



This is a comprehensive write-up prepared for customer information which covers the following topics

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## Introduction

One of the biggest problems in the nascent days of the cable manufacturing sector was availability of quality specialized cables. Indian suppliers of such cables were scarce and could not supply the desired quality. Alternatively, importing these cables was possible but they were too expensive with high delivery periods. In order to solve this problem Udey Pyrocables was founded back in 1976. We pioneered the manufacturing of Thermocouple Extension Cables, Instrumentation Signal cable & Pneumatic Multi-tube bundle in India.

Even today we follow the same ideology and try to bridge the gap by **supplying excellent quality, affordable prices and reasonable delivery schedules of scarcely available products domestically**. Some of the newer products that we're supplying with this objective are VFD cables, Bus cables, Solar Cables, VDE standard control cable & Polyurethane Cables.

We **specialize in providing tailor made service** for each of our client's requirements and would love to work in association with you to develop better experience with regards to the cable design, cable quality & purchasing experience.

Udey Pyrocables manufactures a wide range of cables on the latest modernized machines to produce quality cables. We have an in-house testing laboratory which meets the requirements of International Standards and can conduct Physical, Routine, Acceptance, Type Tests, FRLS, Halogen free tests etc. all the Instruments are **NABL calibrated**. **Our Plant is located at Lonavala with a total area of 10 acres (100 KMs from Mumbai and 60 KMs from Pune in Maharashtra).**

Our company is **ISO 9001:2015 registered, ISI & CE certified** having approvals with eminent consultants & contractors. Safety and quality are of prime importance to us and in order to ensure the same testing is conducted at every stage of production so that every cable leaving our plant is perfect. We have worked with and delivered outstanding service and products to some of the biggest companies in India & beyond (exporting to 15 countries including the US, Japan, Singapore, Egypt, Middle East etc)

We have complete professional Management with an experienced team of engineers, we take care from our offer to the order placement where cable is designed as per your site requirements and conditions, job cards are made and QA Plan is submitted to you where eve stage our QC department ensures complete checks on every process to full stage of readiness, to shipment.



## Product Range

### Power & Control Cables

Standard: IS 7098 & IS 1554  
Conductor: Al., Cu., ATC  
Size: 1.5 - 400 sq.mm.  
XLPE/ PVC insulated  
Armoured/ Unarmoured  
Extruded/ Taped  
Range - Upto 1.1 kV & 1.9/ 3.3 kV

### Flexibles & Housing wiring

Standard: IS 694  
Conductor: Cu., ATC  
Size: 0.5 - 400 sq.mm.  
PVC/ ZHLS/ FRLS

### Instrumentation, Signal & RTD cable

Standard: BS 5308, BS EN 50288-7, IEC 189, EIL 6-52-46, EIL 6-52-51, IEC 60092-375, 376, BS EN 50288 PART-7, VDE 0815, VG 95218, NEK 606  
Conductor: Cu., ATC  
Size: 0.5 - 2.5 sq.mm.  
Shielding: Al-Mylar + drain/ ATC braid  
Individual-Overall/ Overall  
Armoured/ Unarmoured  
PVC/ FR/ FRLS/ ZHLS/ Silicon Rubber/ PTFE/  
Fiberglass/ Kapton

### Thermocouple Cable

Standards: ANSI 96.1, IEC 584-3, BS 1843, IS 8784, DIN 43714, EIL 6-52-46  
Conductor: J, K, E, T, R, S, B, N  
Size: 0.5 - 2.5 sq.mm.  
Shielding: Al-Mylar + drain/ ATC braid  
Individual-Overall/ Overall  
Armoured/ Unarmoured  
PVC/ FR/ FRLS/ ZHLS/ Silicon Rubber/ PTFE/  
Fiberglass/ Kapton

### Fire Resistant Cable (FS Cable)

Standards: BS 7846  
Conductor: ATC, ABC  
Size: 1.5 - 400 sq.mm.  
Fire Barrier Tape: Mica Glass Tape  
Armoured/ Unarmoured  
XLPE/ Silicon - ZHLS

### Communication Cables

Profibus Cable  
Profinet Cable  
Foundation Fieldbus Cable  
Modbus Cable  
DeviceNet Cable  
Can Bus Cable



