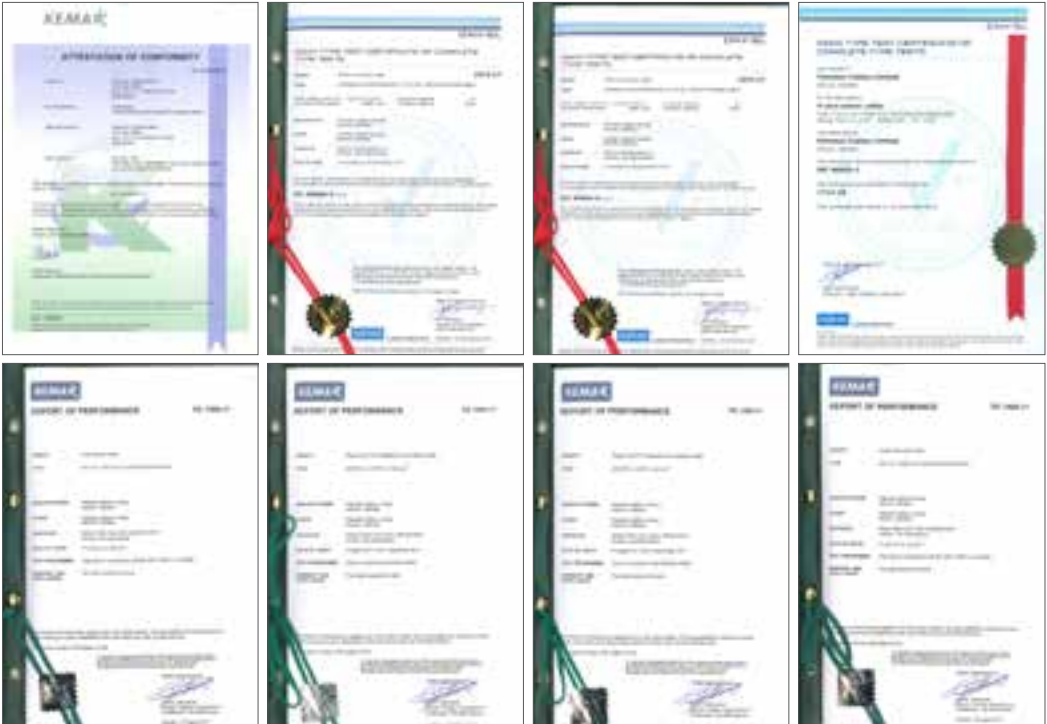
### ISO

Pakistan Cables is ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007 certified.



### KEMA

Pakistan Cables is the first cable manufacturer in Pakistan to have its cables type tested by the world renowned KEMA Laboratory, Netherlands in 1984. Pakistan Cables also attained the prestigious GOLD certifications by KEMA Laboratory, Netherlands. It currently holds eight KEMA certifications in total.



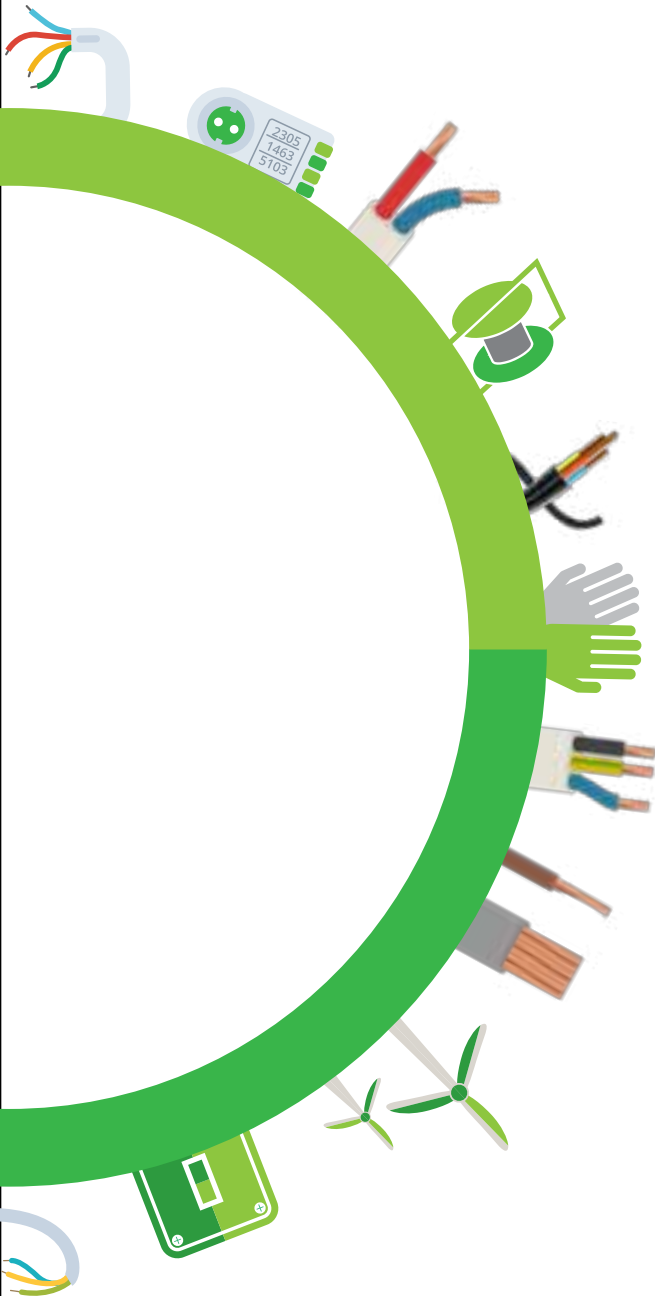
## CNC

Pakistan Cables is the only cable manufacturer in Pakistan with the CNC certification, which certifies that Pakistan Cables product range meets European Health, Safety, and Environmental protection legislation and can be legally sold and moved within the European Union.



## Other certifications

The Company's products are also PSQCA certified, ERDA (Electrical Research and Development Association), India, TUV SUD PSB Pte. Ltd., Singapore, and have also been successfully type tested in Pakistan's well reputed High Voltage and Short Circuit Laboratory in Rawat. Moreover, it remains the only Pakistani manufacturer approved by Oman's regulatory authority to sell into the Oman market.



## CHAPTER 5

# Handling, Storage and Safety of Cables

## Handling, Storage and Safety of Cables

### Handling

A cable can be damaged due to incorrect handling, which the drums and cables may be subjected to, causing breakdown of the drum flanges and in exceptional cases. This may occur during the movement of the drum barrels. Once the breakdown of the drum occurs the cable is immediately damaged.

Fork-lift trucks may be used in handling provided that care is exercised not to damage or remove the protective lagging when pushing the 'fork' under the drum flanges. Unloading can also be safely accomplished by means of ramps and winches. (See Fig. 1 & 2.)

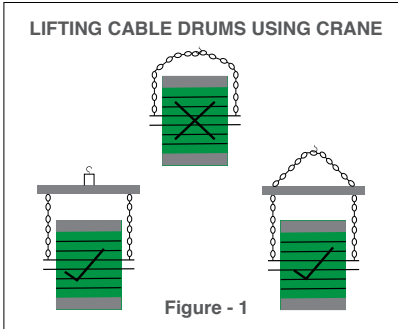


Figure - 1

When lifting drums of cable for loading or unloading, spindles must always be used in conjunction with crane slings, chain or lifting beams. On no account any drum be lifted by wire slings. (See Fig.1)

When lifting drums of cable, lifting beams or stretchers between the sling of chain pairs must be used to prevent flanges crushing on to the cable. (See Fig.1)

**NOTE:** Normally the hooks or slings should be close to the drum flanges.

## پاور کیبل کا اٹھانا، ذخیرہ کرنا اور حفاظت

### پاور کیبل کا اٹھانا

کیبل کے ڈرموں کو اٹھانے میں بے احتیاطی اور غلطیوں کی وجہ سے نقصان پہنچ سکتا ہے۔ اکثر یہ نقصان ڈرم فلائجر کے ناقابل استعمال ہو جانے اور بعض اوقات ڈرم بیروں کی چولیس ڈھیلی پڑ جانے کی صورت میں ہوتا ہے ڈرم کے ناقابل استعمال ہو جانے کے بعد کیبل کو بھی نقصان پہنچنے کے امکانات پیدا ہو جاتے ہیں

فورک لفٹ ٹرک استعمال کرنے میں کوئی حرج نہیں بشرطیکہ فورک کو ڈرم فلائج سے نیچے گھسیٹنے وقت یہ احتیاط کرنی جائے گی وہ ڈرم کی حفاظت پکینٹ کو نقصان نہ پہنچائیں اترتے وقت بھی اس طرح احتیاط کرنی چاہئے تصویر میں ظاہر کردہ ریپ اور وینچ کے استعمال سے نقصان سے بچا جا سکتا ہے اور سامان کو بحفاظت اتار اچا سکتا ہے (دیکھئے تصویر 1 اور 2)

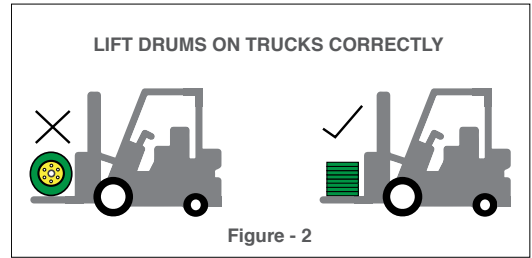


Figure - 2

کیبل ڈرمز کو اتار تے پڑھاتے وقت کریں سنگ چین یا فلنگ بیم کے ساتھ سپنڈل بھی لازماً استعمال کیا جانا چاہئے، کسی بھی حالت میں کسی بھی وجہ سے ڈرم کو کسی اور انداز میں (مثلاً چنڑ یا دائرہ سنگ) ہرگز نہیں اتارنا چڑھانا چاہئے۔ (دیکھئے تصویر نمبر 1)

ڈرم اٹھاتے وقت چین کی جوڑی کے درمیان لفٹنگ بیم سٹریچر ضرور استعمال کئے جائے چاہئیں اس سے کیبل کو اپنے ہی فلائجر کے بوجھ تلے دب کر خراب ہونے سے بچا جا سکتا چاہئے۔ (دیکھئے تصویر نمبر 1)

**نوٹ:** ہک یا سنگ کو ڈرم فلائجر کے قریب رکھنا چاہئے۔

Under no circumstances should a drum be rolled off a vehicle on to a 'cushion' of sand, tarpaulin, etc. This action could crumple the flanges and barrel of the drum, driving splinters and/or nails into the cable. (See Fig.3)

کسی بھی وجہ سے اور کسی بھی حالت میں ڈرums کو پیچھے نہیں لڑھکایا جانا چاہئے۔ ریت، مٹی یا تارپال سے بنے ہوئے اڈے پر بھی ڈرums کو نہیں لڑھکانا چاہئے۔ اس عمل سے ڈرums کے فلائج اور بیروں خراب ہو سکتے ہیں۔ اس سے بعض اوقات خود کیبل میں کیبل یا لکڑی کی ٹھیکیاں وغیرہ چبھ سکتی ہیں۔ (دیکھئے تصویر 3)

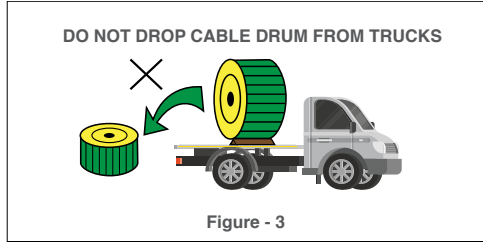


Figure - 3

### Rolling Drums:

Drums of cable must always be rolled in the direction shown by the arrow painted on the flanges, but such rolling should in any case be kept to a minimum.

### Turning Drums:

The best way to turn a cable drum is to roll it on to two wellgreased thin plates or boards about 2 feet (square). The plates can then be used as a turntable and the drum rotated to the desired direction.

### Lowering and Lifting Drums:

When drums are moved from one level to another, e.g. truck to ground, wharf ship, etc., lifting and lowering gear must always be used. When drums are lifted from the upper layer of a tiered stack, care must be taken to ensure that no movement of the bottom layer occurs so as to cause collapse. Drums, whether loaded or empty, and too heavy to be man-handled, should always be slung; they should never be dropped. (See Fig. 1 & 2)

### Pre Installation Inspection:

To ensure reliability, it must be confirmed before laying that the cable has not been damaged in transit or storage. Every drum to be inspected for any cable damage before accepting the shipment.

Report if any of the following is observed:

1. Drum is kept flat on its flange.
2. Several drums are stacked on top of each other.
3. Nails protruding on the inside of the flange.
4. Drum flange is damaged.
5. Lagging has been removed or broken which may have caused damage to sheath.
6. Cable end cap has been removed or damaged.
7. Cable drum has been dropped.

### ڈرums کو لڑھکانا

کیبل کے ڈرums کو دوسروں میں لڑھکانے کی اجازت ہے۔ اول یہ کہ صرف فلائج پر سکلے تیرے نشان پر ہی لڑھکائے جائیں۔ دم یہ عمل صرف مختصر فاصلہ تک محدود رکھا جائے۔

### ڈرums کو موڑنا

کیبل ڈم کو موڑنے کو بہترین طریقہ یہ ہے کہ اس کو تقریباً 2 فٹ مربع کے دو تختوں یا اچھی طرح سے گریس لگی ہوئی دو تیلی پلیٹوں پر رکھا جائے۔ پھر ان تختوں یا پلیٹوں کو ٹرن ٹیبل کے طور پر استعمال کرتے ہوئے ڈم کو مطلوبہ سمت میں موڑ لیا جائے

### ڈرums کو اتارنا اور چڑھانا

جب کیبل ڈرums کو ایک جگہ سے دوسری جگہ اتارنا چڑھانا مقصود ہو (مثلاً ٹرک سے زمیں پر یا بندرگاہ کی گودی سے جہاز پر لادنے کے لئے) تو ہمیشہ صحیح اوزار یعنی لفٹ اور وچ وغیرہ استعمال کرنا چاہئے۔ اگر ڈھیریں رکھے ہوں ڈرums میں سے اوپر نیچے اتارنے مقصود ہوں تو یہ احتیاط ہمیشہ کرنی چاہئے کہ اس عمل کے دوران ڈھیر میں نیچے سطحوں پر رکھے ہوئے ڈم ہل نہ جائیں۔ ایسی صورت میں سارے ڈھیر کے بگھرنے کا واضح اندیشہ ہوتا ہے۔ خالی ہوں یا پھر بھرے ہوئے ڈم عام طور پر زوباز سے اٹھانا آسان نہیں۔ انہیں ہمیشہ سلنگ سے اٹھانا اور رکھنا چاہئے ڈرums کو کسی بھی صورت پھینکنے یا پھینکنے کی اجازت نہیں۔ (دیکھئے تصویر نمبر 1 اور 2)

### کیبل کی تنصیب شروع کرنے سے پہلے کا معائنہ

کیبل کی تنصیب شروع کرنے سے پہلے تسلی کر لین کہ کیبل سفر کے دوران یا ذخیرے کے دوران یا ذخیرے کے دوران خراب تو نہیں ہو گئی۔ تمام آمدہ ڈرums کو وصول کرنے سے پہلے اچھی طرح معائنہ کر لیں کہ کیبل کو کوئی ضرر تو نہیں پہنچا۔

مندرجہ ذیل عوامل اگر موجود ہوں تو اس سے آگاہ کریں:

- 1- اگر کیبل ڈم Flange کی سطح پر پڑا ہو۔
- 2- کئی ڈم اوپر سے رکھے گئے ہوں۔
- 3- ڈم میں لگی ہوئی کیبلوں کی Flange کے اندر کی جانب تو نہیں نکلی ہوئی۔
- 4- ڈم کے Flange کو کوئی ضرر پہنچا ہو۔
- 5- حفاظتی Lagging جدا کر دی گئی ہو یا ٹوٹ گئی ہو
- 6- کیبل کے End Caps یا تو بھرے سے ہو ہی نہیں یا پھٹ جانے کی وجہ سے ختمی کے آثار ہوں۔
- 7- کیبل ڈم گرایا گیا ہو۔



## کسیل کا بچھانا

## Laying of Cables

The cable should preferably be drawn to its final position in a continuous manner. During stops, the cable will settle between rollers and may cause high strain on men and machines during restarting. Whether the pulling is manual or with a winch, it is necessary for one man to be stationed at the drum with a plank of wood wedged against the flange of the drum so that over running of the drum is prevented if the pulling stops. Otherwise, many loose turns can easily develop on the drum.

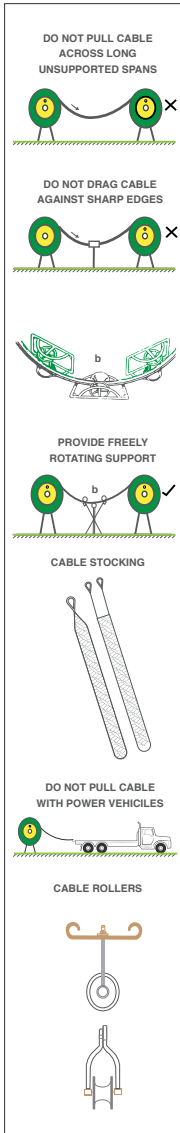
When pulling by a winch it is advantageous for the cable end to be taken by hand as far as possible before attaching the winch rope. This allows the leading cable rollers, skid plates, etc to take the load and settle under well-controlled conditions. The winch operator must, at all times, carefully observe the dynamometer to prevent overloading. On long pulls, good communication is essential, preferably by radio.

When pulling a power winch, more attention has to be given to the maximum pulling load which is permissible. For such installations a pulling eye attached to the conductors is necessary and for copper conductors a pulling tension of 6 kg force per sq. mm of total conductor area can be applied (with the provision of 2000 kg force maximum).

Graphite paste should be used for lubrication when cables are being pulled into ducts or pipes.

For open trench straight installations, a cable stocking can be used. It is advisable, however, to protect the PVC oversheath with a layer of bitumen tape applied with 50% overlap.

Cables should never be bent to a small radius. As large a radius as space permits should be adopted. Under no circumstances should the bending radius be less than the minimum permissible limits. It is particularly important to have a generous bending radius when cables are to be pulled by a power winch, so as to keep within the maximum permissible pulling tension and prevent the cable being flattened around bends or in ducts.