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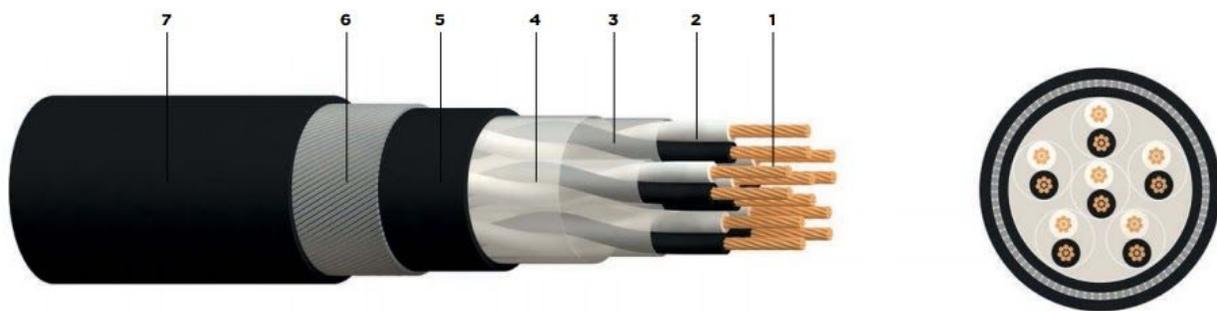
	Optical Fiber Cable Cat 5e, 6 & 7
<b>Control Cables As per VDE</b>	VDE 0207 LiYY LiYCY LiYCY PUR LiYCY-TP Li2YCY Pimf YY Cable CY Shielded Control cable SY Cable
<b>VFD Cable</b>	Conductor: Cu., ATC, Al. Size: 1.5 - 400 sq.mm. Ground Conductors - 1 or 3 Insulation: XLPE/ PVC Shielding: Al foil + ATC braid/ Copper Tape Individual-Overall/ Overall PVC/ FRLS/ ZHLS
<b>Uninyvin Cable</b>	Conductor: ATC HR PVC, Glass Fiber, Nylon Fiber, Nylon Lacquer
<b>Heat resistant Cable</b>	Based on the peak temperature and operating temperature these cables are designed. Material options - Silicon Rubber/ PTFE/ PFA/ FEP/ PEEK/ Kapton/ Fiber Glass etc
<b>Solar Cables</b>	Standards: 2pfg 1169 Conductor: ATC Size: 2.5 - 400 sq.mm.
<b>Robotic Cables</b>	Conductor: Class 5 or Class 6 ABC Insulation: PE, TPE, EPR Sheathing: PU Shielding: ATC braid (Optional)



## Cable Construction

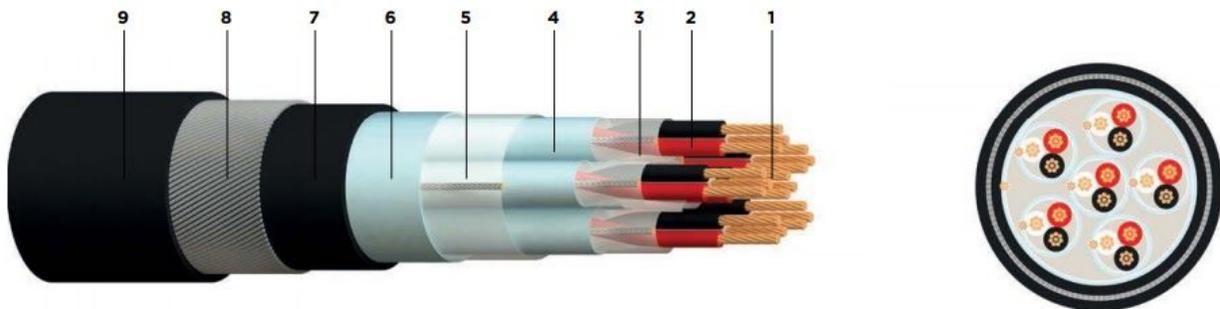
### Pair Cable (Overall Shielded)

- 1 - Conductor
- 2 - Insulation
- 3 - Cable Pairs/ Twisting
- 4 - Overall Shielding
- 5 - Inner Sheath
- 6 - Armour
- 7 - Outer Sheath