کسیل کو بچھانے اور کھینچنے کا عمل توجہی طور پر ابتداء سے آخر تک ایک تسلسل میں کیا جانا چاہیے۔ وقفہ کرنے کی صورت میں کسیل رولر میں بیٹھ جائیں گے اور عمل کو دوبارہ شروع کرنے پر انسانوں اور مشینوں کو اضافی طاقت درکار ہوگی۔ کسیل کھینچنے کا عمل مشینوں کے ذریعہ ہو یا انسانوں کے ذریعہ یہ لازم ہے کہ ایک نگران شخص کلیدی کے مداخلتی نتیجے کے ساتھ ڈرم کے پاس موجود رہے تاکہ کھینچائی رک جانے کی صورت میں ڈرم کے بلا روک تھل جانے کے عمل کو کام دی جا سکے بصورت دیگر کئی پکر ڈھیلے پڑ جائیں گے۔

جب کسیل کی کھینچائی وینچ کے ذریعہ جاری ہو تو جہاں تک ممکن ہو کسیل کے سرے کو ہاتھوں سے وینچ کی رسی سے منسلک کیا جائے ایسا کرنے سے کسیل رولر اور سکڈ پلیٹ قابو میں رہیں گے وینچ اپر ٹیر کے لئے لازم ہے کہ وہ کھینچناؤ ظاہر کرنے والے ڈائنامیٹر پر نگاہ رکھے اور مقررہ حد سے تجاوز نہ ہوئے دسے جہاں کھینچائی کا عمل طویل فاصلوں تک پھیلا ہو وہاں توجہی طور پر ریڈیو بصورت دیگر نہایت قابل اعتبار رابطوں کی موجودگی لازم ہے۔

جب کھینچائی وینچ کے ذریعے کی جائے تو وینچ پر پڑنے والے دباؤ اور اس کی منظور شدہ حد کا خیال رکھنا لازم ہے ایسی صورت حال میں کھینچناؤ کنٹرول کسیل کے ساتھ جوڑا جانا ضروری ہے کھینچائی کی مقدار  $6 \text{ Kg/Sq mm}$  ہے اور آخری حد  $2000 \text{ kg}$  ہے۔

جب کسیل کسی چوکور نالی یا گول پائپ میں کھینچے جارہے ہوں تو گرے فائٹ لیپ کا استعمال کیا جائے۔

کھلی نالیوں میں کسیل مچھانی یا بغیر موٹر قسم کی تنصیبات کے لئے کسیل اسٹاکنگ کا استعمال کیا جا سکتا ہے کسیل کے دہرے غلاف کو محفوظ رکھنے کے لئے ڈیو من کا استعمال پسندیدہ ہے ٹیپ کی دوسری پلیٹ پہلی پلیٹ کے کم از کم 50 فیصد کو ڈھانپ رہی ہو۔

کسیل کے گھیر کو چھوٹے رداس Radius میں نہیں موڑنا چاہئے۔ موجود جگہ میں جس حد تک ممکن ہو بڑا گھیر بنانا چاہئے۔ کسی بھی مجبوری کو بہانہ بنا کر کسیل کا گھیر مقررہ حدود سے کم نہیں کیا جا سکتا ہے۔ یہ خاص طور پر ان حالات میں لازم ہے جہاں کسیل کو وینچ کے ذریعہ کھینچنا جاسے تاکہ مقرر شدہ گھیر و میں اضافہ نہ ہو اور کسیل موڑ پڑ چھٹا ہو جانے سے محفوظ رہے۔

### Final placing of Cable

Before disconnecting the pulling rope, the cable is laid off i.e. starting at one end, it is carefully lifted from the rollers and deposited on the bottom of the trench. About 10m of cable should be lifted at one time, any slack being carried forward. The end position of a cable run may require double handling because it is not possible to draw cables straight into buildings. In this case the cable is overpulled, then man-handled into the required position. At all times the loops should be kept as large as possible so that the bending radius is always above the minimum permitted.

Similarly at the drum locations the necessary length of cable may be unwound from the drum and laid out, in a figure of '8' if space is limited, prior to cutting to length and placing into position. Immediately after cutting the cable ends must be suitably sealed to prevent ingress of moisture. In this respect it is also important to carefully examine the pulling end seal to ensure that it has not been damaged during laying. (see figures 4 & 5)

### Backfilling and Reinstatement

Prior to backfilling, it is necessary to carry out a visual inspection, and items which need to be checked are:

- 1) The cables have a suitable bedding, such as sieved sand or soil. Stone chips and other sharp objects in the cable route should be removed.
- 2) The spacing is correct if there is more than one cable in the trench.
- 3) Pulling equipment is carefully removed.
- 4) The cable is free from obvious damage caused during installation. A very high proportion of cable failures in service are due to such damage. It may be necessary to inspect the underside with a mirror. In such cases it is advisable to make a first inspection whilst the cable is still on rollers.
- 5) The cable to be MEGGER tested to ensure health of insulation through out.

#### Note:

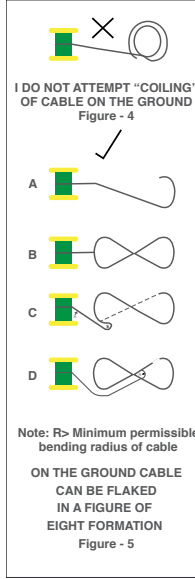
Precautions must be taken in the event cables are to be installed below 0°C.

In case of PVC sheathed cables, the length on drum should be pre conditioned by keeping drums in enclosed space for a minimum of 24-Hours at a temperature of 15°C or higher.

Cable length should be pulled slowly and laid the same day. It should not be dropped, kinked or bent sharply.

### کیبل بچھانے کے عمل کے آخری اقدامات

کیبل کو کھینچنے والی رسی کو علیحدہ کرنے سے پہلے تمام لوازمات جو اس عمل کا حصہ تھے دور کر دیئے جائیں، کیبل کو رولرز سے ہٹا کر نالی کے زینٹی فرش پر رکھ دینا چاہیے۔



تقریباً 10 میٹر کیبل بلنڈ کر کے تمام ناہمواریوں کو ختم کر دیا جائے۔ کیبل کے آخری سرے کو نصب کرنے کے لئے انسانی محنت اور مہارت درکار ہوگی۔ ہر صورت میں اس امر کی پابندی کی جائیگی کہ کیبل کا گھیر مقررہ حد سے کم نہ ہو جائے۔

دوسرے سرے پر بغیر کیبل کو ڈرم سے اتار دیا جائے اور 8 کی شکل میں ذخیرہ کر دیا جائے۔ اگر جگہ کم ہو تو مناسب ٹکڑوں میں بانٹ دیا جائے۔ سروں کو فوراً مناسب طریقے سے سیل بند کر دیا جائے تاکہ نمی وغیرہ اندر داخل نہ ہو سکا کھینچنے کے عمل میں شامل آلات کا معائنہ بھی کیا جائے تاکہ تصدیق ہو جائے کہ ان میں تو کوئی خرابی نہ ہوگی ہو۔

### کیبل کو بچھانے کے بعد احتیاط

کیبل بچھانے کے بعد نالی کو بند کرنے سے پہلے کیبل کی تمام لمبائی پر گہری آنکھ سے معائنہ کرنا لازم ہے جس میں ان امور کا خیال رکھنا لازم ہے۔

- 1) کیبلوں کے اطراف سے چھنی ہوئی ریت یا مٹی موجود ہے پتھر کے ٹکڑے اور نوکیلے جسم اگر موجود ہوں تو ان کو نکال دیا جائے۔
- 2) اگر ایک سے زیادہ کیبل ڈالے جا رہے ہوں تو ان کے درمیان فاصلہ درست مقدار کا ہو۔
- 3) کھینچنے والے آلات اور اوزار مکمل طور پر ہٹا دیئے جائیں۔
- 4) کیبل بچھانے کے عمل کے دوران لگ جانے والے ذخموں سے پاک ہو۔ کیبل کے نیچے اینڈ کے ذریعہ چٹلی سرخ کی محفوظ ہونے کی تصدیق بھی لازم۔
- 5) کیبل کو میگر سے ٹیسٹ کیا جائے تاکہ انسولیشن کے صحت مند ہونے کی تصدیق ہو جائے۔

#### نوٹ:

جن حالات میں درجہ حرارت 0°C سے کم رہتا ہے وہاں کیبل بچھانے میں احتیاط سے کام لینا چاہیے۔

اگر کیبل کی سب سے اوپر والی سطح PVC ہو تو ایسی کیبل کو بچھانے سے پہلے ڈرم کو کسی ایسی جگہ پر کم از کم 24 گھنٹے کے لئے رکھنا چاہیے جو ہر طرف سے بند ہو۔ ایسے ماحول کا درجہ حرارت کم از کم 15°C ہونا چاہیے۔

کیبل کو ڈرم پر سے آہستہ سے کھینچ کر اتاراجائے اور کام کو اسی دن مکمل کر لیا جائے۔

کیبل کو نہ ہی اوپر سے گرایا جائے، نہ ہی بل ڈالا جائے اور نہ ہی کم دائرے میں موڑا جائے۔

## پاور کیبل کو اسٹور کرنا

## Storage

If at any time the drums of cable are required to be stored for reasonably long periods, e.g. prior to shipment or installation, the following points should be noted.

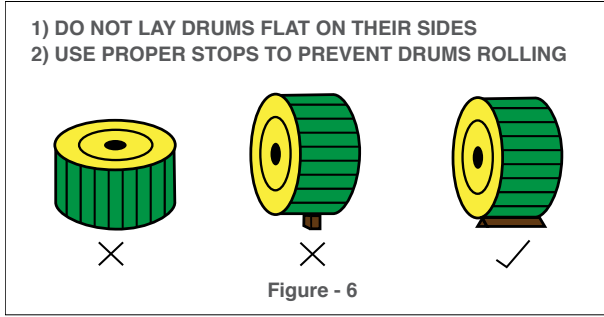
- 2.1 The site for storage of drums should be well drained, hard packed soil, or preferably a concrete surface, which will not allow the drums to sink and so give rise to damage due to the extreme difficulty in moving drums when they are sunk into the ground.
- 2.2 All drums should be stored with the lagging intact, and in such a manner as to leave sufficient space between them for air circulation. Check and tighten barrel bolts on the drums at regular intervals.
- 2.3 Tier stacking of drums is not recommended. In no circumstances must the drums be stored on the flat i.e., with flanges horizontal. (See Fig. 6)

اگر کبھی کیبل ڈرمز کو کچھ عرصہ تک اسٹور میں رکھنے کی ضروری پڑ جائے (جیسے روانگی یا استعمال کے انتظار کے دوران) تو درج ذیل امور کا دھیان رکھا جانا چاہئے۔

اسٹور کے فرش پر پانی کھڑا ہونے کا کوئی اندیشہ نہیں ہونا چاہئے۔ سب سے اچھی بات تو یہ ہوگی کہ فرش پکا ہو۔ اگر ایسا ممکن نہ ہو تو فرش کی اچھی طرح بھرائی اور کٹنائی ہونی چاہئے۔ نرم فرش میں ڈرم کے دھنس جانے کا خطرہ رہے گا۔ اگر کوئی ڈرم فرش میں دھنس گیا تو نہ صرف اس کے نکلنے میں مشکلات پیش آئیں گی بلکہ اس دوران ڈرم اور کیبل کو نقصان پہنچنے کا بھی خطرہ ہو سکتا ہے۔

اسٹور میں رکھنے وقت ہر ڈرم کی لیگنگ سالم ہونی چاہئے۔ ہوا کی گردش آسان بنانے کے لئے ہر دو ڈرموں کے درمیان کچھ فاصلہ چھوڑنا ضروری ہے۔ وقفہ وقفہ سے ہر ڈرم ہیرل کے ہولٹ کو چیک کرتے رہنا چاہئے۔

ڈرموں کی سمبھری بنا کر نہیں رکھی جانی چاہئے۔ کسی بھی صورت میں ڈرموں کو پچھا کر یعنی فلائج کو افقی رخ رکھ کر اسٹور نہیں کرنا چاہئے۔ (دیکھئے تصویر نمبر 6)



- 2.4 All drums during installation (i.e. when the lagging have been removed) should be stored with the rims of flange touching, so that there is no danger of the flanges of drums coming into accidental contact with unprotected cable on other drums.

استعمال کے دوران (یعنی لیگنگ کھل جانے کے بعد) ڈرموں کو اس طرح رکھنا چاہئے کہ ان فلائج کے کنارے آپس میں ملے ہوئے ہوں۔ اس سے تنگی تاروں کے حادثاتی طور پر فلائجوں کے ساتھ مل جانے کا اندیشہ ختم ہو جاتا ہے۔ ویسے کیبل کو کبھی غیر محفوظ انداز میں کھلا نہیں رہنے دینا چاہئے۔

### IMPORTANT:

Cable ends must be sealed with end cap during storage and transportation.

**اہم بات:**  
اسٹور میں رکھنے یا سفر کے دوران کیبل کے دونوں سرے لازمی طور پر اینڈ کیپ سے سیل بند کر دینا چاہئے۔

## Fundamental requirements for Safety

### حفاظت کے بنیادی تقاضے

The main factors to be considered while selecting a cable are;

مناسب کیبل کے چناؤ کے لئے مندرجہ ذیل عوامل کو مد نظر رکھیں

1. Continuous current carried by cable.
2. Permissible voltage drops.
3. Maximum fault current and time of its duration.
4. Ambient temperature conditions of the installation.

(1) کیبل میں مسلسل برقی رو گزرنے کی صلاحیت ہو۔

(2) کیبل کی لمبائی میں دو لٹیج مقررہ حد سے زیادہ گرنے نہ پائیں۔

(3) کیبل میں شارٹ سرکٹ کے دوران برقی رو گزرنے اور مقررہ کر داؤقت کے مطابق جھٹکے کو برداشت کرنے کی صلاحیت ہو۔

(4) کیبل کی تنصیب میں وہاں کے ماحول کے درجہ حرارت کا خیال رکھنا چاہئے۔

In addition to the above factors it is necessary to account for the possibility of load being increased due to future developments.

مندرجہ بالا عوامل کے علاوہ اس بات کا بھی خیال رکھیں کہ کیبل پر مستقبل میں برقی رو کا اضافی کرنٹ اٹھانے کی صلاحیت ہو۔

The ratings are mentioned in our catalogues, which are based on BS 7671 (Wiring Regulations).

کیبل کی برق خصوصیات ہمارے کتاچوں (Catalogues) میں درج ہیں جو کہ BS-7671 (وائرنگ کے قواعد و ضوابط) سے لی گئی ہیں۔

### Workmanship and materials

### مہارت اور ساز سامان

- Good workmanship and proper materials are always used

\* بہترین مہارت اور میاری سازو سامان کا استعمال ہوگا۔

### General

### مجموعی مقاصد :

- All equipment shall be constructed, installed and protected and shall be capable of being maintained, inspected and tested so as to prevent danger so far as is reasonably practicable.
- All equipment shall be suitable for maximum power demanded by the current-using equipment when it is functioning in its intended manner.
- All electrical conductor shall be of sufficient size and current-carrying capacity for the purposes for which they are intended.
- All conductors shall either (i) be so insulated and where necessary further effectively protected, or (ii) be so placed and safeguarded, to prevent danger so far as is reasonably, practicable.
- Every electrical joint and connection shall be of proper construction as regards conductance, insulation, mechanical strength and protection.

\* جہاں تک ممکن ہو تمام آلات کی تعمیر، تنصیب اور حفاظت اس انداز سے کی جائے کہ انکی خرابی گیری معائنہ اور آلات کی جانچ پڑتال بے خطر کی جاسکے

\* تمام برقی آلات اس مقدار کے وولٹ لیپیٹرز (VA) کے مطابق بنائے جائیں گے جس کے لئے ان کو استعمال ہونا

\* تمام برقی تار اور کیبل مطلوبہ کرنٹ گزارنے کی صلاحیت کے مطابق ہونگے تمام برقی تار اس طرح ہونگے

(i) کہ برقی غلاف چڑھے ہونگے اور اس کے علاوہ جہاں ضرورت ہو مزید تحفظ کے حامل ہونگے یا

(ii) اس طرح لگائے جائیں گے کہ انسانی پہنچ سے دور رہیں تاکہ حادثات ممکنہ حد تک کم ہو سکیں

\* تمام برقی جوڑ اور کنکشن اپنی ساخت کے اعتبار سے مناسب ایصالیت، غلاف، میکانیکی طاقت اور تحفظ کے حامل ہوں

## Overcurrent protective devices

Where necessary to prevent danger, every installation and every circuit thereof shall be protected against over-current by devices which:

- (i) will operate automatically at values of current which are suitably related to the safe current rating of the circuit,
- (ii) are of adequate breaking capacity and where appropriate
- (iii) are suitably located and are constructed as to prevent danger from overheating, arcing or the scattering of hot particles when they come into operation and to permit ready restoration of the supply without danger.

## Precautions against earth leakage and earth fault currents

- Where metalwork of electrical equipment, other than current-carrying conductors, may become charged with electricity in such a manner as to cause danger:
  - (i) the metalwork shall be connected with earth in such a manner as will cause discharge of electrical energy without danger, or
  - (ii) other equally effective precautions shall be taken to prevent danger.
- Every circuit shall be arranged so as to prevent the persistence of dangerous earth leakage currents.
- Where metalwork is connected with Earth in accordance with relevant regulations. The circuit concerned shall be protected against the persistence of an Earth fault current by:
  - (i) the over-current protective devices as required by regulation or
  - (ii) a residual current device or equally effective device.

The method described in item (ii) above shall be used whenever the prospective Earth fault current is insufficient to cause prompt operation of the over-current protective devices.
- Where any metalwork of electrical equipment is connected with earth in accordance with regulation and is accessible simultaneously with substantial exposed metal parts of other services, the latter shall be effectively connected to the main earthing terminal of the installation.