### Triad Cable (Ind. & Overall Shielded)

- 1 - Conductor
- 2 - Insulation
- 3 - Cable Pairs/ Twisting
- 4 - Individual Shielding
- 5 - Cable assembly
- 6 - Overall Shielding
- 7 - Inner Sheath
- 8 - Armouring
- 9 - Outer Sheath





## Electrical Properties

	0.5 Sq.mm.		0.75 Sq.mm.		1.0 Sq.mm.		1.5 Sq.mm.		2.5 Sq.mm.	
	Bare	Tinned	Bare	Tinned	Bare	Tinned	Bare	Tinned	Bare	Tinned
<b>Conductor Resistance (Ω/km)</b>	36.7	38	25	25.3	18.5	19	12.3	12.56	7.56	7.71
<b>Insulation Resistance</b>										
XLPE (MΩ/km)	1000									
PVC (MΩ/km)	5									
<b>Capacitance</b>	<b>Core to Core @ 1000 Hz</b>									
XLPE (nF/km)	< 150									
PVC (nF/km)	< 250									
<b>Capacitance</b>	<b>Core to Screen @ 1000 Hz</b>									
XLPE (nF/km)	< 400									
PVC (nF/km)	< 400									
<b>L/R RAtio (μH/km)</b>	< 25						< 40		< 60	
<b>Test Voltage</b>										
Core to Core (kV)	2000 V AC for 1 min.									
Core to Screen (kV)	1000 V AC for 1 min.									
Rated Voltage (V)	300/500									

\* Please note electrical parameters mentioned above are for class 2 conductor



## Conductor

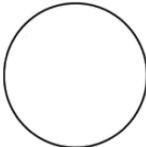
### Conductor Standard

IS 8130, IEC 60288, HD 383

### Conductor Material

Instrument cable conductors are generally bare copper, solid, stranded or flexible in compliance with IEC publication 334/BS 5308/ IS 8130 / International standard for the resistance of copper. Conductor may also be tinned.

### Conductor Design & Characteristics

Criteria	Solid Class 1	Stranded Class 2	Multi Stranded Class 5
Construction			
No of Strands	1 Strand	7 Strands	No of strands is decided on the basis of strand size. Max strand size 0.26 mm
Conductor Resistance at 20°C	12.1 Ω/ kM Lowest resistance for a particular size	12.2 Ω/ kM Slightly higher resistance than solid	13.1 Ω/ kM Highest resistance for a particular size
Flexibility	Poor	Good	Excellent
Diameter	Smallest final size	Slightly bigger than Solid	Biggest final size
Ease of installation	Poor	Good	Good

\* Assumption made while preparing the table: Conductor size 1 sq.mm.



## Conductor Coatings

Material	Properties	Peak Temperature
Tinned	<ul style="list-style-type: none"><li>* Eliminates soldering problem</li><li>* Protects the conductor material from the insulation (eg. Silicone Rubber)</li><li>* Prevents oxidation of Copper at high temperature</li></ul>	150°C
Silver	<ul style="list-style-type: none"><li>* Higher electropositive than Copper so in case of electro corrosion takes place Copper will stay protected</li><li>* High temperature coating</li></ul>	200°C
Nickel	<ul style="list-style-type: none"><li>* Soldering happens readily at high temperatures also</li><li>* Electrolytic corrosion does not take place at higher temperatures</li></ul>	300°C

## Conductor Selection Criteria

\* Type of Installation - For fixed installation Solid (Class 1) conductor is preferred, for continuous flexing and bending Multi Stranded (Class 5) conductor is preferred

\* Ambient Temperature

\* Distance - If the current/ signal needs to cover a long distance from one to the other end, voltage distance plays an important role in deciding the size of the conductor as longer the length greater the voltage drop.

\* Ambient Environment - For example in a corrosive environment Tinned Copper is preferred



## Insulation

### Insulation Standard

IS 5831, IS 7098, EN 50290

### Insulation Material

The insulation of cable conductors normally consists of polyethylene, cross-linked polyethylene, cross linked HFFR/ZHFR, HFFR/ZHFR, PVC (polyvinyl chloride). Special materials, for example high temperature resistance Elastomer, fluoropolymers or non-halogenic flame retardant materials, may be used for special application.