## افراط کرنٹ سے تحفظ دینے والے آلات:

- \* جہاں خطرے سے بچاؤ لازم ہے ہر تھیب اور ہر حرکت کا افراط کرنٹ کا تحفظ ایسے آلات سے دیا جائے جو
  - (i) افراط کرنٹ کی صورت میں خودکار طریقے سے منقطع ہو سکیں۔
  - (ii) اس طاقت کے حامل ہوں گے کہ کرنٹ کو قطع کرنے اور رواں کرنے کی اضطراری کیفیت کو برداشت کر سکیں اور
  - (iii) مناسب جگہ پر نصب ہوں اور ان کے ساخت اس نوعیت کی ہوگی کہ زیادہ گرمی شعلہ پیدا ہونے یا چنگاری نکلنے کی صورت میں محفوظ رہ سکیں اور برقی کرنٹ کو بے خطر رواں رکھ سکیں اور بحال کر سکیں۔

## ارض لیکج اور ارض فالٹ کرنٹ کی صورت میں احتیاط:

- \* جہاں برقی یا آلات کے ایسے دھاتی حصے جو کرنٹ گزارے سے متعلق نہ ہوں اگر حادثاتی طور پر برقی چارج کی شکار ہو جائیں اور اس طرح خطرے کا سبب بن سکتے ہوں تو:
  - (i) ایسے دھاتی جسم کو ارض سے ملا دیا جائے تاکہ برقی چارج ارض میں دفن ہو جائیں۔
  - (ii) خطرے سے بچنے کے لئے دیگر تدابیر بھی عمل میں لائی جائیں۔
- \* ہر حرکت کے لئے ایسا انتظام کیا جائے کہ خطرناک مقدار کے ارض لیکج کرنٹ مستقل طور پر رواں رہنے سے محفوظ رہیں۔
- \* مزکورہ بالا ضابطہ کے تحت ارض سے جوڑے گئے دھاتی حصوں کو مستقل ارض لیکج کے برقرار رہنے سے بچاؤ کے لیے:
  - (i) افراط کرنٹ تحفظ کے آلات ضابطوں کے مطابق لگائے جائیں گے
  - (ii) ارض لیکج حرکت بریکر یا اس کا ہم پلہ کوئی دوسرا آگہ لگایا جائے گا۔

ارض لیکج حرکت بریکر اس صورت میں لگایا جائے گا کہ جب ارض فالٹ کرنٹ اس قدر خفیف ہو کہ افراط کرنٹ سے تحفظ کے آلات کام نہ کر سکیں۔
- \* ایسی صورت حال میں جبکہ برقی آلات کے دھاتی حصے ضابطوں کے مطابق ارض سے جوڑ دیئے گئے ہوں اور ان کے قریب دیگر خدمات مثلاً گیس یا پانی وغیرہ کے لئے خاطر خواہ جسامت کے دھاتی جسم بھی پہنچنے کے اندر ہوں تو ان دھاتی جسموں کو مضبوطی سے ارض کے ساتھ جوڑنا ہوگا۔

### Protective devices and switches

- A single-pole fuse switch or circuit-breaker shall be inserted in the phase conductor only.
- No switch or circuit-breaker, excepting where linked, or fuse shall be inserted in an earthed neutral conductor and any linked switch or linked circuit-breaker inserted in an earthed neutral conductor shall be arranged to break all the related phase conductor

### Isolation and switching

- Effective means, suitably placed for ready operation, shall be provided so that all voltage may be cut from every installation, from every circuit thereof and from all equipment, as may be necessary to prevent or remove danger.
- Every fixed electric motor shall be provided with an efficient means of switching off, readily accessible, easily operated and so placed as to prevent danger.

### Accessibility of equipment

- Every piece of equipment which requires operation or attention by a person shall be so installed that adequate space are afforded for such operation or attention.

### Precaution in adverse conditions

- All equipment likely to be exposed to weather, corrosive atmosphere or other adverse conditions, shall be so constructed or protected as may be necessary to prevent danger arising from such exposure.

All equipment in surroundings susceptible to risk of fire or explosion shall be so constructed or protected and such other special precautions shall be taken, as may be necessary to prevent danger.

### Additions and alterations to an installation

- No addition or alteration, temporary or permanent, shall be made to an existing installation, unless it has been ascertained that the rating and the condition of any existing equipment, including that of the supplier, which will have to carry any additional loads is adequate for the altered circumstances and the earthing arrangements is also adequate.

تحفظ فراہم کرنے والے آلات اور سوئچ وغیرہ :

\* سنگل پول فیوز سوئچ، یا سرکٹ بریکر کو صرف فیز کے تار میں لگایا جائے گا۔

\* کسی بھی ارض شدہ نیوٹرل تار میں کوئی سوئچ، سرکٹ بریکر یا فیوز نہیں لگایا جائے گا چار پول کے آلات میں نیوٹرل علیحدہ کرنے کی صورت میں ضروری ہوگا کہ اس سے پہلے منسلک تینوں فیز بھی علیحدہ ہو جائیں۔ اس کے بعد نیوٹرل علیحدہ ہو۔

برقی روکا منقطع کرنا اور اس کا کھولنا اور بند کرنا :

\* خطرے کو روکنے یا اس سے بچانے کے لئے ضروری ہوگا کہ ہر تنصیب، اس کے سرکٹ اور آلے سے تمام وولٹیج کو فوری طور پر منقطع کرنے کے لئے موثر ذرائع موقع پر قابل عمل ہوں اور

\* خطرے سے بچانے کے لئے ضروری ہوگا کہ ہر جامد برقی موثر سے تمام وولٹیج فوری طور پر منقطع کرنے کے لئے موثر ذرائع مناسب مقام پر قابل عمل ہوں

برق آلات تک پہنچ:

\* ہر ایسا آلہ جسے چلانے یا جس کی نگرانی کے لئے کسی انسان کی ضرورت ہو، اسے اس طرح نصب کیا جائے کہ اس تک رسائی کے لئے مناسب اور محفوظ ذرائع موجود رہیں اور اسے چلانے اور اس کی نگرانی کے لئے مناسب جگہ مہیا کی گئی ہو۔

اہتر ماحول میں احتیاطی طریقہ کار:

\* تمام ایسے برقی آلات جنہیں کھلے موسم، زنگ آمیز ماحول یا دیگر اہتر حالات میں نصب ہونا ہو ان کے لئے ضروری ہوگا وہ ایسی مخصوص اور محفوظ ساخت کے ہوں کہ ہر ممکنہ خطرے سے محفوظ رہ سکیں۔

\* تمام ایسے آلات برق جنہیں ایسے ماحول میں نصب ہونا ہو جہاں آگ یا دھماکے کا خطرہ موجود ہو ان کے لئے ضروری ہوگا کہ وہ ایسی مخصوص اور محفوظ ساخت کے ہوں اور ان کی تنصیب میں تمام احتیاطی تدابیر استعمال کی جائیں جو ایسے کسی خطرے سے بچانے کے لئے لازمی ہوں۔

موجود تنصیب میں اضافے اور تبدیلیاں:

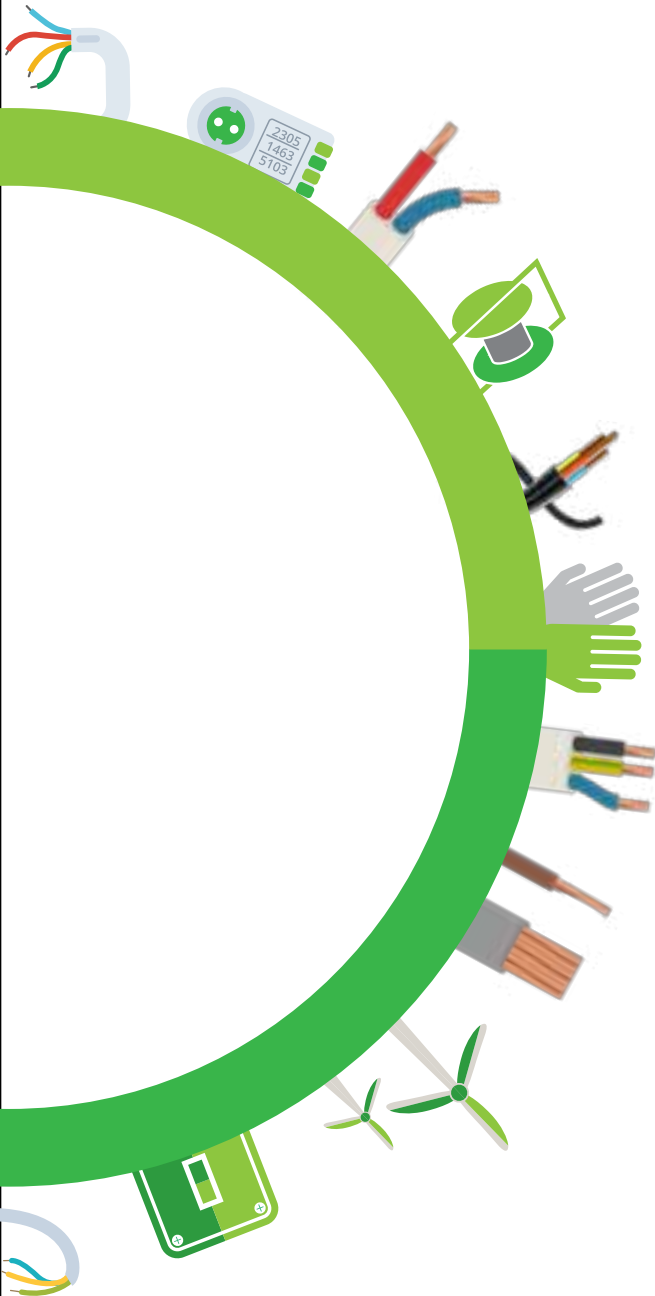
\* کسی بھی موجود تنصیب میں ہر گز کوئی اضافہ عارضی یا مستقل تبدیلی نہیں کی جائے گی تا وقتیکہ یہ تصدیق نہ کر لی جائے کہ وہاں موجود برق آلات بشمول ان آلات کے جو بجلی سپلائی مین کی ملکیت ہوتے ہیں اور جن کو مطلوبہ اضافی برقی فراہم کرنا ہوگی کی استعداد درصحت ضرورت کے مطابق ہے اور یہ کہ ارض کرنے کے مناسب انتظامات بھی موجود ہیں۔

## Inspection and testing

- On completion of an installation or an extension or alteration of an installation, appropriate inspection and tests shall be made, to verify so far as is reasonably practicable that the requirement of regulations have been met. The person carrying out the inspection and tests or a person acting on their behalf, shall inform the person ordering the work of the recommendations for periodic inspection and testing in future.

## معائنہ اور آلات سے تصدیق:

\* کسی بھی تنصیب میں اضافے یا ترمیم کی صورت میں ضروری ہوگا کہ اس تنصیب کا معائنہ اور آلات سے تصدیق کی جائے کہ جہاں تک ممکن ہو سکا ہے متعلقہ ضابطوں میں ذکر کردہ تمام تقاضے پورے کرتے گئے ہیں۔ معائنہ اور تصدیق کرنے والے شخص یا اس کے نمائندے کے لئے ضروری ہے کہ وہ آئندہ معائنے کے لئے اپنی سفارشات اس شخص تک پہنچائے جو اس تنصیب کے معائنے کا حکم دینے کا مجاز ہو۔



## CHAPTER 6

# Useful Information



## Useful Information

1. Conductor Data
  - a. Conductor sizes, D.C resistance of rigid and flexible conductors
  - b. Diameter of stranded compacted circular conductors
2. Color of Insulation
3. Electrical Formulas
4. Cable capacities of Conduit and Trunking
5. Minimum internal radius of Bend
6. Pulling Tensions
7. Conversion table
8. First Aid instructions for Accident caused by Electrocution
9. Product Range.

## Section 1: Conductor Data

### Class 2 Stranded Conductors for Single-core and Multi-core cables

Nominal cross-sectional area mm <sup>2</sup>	Minimum number of wires in the conductor						Maximum resistance of conductor at 20°C	
	Circular Conductor		Circular Compacted Conductor		Shaped Conductor		Annealed Copper Conductor	Plain aluminium Conductor
	Cu	Al	Cu	Al	Cu	Al	Plain wires	
1.5	7	-	6	-	-	-	12.1	-
2.5	7	-	6	-	-	-	7.41	-
4	7	-	6	-	-	-	4.61	-
6	7	-	6	-	-	-	3.08	-
10	7	7	6	-	-	-	1.83	3.08
16	7	7	6	6	-	-	1.15	1.91
25	7	7	6	6	6	6	0.727	1.20
35	7	7	6	6	6	6	0.524	0.868
50	19	19	6	6	6	6	0.387	0.641
70	19	19	12	12	12	12	0.268	0.443
95	19	19	15	15	15	15	0.193	0.320
120	37	37	18	15	18	15	0.153	0.253
150	37	37	18	15	18	15	0.124	0.206
185	37	37	30	30	30	30	0.0991	0.164
240	37	37	34	30	34	30	0.0754	0.125
300	61	61	34	30	34	30	0.0601	0.100
400	61	61	53	53	53	53	0.0470	0.778
500	61	61	53	53	-	-	0.0366	0.0605
630	91	91	53	53	-	-	0.0283	0.0469
800	91	91	-	-	-	-	0.0221	0.0367
1000	91	91	-	-	-	-	0.0176	0.0291

### Class 5 Flexible copper conductors for single core and multi core cables

1	2	3	4
Nominal Cross Sectional Area mm	Maximum diameters of wires in conductor mm	Maximum Resistance of Conductor	
		Plain Wires $\Omega/\text{km}$	Metal Coated Wires $\Omega/\text{km}$
0.5	0.21	39.0	40.1
0.75	0.21	26.0	26.7
1	0.21	19.5	20.0
1.5	0.26	13.3	13.7
2.5	0.26	7.98	8.21
4	0.31	4.95	5.09
6	0.31	3.30	3.39
10	0.41	1.91	1.95
16	0.41	1.21	1.24
25	0.41	0.780	0.795
35	0.41	0.554	0.565
50	0.41	0.386	0.393
70	0.51	0.272	0.277
95	0.51	0.206	0.210
120	0.51	0.161	0.164
150	0.51	0.129	0.132
185	0.51	0.106	0.108
240	0.51	0.0801	0.0817
300	0.51	0.0641	0.0654
400	0.51	0.0486	0.0495
500	0.61	0.0384	0.0391
630	0.61	0.0287	0.0292

## Diameters of stranded circular compacted copper and aluminium conductors

1	2	3
Stranded compacted circular Conductors (Class 2)		
Cross sectional Area mm <sup>2</sup>	Minimum diameter (mm)	Maximum diameter (mm)
10	3.6	4.0
16	4.6	5.2
25	5.6	6.5
35	6.6	7.5
50	7.7	8.6
70	9.3	10.2
95	11.0	12.0
120	12.3	13.5
150	13.7	15.0
185	15.3	16.8
240	17.6	19.2
300	19.7	21.6
400	22.3	24.6
500	25.3	27.6
630	28.7	32.5

## Section 2: Colour of Insulation

XLPE / PVC cables have coloured cores

Number of cores	Colours
Single	Black or Red
Two	Red, Black
Three	Red, Yellow, Blue
Four	Red, Yellow, Blue, Black

Black denotes the neutral and other colours for phase conductors in two, three or four core cables.

Following colour identification is also offered provided the quantity is economical:

Number of cores	Colours
Single	Blue or Brown
Two	Blue, Brown
Three	Brown, Black, Grey
Four	Brown, Black, Grey, Blue

Blue denotes the neutral and other colours for phase conductors in two, three and four core cables.

## Section 3: Electrical Formulas

DESIRED DATA	ALTERNATING CURRENT	
	Single Phase	Three Phase
Amperes when kva is known	$kva \times 1000 / E$	$kva \times 1000 / 1.73 \times E$
Amperes when kilowatts are known	$kw \times 1000 / E \times pf$	$kw \times 1000 / 1.73 \times E \times pf$
Amperes when horsepower is known	$hp \times 746 / E \times \%Eff \times pf$	$hp \times 746 / 1.73 \times E \times \%Eff \times pf$
Kilovolt-Amperes	$I \times E / 1000$	$I \times E \times 1.73 / 1000$
Kilowatts	$I \times E \times pf / 1000$	$I \times E \times 1.73 \times pf / 1000$
Horsepower	$I \times E \times \%Eff \times pf / 746$	$I \times E \times 1.73 \times \%Eff \times pf / 746$

E = volts (conductor to conductor)

I = Amps

%Eff = percent efficiency in decimals

pf = power factor in decimals

kva = kilovolt ampere

kw = kilowatts

hp = horsepower

## Section 4: Cable capacities of conduit and trunking

A number of variable factors affect any attempt to arrive at a standard method of assessing the capacity of conduit and trunking.

Some of these are

- reasonable care (of drawing-in)
- acceptable use of the space available
- tolerance in cable sizes
- tolerance in conduit and trunking

The following tables can only give guidance on the maximum number of cables which should be drawn in. The sizes should ensure an easy pull with low risk of damage to the cables.

Only the ease of drawing-in is taken into account. The electrical effects of grouping are not. As the number of circuit increases the installed current carrying capacity of the cable decreases. Cable sizes have to be increased with consequent increase in cost of cable and conduit.

It may sometimes be more attractive economically to divide the circuits concerned between two or more enclosures.

The following three cases are dealt with single core thermoplastic (PVC) insulated cables in:

- i. Straight runs of conduit not exceeding 3 m in length (Tables 1 & 2).
- ii. Straight runs of conduit exceeding 3 m in length or in runs of any length incorporating bends or sets (table 3 & 4)
- iii. Trunking (Table 5 & 6)

- A) Single –core thermoplastic (PVC) insulated cables in straight runs of conduit not exceeding 3 m in length.

For each cable it is intended to use, obtain the appropriate factor from Table 1.

Add the cable factors together and compare the total with the conduit factors given in Table 2.

The minimum conduit cable size is that having a factor equal to or greater than the sum of cable factors.

**Table 1:** Cable factors for use in conduit in short straight runs.

Type Of Conductor	Conductor cross sectional area (mm <sup>2</sup> )	Cable Factor
Solid	1	22
	1.5	27
	2.5	39
Stranded	1.5	31
	2.5	43
	4	58
	6	88
	10	146
	16	202
	25	385

**Table 2:** Conduit factors for use in short straight runs.

Conduit diameter (mm)	Conduit Factor
16	290
20	460
25	800
32	1400
38	1900
50	3500
63	5600

- B) Single –core thermoplastic (PVC) insulated cables in straight runs of conduit exceeding 3 m in length or in runs of any length incorporating bends or sets.

For each cable it is intended to use, obtain the appropriate factor from Table 3

Add the cable factors together and compare the total with the conduit factors given in Table 4 taking into account the length of run it is intended to use and the number of bends and sets in that run.

The minimum conduit size is the size having a factor equal to or greater than the sum of the cable factors. For the larger sizes of conduit, multiplication factors are given relating them to 32 mm diameter conduit.

**Table 3:** Cable factors for use in conduit in long straight runs over 3 m or runs of any length incorporating bends.

Type Of Conductor	Conductor cross sectional area (mm <sup>2</sup> )	Cable Factor
Solid or Stranded	1	16
	1.5	22
	2.5	30
	4	43
	6	58
	10	105
	16	145
	25	217

The inner radius of a conduit bend should be not less than 2.5 times the outside diameter of conduit.