### Insulation Material Selection Criteria

The choice of insulating material is primarily determined by the following requirements:

- \* Electrical transmission properties
- \* Minimum and/or maximum operating temperatures
- \* Flammability properties
- \* Resistance to radiation
- \* Resistance to oil and chemicals

### Properties of generally used insulating materials

Properties	PVC	XLPE
Electrical Properties		
Dielectric Constant	4-7	2.3
Specific Volume Resistivity @ 20°C	10 <sup>14</sup> Ω.cm	10 <sup>15</sup> - 10 <sup>16</sup> Ω.cm
Specific Volume Resistivity @ 70°C	10 <sup>10</sup> - 10 <sup>11</sup> Ω.cm	10 <sup>12</sup> Ω.cm
Thermal Properties		
Max Operating Temperature	70°C	90°C
Low Temperature Properties	Tends to come brittle	Good



## Cabling Elements & Laying

### Cabling Element

This is the general description for cores, pairs, triples, quads and bundles

**A core** is an insulated conductor

**A pair** consists of two twisted cores which form a line circuit

**A triple** consists of three twisted cores which form line circuits with one another

**A quad** consists of four twisted cores in which the diametrically opposed cores form a line circuit

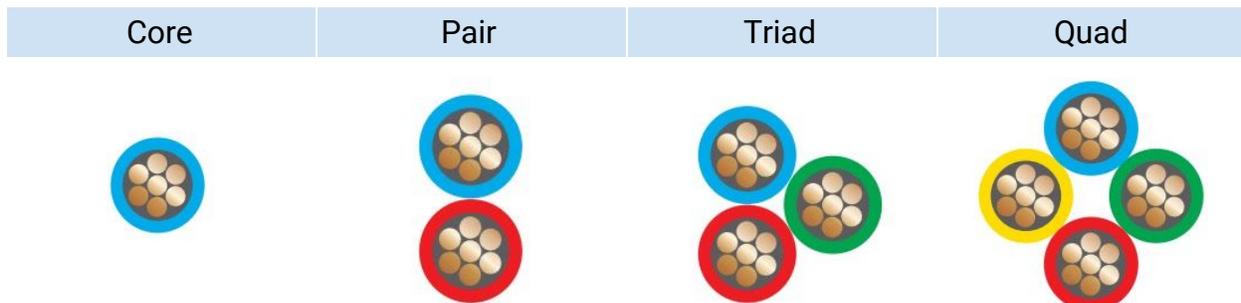
**A bundle** consists of multistranded cores, pairs or quads

For twisting insulated wires to form a pair the preferred lay length is between 80-100mm for conductor size upto 1.5 sq.mm. and 150 for conductor size 2.5 sq.mm.

The cable assembly consists of all the cabling elements in cable, including the wrapping over the cabling elements.

To keep the interference of cabling elements (pairs, triples, quads) negligible, the length of twist of adjacent elements must be different. This provides for a more complicated standing technique during manufacture. When using individually screened pairs, it is not necessary to vary the length of twist between those cabling elements.

The cable elements are twisted in concentric layers. In the case of multilayer cables the direction of lay changes from a layer to layer. This last measure also contributes to mutual decoupling in the case of unscreened pair, triple or quad elements.





## Screening

Screening is provided to reduce or prevent the possible external interference in cables such as

- \* Cross-talk from adjacent line circuits in the cable itself
- \* Externally induced interference from sources outside the cable e.g. electrical equipment, machine or plants running on HF energy

### Screening against internal interference

Only the capacitance unbalance between the cabling elements is of significance to internal interference. The magnetic interference can be injected.

Internal interference can be reduced by:

- \* different lay lengths for the cable elements (Done in case of CAT 6 cables)
- \* providing individual screening of cable elements

Individual screening normally consists of a helically lapped plastic – laminated aluminium foil which, together with a drain wire, endures a continuous electrical connection. The foil is applied with a 25% overlap so as to guarantee a 100% covering to the cable element in bends. Braids or layers of lapped copper wires may also be used, though for cost reasons they are less popular.