**Table 4:** Conduit factors for runs incorporating bends and long straight runs.

Length of run (m)	Conduit diameter (mm)																						
	Straight				One Bend				Two Bends				Three Bends				Four Bends						
	16	20	25	32	16	20	25	32	16	20	25	32	16	20	25	32	16	20	25	32			
1	Covered by Tables 1 and 2				188	303	543	947	177	286	514	900	158	256	463	818	130	213	388	692			
1.5					182	294	528	923	167	270	487	857	143	233	422	750	111	182	333	600			
2					177	286	514	900	158	256	463	818	130	213	388	692	97	159	292	529			
2.5					171	378	500	878	150	244	442	783	120	196	358	643	86	141	260	474			
3					167	270	487	857	143	233	422	750	111	182	333	600							
3.5	179	290	521	911	162	263	475	837	136	222	404	720	103	169	311	563							
4	177	286	514	900	158	256	463	818	130	213	388	692	97	159	292	529							
4.5	174	282	507	889	154	250	462	800	125	204	373	667	91	149	275	500							
5	171	278	500	878	150	244	442	783	120	196	358	643	86	141	260	474							
6	167	270	487	857	143	233	422	750	111	182	333	600											
7	162	263	475	837	136	222	404	720	103	169	311	563											
8	158	256	463	818	130	213	388	692	97	159	292	529											
9	154	250	452	800	125	204	373	667	91	149	275	500											
10	150	244	442	783	120	196	358	643	86	141	260	474											

Additional factors:

For 38 mm diameter use 1.4 x (32 mm factor)

For 50 mm diameter use 2.6 x (32 mm factor)

For 63 mm diameter use 4.2 x (32 mm factor)

- C) Single –core thermoplastic (PVC) insulated cables in trunking.  
 For each cable it is intended to use, obtain the appropriate factor from Table 5.  
 Add the cable factors together and compare the total with the factors for trunking given in Table 6.  
 The minimum size of trunking is that size having a factor equal to or greater than the sum of cable factors.

**Table 5:** Cable factors for trunking

Type of Conductor	Conductor cross sectional area (mm <sup>2</sup> )	PVC BS 6004 Cable factor
Solid	1.5	8.0
	2.5	11.9
Stranded	1.5	8.6
	2.5	12.6
	4	16.6
	6	21.2
	10	35.3
	16	47.8
	25	73.9

**Notes:**

- 1) These factors are for metal trunking and may be optimistic for plastic trunking, where the cross sectional area available may be significantly reduced from the nominal by the thickness of wall material.
- 2) The provision of spare space is advisable, however any circuits added at a later date must take into account grouping, Regulation 523.5.

**Table 6:** Factors for trunking.

Dimensions of trunking (mm x mm)	Factor
50 x 38	767
50 x 50	1037
75 x 25	738
75 x 38	1146
75 x 50	1555
75 x 75	2371
100 x 25	993
100 x 38	1542
100 x 50	2091
100 x 75	3189
100 x 100	4252
150 x 38	2999
150 x 50	3091



Dimensions of trunking (mm x mm)	Factor
150 x 75	4743
150 x 100	6394
150 x 150	9697
200 x 38	3082
200 x 50	4145
200 x 75	6359
200 x 100	8572
200 x 150	13001
200 x 200	17429
225 x 38	3474
225 x 50	4671
225 x 75	7167
225 x 100	9662
225 x 150	14652
225 x 200	19643
225 x 225	22138
300 x 38	4648
300 x 50	6251
300 x 75	9590
300 x 100	12929
300 x 150	19607
300 x 200	26285
300 x 225	29624
300 x 300	39428

**Note:** Space factor is 45 % with trunking thickness taken into account

**Other sizes and types of cable or trunking:**

For sizes and types of cable or trunking other than those given in Tables 5 and 6 the number of cables installed should be such that the resulting space factor does not exceed 45% of the net internal cross sectional area.

Space factor is the ratio (expressed as a percentage) of the sum of overall cross sectional area of cables (including insulation and any sheath) to the internal cross sectional area of the trunking or other cable enclosure in which they are installed. The effective overall cross sectional area of a noncircular cable is taken as that of circle of diameter equal to the major axis of cable.

Care should be taken to use trunking bends etc. which do not impose radii on cable less than those mentioned in Section 5.

## Section 5: Minimum Internal Radius of Bend

Bending or twisting cables sharply may permanently damage the insulation or other components of cables which ultimately result in premature failure. It is therefore recommended that as large a radius of bend as possible should be adopted during installation but not in any case less than those mentioned below:

### General Wiring Cables:

S. No	Overall Cable diameter (D)	Minimum Bending Radius mm
1	$D \leq 10$	3 x D
2	$10 < D \leq 25$	4 x D
3	$D > 25$	6 x D

### LV Power Cables:

S. No	Cable Type	Minimum Bending Radius mm
1	Single Core Cables (Unarmoured & Armoured)	8 x D
2	Multi Core Cables (Unarmoured & Armoured)	12 x D

D = Overall Diameter of CableSection

## Section 6: Pulling Tensions

- While pulling with conductors using pulling eyes following pulling tensions to be adopted.

**Copper stranded conductor --- 5 times the conductor cross sectional area (kg)**

**Aluminum stranded conductor --- 3 times the conductor cross sectional area (kg)**

For multicore cables, the maximum tension can be increased by number of core in the cable, provided pulling eye is attached to each conductor.

- The above values are also adopted in case of pulling with stocking .The stocking should be of the correct diameter and length so that tension is transferred to the conductor. There should not be any relative movement between extruded layers and conductor at the pulling end.

- When cable is pulled using the armour pulling eye following tension to be adopted.

**Galvanized Steel Wire Armour --- 10 times the conductor cross sectional area (kg)**

**Aluminum wire Armour --- 3 times the conductor cross sectional area (kg)**

Pulling tension not to exceed 2000 kg.

## Section 7: Conversion Tables

### SI Prefixes Expressing Decimal Factors

Factor	Prefix	Symbol	Factor	Prefix	Symbol
$10^{18}$	exa	E	$10^{-1}$	deci	D
$10^{15}$	peta	P	$10^{-2}$	centi	C
$10^{12}$	tera	T	$10^{-3}$	milli	M
$10^9$	giga	G	$10^{-6}$	micro	$\mu$
$10^6$	mega	M	$10^{-9}$	nano	N
$10^3$	kilo	k	$10^{-12}$	pico	P
$10^2$	hecto	h	$10^{-15}$	femto	f
$10^1$	deka	da	$10^{-18}$	atto	a

### SI Base Units

Quantity	Unit	Symbol
length	meter	m
Mass	Kilogram	kg
Time	Second	s
Electric current	Ampere	A
Thermodynamic temperature*	Kelvin	K
Amount of substance	Mole	mol
Luminous intensity	Candela	cd

\*Celsius temperature is, in general, expressed in degrees Celsius (symbol °C)

Multiply	By	To Obtain
----------	----	-----------

Weight-Imperial		
Ounces	28.3495	grams
Pounds (Av)	453.59	grams
Pounds (Av)	0.45359	kilograms
Tons (short)	907.19	kilograms
Tons (long)	1016.05	kilograms

Weight-Metric		
Grams	0.03527	Ounces
Grams	0.002205	Pounds
Kilograms	35.274	Ounces
Kilograms	2.2046	Pounds
Kilograms	0.001102	tons (short)
Kilograms	0.0009842	tons (long)

**Miscellaneous-Imperial**

Pounds per 1000 feet	1.48816	Kg/Km
Pounds per mile	0.28185	Kg/Km
Pounds per square inch	0.0007031	Kg.per square mm.
Pounds per square inch	0.07031	Kg.per square cm.
Pounds per cubic	27.68	grams per cubic cm.
Feet per second	18.288	meters per minute.
Feet per second	1.09728	kilometers per hour.
Miles per hour	1.60935	kilometer per hour.
Ohms per 1000 feet	3.28083	ohms per kilometer.
Ohms per mile	0.62137	ohms per kilometer.
Decibels Per 1000 feet	3.28083	decibels per kilometer.
Decibels per miles	0.62137	decibels per kilometer.
Decibels	0.1153	nepers.

**Miscellaneous-Metric**

Kg/Km	0.67197	pounds per 1000 feet.
Kg/Km	3.54795	pounds per mile.
Kg.Per square mm	1422.34	pounds per square inch.
Kg.Per square cm	14.2234	pounds per square inch.
Grams per cubic cm	0.03613	pounds pre cubic inch.
Meters per minute	0.05468	feet per second.
Kilometers per hour	0.91134	feet per second.
Kilometer per hour	0.62137	miles per hour.
Ohms per kilometer	0.3048	ohms per 1000 feet.
Ohms per kilometer	1.6093	ohms per mile.
Decibles per kilometer	0.3048	decibels per 1000 feet.
Decibles per kilometer	1.6093	decibels per mile
Nepers	0.1153	decibels

**Length-Imperial**

Mils	0.001	inches.
Mils	0.0254	mm.
Inches	1000	mils.
inches	25.4	mm.
inches	2.54	cm.
Feet	30.48	cm.
Feet	0.3048	meters.
Feet (thousands of)	0.3048	kilometers.
Yards	0.9144	meters.
Miles	1.6093	kilometers.

**Temperature**

°Fahrenheit	5/9(°F)-32	°Celsius
°Celsius	9/5(°C)+32	°Fahrenheit

**Length-Metric**

Millimeters	39.37	mils.
Millimeters	0.03937	inches.
Centimeters	0.3937	inches.
Centimeters	0.032808	feet.
Meters	39.37	inches.
Meters	3.2808	feet.
Meters	1.0936	yards.
Kilometers	3280.83	feet.
Kilometers	0.62137	miles.

**Area-Imperial**

Square mils	1.2732	circular mils
Square mils	0.000001	square inches
Circular mils	0.7854	square mils
Circular mils	0.0000007854	square inches
Square mils	0.0005067	square mm.
Square inches	1000000	square mils
Square inches	1273240	square mils
Square inches	645.16	square mm.
Square inches	6.4516	square cm.
Square feet	0.0929	square meters
Square yards	0.8361	square meters

**Area-Metric**

Square millimeters	1973.52	circular mils
Square millimeters	0.00155	square inches
Square centimeters	0.155	square inches
Square meters	10.7638	square feet
Square meters	1.19599	square yards

**Volume-Imperial**

Cubic inches	16.38716	cubic cm.
Cubic feet	0.028317	cubic meters.