### Screening against external interference

Looking at the external interference, the influence of magnetic interference can no longer be neglected; one must differentiate between LF and HF electric and magnetic fields and choose a suitable screening solution. The material and design of a screen has to be adapted to the kind of interference.

\* Screening against electrical interference - Material with good electrical conductivity has to be used as screening against electric interference. The degree of screening which can be achieved depends on the frequency, especially when using braids. Copper braids or lapped plastic-coated aluminium or copper tapes can be provided as an alternative in the LF range. **Longitudinally welded copper tapes are a suitable screening in the HF range.**

\* Screening against magnetic interference - Iron tapes are recommended as screening against magnetic interference, though if particularly high screening levels are required, highly-permeable materials such as tapes of Mu-Metal or amorphous metals should be used.

\* Screening in the LF range - At frequencies of up to 10 KHz, the influences of both electrical and magnetic interference can be regarded separately. Interference from electric fields can be almost completely avoided by the use of conductive screens; however, care must be taken to ensure a high degree of coverage since otherwise the electric field may affect the cable assembly. Screening against LF magnetic interference requires those measures specified above; since conductive screens may be penetrated by



magnetic interference and are thus useless, An eddy current, which weakens the magnetic interference only sets in with these screenings at frequencies above 10 KHz.

\* Screening in the HF range - Screening in the HF range is based on losses (i.e withdrawal of energy) in the electromagnetic interference by absorption and reflection in or on the screening material. Thus the magnetic field component is weakened by absorption (opposing field by eddy currents) whereas the electric field component is attenuated by reflection.

## Types of Screening assembly

- \* Individual & Overall Screening
- \* Overall Screening
- \* Unscreened

## Types of Screening materials



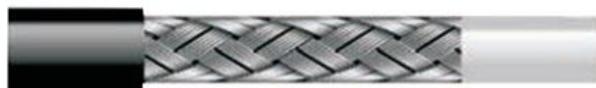
Aluminium / Mylar tape with tinned copper drain wire



Copper tape with tinned copper drain wire (Optional)



Bare Copper braid for EMI shielding



Tinned Copper braid for EMI shielding in corrosive atmosphere

## Armouring

The primary purpose of armour is to protect the cable against mechanical damage during installation and operation. **Apart from this mechanical protection, armour can also fulfill various electrical functions, eg. earth conductor, screen or inductive protection.**

### Armour Standard

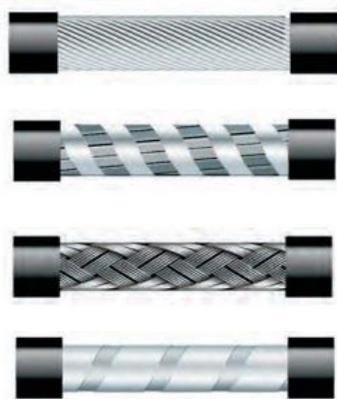
IS 3975, EN 10257-1, EN 10218-1, IS 1554

### Armouring Selection Criteria

Unless otherwise specified in different specifications, the mechanical and electrical requirements for installation and operation determine the design of the armour. The following are of prime importance :

- \* Max. expected tensile loads
- \* Max. expected pressure and impact loads after laying
- \* Protection against rodents
- \* Type of connections
- \* Min. required bending radius
- \* Minimum cross-section if used as earth conductor
- \* Size of reduction factor depending on the induced EMF

### Types of Armour



Single layer Galvanised Steel wire

Galvanised Steel Flat Strip

Galvanised Steel Wire braid

Galvanised steel tape armour



## Sheathing

The bedding and overall sheaths of instrument cables are most commonly made of polyvinyl- chloride (PVC) and sometimes polyethylene (PE). HFFR Non-halogenic (zero halogen), flame retardant materials, high temperature resistant fluoropolymers or polyamides are much used in special applications.

## Bedding

Bedding must be provided if supplementary elements such as armour are applied. In such cases they mainly serve to protect the cable assembly against humidity and mechanical loads. Commonly PVC , FR PVC , FRLS PVC, and HFFR are used.

## Sheathing

Sheathing is provided over all kinds of instrumentation cables (Armoured or unarmoured or braided). The purpose of sheathing is to protect the cable from the environmental effects on the cable. Commonly PVC, FR PVC , FRLS PVC, and HFFR are used.