**Volume-U.S.**

Quarts (liquid)	0.9463	liters.
Gallons	3.7854	liters.

**Volume-Metric**

Cubic centimeters	0.06102	cubic inches.
Cubic meters	35.3145	cubic feet.
Liters	1.05668	quarts (liquid U.S.)
Liters	0.26417	gallons (U.S.)

## Section 8: First Aid Instruction for Accident Caused by Electrocutation

### Preliminary Precautions

1. Switch off the line. Then only remove the victim from contact with the electric conductor. If the line is alive and the victim is being removed inspite of this fact, the rescuer is exposed to danger.

In such a case, adopt any of following procedures:

In the case of low-Voltage installation:

- a) Insulate yourself from the ground by several layers of dry boards, beams or wooden boxes.
- b) Remove the line from the victim by means of long, dry wooden sticks, dry ladder etc.

If this does not work:

- c) Pull or push the victim away from the line while standing on insulating board etc. Wrap several layers of dry clothing around your hands, do not touch the victim except by clothing.

In the case of high voltage installation:

1. Only experts should be permitted to remove the victim.
2. If the victim is hanging on the wires, spread straw hay or bedding underneath .
3. Notify the Power Company and call the doctor.
4. Post a guard at the site of accident.

### Treatment in Case of Unconsciousness

After the victim has been removed from contact with the power line, start first of all with immediate attempts to restore the breathing.

- Place the unconscious person on his back, head to one side with a pillow under his shoulders.
- Open his collar, scarf, belt and tight clothing etc.
- Carefully open the mouth of patient and place some hard object, preferably a piece of wood between his teeth, (remove any denture).
- Slowly but with sufficient strength pull out his tongue. Using a handkerchief let somebody hold or tie to the chin of victim.
- Try to get him to breathe spontaneously, by tickling his nose and throat.
- If no immediate success is achieved, start at once with artificial breathing, Kneel down behind the head of the victim, grasp his arms under the elbows, press them firmly against his chest and then draw them slowly a part in a circle over his head. After two seconds bring the arms back to their initial position. Repeat the exercise at the rate of 16 – 20 times a minute. If necessary, for several hours, until the arrival of a doctor. More rapid movements are harmful and needlessly tiring. Stop the artificial respiration as soon as the victim starts breathing; activate the blood circulation by sprinkling his head and chest with cold water and rubbing heart. If the victim recovers, cover him up and let him sip warm drinks from a teaspoon as soon as he is able to swallow.
- Leave any further aid for the doctor.

## Section 9: Product Range

PRODUCT	SPECIFICATION	RANGE	USAGE
<b>GENERAL WIRING</b>	450/750V & 300/500V BS-6004, BS-50525, BS-6500	a) SINGLE CORE (PVC Insulated) 1 mm <sup>2</sup> to 630 mm <sup>2</sup>  b) SHEATHED CABLES Single Core 1 mm <sup>2</sup> to 10 mm <sup>2</sup> Multi Core 1 mm <sup>2</sup> to 10 mm <sup>2</sup>	Homes, offices, recreational areas, multi-storied complexes, buildings and plazas such as hospitals, hotels, apartments, and other commercial spaces.
<b>L.V. CABLES</b>	600/1000V & 1900/3300V	a) SINGLE CORE 16 mm <sup>2</sup> to 1000 mm <sup>2</sup>  b) MULTI CORE 16 mm <sup>2</sup> to 400 mm <sup>2</sup> Armoured / Unarmoured / Screened	Multiple sectors e.g. Cement, Chemical, Textile, Oil & Gas, Process Automation, Airports, Railways, Metros, Sugar Industry, and similar other projects
COPPER OR ALUMINIUM CONDUCTOR XLPE OR PVC INSULATED	BS-6346 BS-5467 IEC-60502-1	Armoured / Unarmoured / Screened	
<b>M.V. CABLES</b>	11000 -15000 V	a) SINGLE CORE 16 mm <sup>2</sup> to 630 mm <sup>2</sup>  b) MULTI CORE 16 mm <sup>2</sup> to 400 mm <sup>2</sup> Armoured/Unarmoured	Primary Cable of Utility Companies for distribution to Sub-Station. Industrial Projects
COPPER OR ALUMINIUM CONDUCTOR, XLPE INSULATED	IEC-502, IEC-60502-2	Armoured/Unarmoured	
<b>LOW SMOKE ZERO HALOGEN (LSZH) CABLES</b>			Hotels, Commercial Buildings, Hospitals, Shopping Malls, Cinemas, Airports, Mass Transit, Ships, Data Centers and Similar Public Places.
General Wiring			
a) LSZH INSULATED 70°C	BS EN-50525-3-31 450 / 750 V	1.5 mm <sup>2</sup> to 630 mm <sup>2</sup>	
b) XL-HFFR INSULATED 90°C	BS EN-50525-3-41 450 / 750 V	1.5 mm <sup>2</sup> to 630 mm <sup>2</sup>	
<b>LV CABLE</b>			
COPPER OR ALUMINIUM CONDUCTOR XLPE INSULATED LSZH SHEATHED	IEC-60502-1, 600/1000V	a) SINGLE CORE 1.5 mm <sup>2</sup> to 1000 mm <sup>2</sup> Armoured / Unarmoured  b) MULTI CORE 1.5 mm <sup>2</sup> to 400 mm <sup>2</sup> Armoured / Unarmoured	
<b>ENHANCED FIRE RETARDANT CABLES</b>			Multiple sectors e.g. Cement, Chemical, Textile, Oil & Gas, FMCG, Process Automation, Airports, Railways, Metros, Sugar Industry, and similar other projects
COPPER OR ALUMINIUM CONDUCTOR XLPE INSULATED LSZH SHEATHED	IEC-60502-1, 600/1000V IEC-60332-3-22, CAT-A IEC-60332-3-24, CAT-C	Single & Multi Core Cable 1.5 mm <sup>2</sup> to 400 mm <sup>2</sup> Armoured/Unarmoured	
<b>CONTROL CABLES</b>	600/1000 V	MULTI CORE	Industrial Control Wiring
COPPER CONDUCTOR XLPE OR PVC INSULATED, PVC SHEATHED	BS-6346, IEC-60502-1	1.5 mm <sup>2</sup> to 4.0 mm <sup>2</sup>	
<b>TELEPHONE /INTERCOM CABLES</b>	PCL Design	1 pair to 5 pairs Unarmored	Telecommunications
PE INSULATED			
<b>AUTO MOBILE CABLES</b>	JIS-D611, C-3406	Different types & sizes as per customer's requirements	Automotive Industry
<b>SPECIAL CABLES</b>			
a. AIR FIELD LIGHTING CABLE	Civil Aviation Authority	As per customer requirements	Airport lighting
b. COAXIAL CABLES	5C - 2V 75ohm, RG-6, RG-11	As per customer specifications	Dish Antenna CC TV and cable wiring
c. SUBMERSIBLE CABLES	BS-6004, Customer Specification	All sizes as per customer requirements	Water submersible pumps
d. MISCELLANEOUS OTHER CABLES	As per Customer Specifications	As per customer requirements	As per customer requirements and usage
<b>CONDUCTORS</b>			
PACC: Plain Annealed Copper Conductor	BS-6360, BS EN-60228	Upto 1000mm <sup>2</sup>	Earthing Conductor
HDBC: Hard Drawn Bare Conductor	BS-7884	Upto 400mm <sup>2</sup> and above sizes as per customer requirement	
ACSR: Alum Conductor Steel Reinforced	BS-215, ASTM B-232, IEC-61089	Upto 1250mm <sup>2</sup>	
AAC: All Alum Conductor	BS-215, ASTM B-231, BS-50182, IEC-61089	Upto 865mm <sup>2</sup> and above sizes as per customer requirement	Overhead Transmission Lines
ACCC: Alum Conductor Composite Core	ASTM B-857	Upto ACCC drake and above size as per customer requirement	
<b>HIGH CONDUCTIVITY OXYGEN FREE COPPER ROD</b>	ASTM B-49	8mm Dia	Electrical & Enamel wire manufacturing Distribution/Installation & communication wires
<b>ALUMINIUM SECTION (Profiles)</b>	BS-1474, ASTM-B221, BS-3987 & AAMA CLASS-1	a) Sections for sliding doors and windows b) Sections for hinged doors and windows c) Sections for fixed glazing/shop fronts d) Sections for double glazed sliding Doors and Windows  e) Sections for double glazed openable Doors and Windows f) Glass door sections g) Curtain wall sections/Structural glazed sections h) Centrally pivoted window sections i) Swing door sections j) Sections for casement/awning windows k) False ceiling sections l) Special sections to suit customer's specifications	Architectural, Industrial & Commercial Applications
Alum-Ex Brand			
Anodized as Well as Powder Coated			
<b>PVC Compound</b>	BS-7655, BS-60363	Different types as per customer's requirements	Insulation and Sheath of electrical cables



TRUSTED NOT TO COMPROMISE

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ISO  
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Quality  
Management  
System

ISO  
14001

Environmental  
Management  
System

OHSAS  
18001

Occupational  
Health and Safety  
Management  
System

KEMA  
TYPE  
TESTED



BUREAU  
VERITAS

CNC  
Conformity n Compliance  
SERVICES