## Standard

IS 5831, IS 7098, EN 50290

## Outer Sheathing Selection Criteria

Outer sheathing is provided over the armouring in case of Armoured cables or above laid up cable in case of unarmoured cable. Transportation, storage, installation and operation determine the choice of material and specification. The following must be considered while selecting the appropriate material

- \* Type of installation, ie. indoor, outdoor installation, on ramps, in earth or water.
- \* Type and extent of mechanical loads during and after installation
- \* Possible environmental influences of : humidity, oil, chemicals & solar radiation etc
- \* Max. and min. temperatures during installation and operation
- \* Desired Fire properties



## Temperature Rating of High Temperature Materials

Material	Peak Temperature
Silicon Rubber	150°C
FEP	200°C
PFA	260°C
PTFE	260°C
PEEK	300°C
Fiberglass	300°C
Kapton	400°C
Silicon Fiber	1000°C
Ceramic Fiber	1200°C

## Properties of generally used materials

Property	LSZH	PVC	PE	PU
Halogen Free	Yes	No	Yes	Yes
Flame Retardant	Yes	Yes	No	No
Abrasion Resist.	Low	Medium	Good	Good
Flexibility	High	High	Low	High
Hardness	Medium	Soft	Medium	Soft
Oil	Good	Satisfactory	Good	Good
Water	Good	Good	V. Good	Good
Weathering	V. Good	Good	Good	V. Good



## Fire Performance in Cables

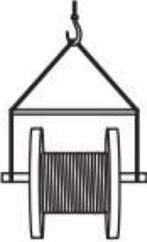
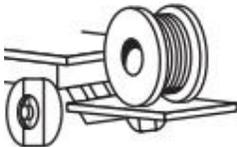
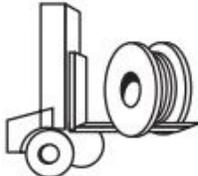
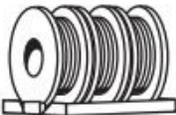
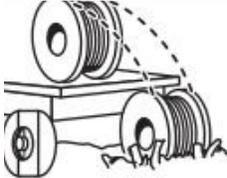
Test	Specification	General PVC	FRLS PVC	LSZH
Oxygen Index	ASTM D 2683	> 23%	> 29%	> 31%
Temperature Index	ASTM D 2683	120°C	250°C	300°C
Smoke Density	ASTM D 2643/77	<80%	<60%	<40%
Acid Generation	IEC 754-1	<26%	<20%	<2%
Flammability Test	IEEE 383	Complete length of 850mm is burnt	Un-Burnt portion greater than 300mm	Un-Burnt portion greater than 300mm



## Testing Conducted on Finished Instrumentation Cable

SR. NO.	Characteristic	Method of Testing
1	Routine Test	
A	Conductor Resistance	L.C.R. meter
B	Insulation Resistance	Insulation Tester / Megohmmeter
C	Voltage Test	High voltage Tester
D	Dimension check	Vernier
E	Capacitance	L.C.R. meter
F	L / R Ratio	L.C.R. meter
G	Physical Test PVC	Tensile Tester
H	Colour Code	Visual
2	Type Test	
A	Persulphate Test (For Tinned Copper only)	Chemicals
B	Zinc coating	Chemicals
C	Flame Test	Burner
D	Oxygen Index	(For FR & FRLS only)
E	Temperature Index	(For FR & FRLS only)
F	Smoke density	(For FRLS only)
G	HCL Emission	(For FRLS only)
3	Acceptance Test	
A	Annealing Test	Tensile Tester
B	Conductor Resistance	L.C.R. meter
C	Dimensional Check	Vernier
D	Physical Test Tensile	Tensile Tester
E	Physical Test Elongation	Tensile Tester
F	Voltage Test	High voltage Tester
G	Insulation Resistance	Insulation Tester / Megohmmeter
H	Capacitance	L.C.R. meter
I	L / R ratio	L.C.R. meter
J	Inductance	L.C.R. meter

## Material Handling

Do	Don't
	
<p>Cradle both reel and flange between the forks</p>	<p>Do not lift by top flange. Cable reel or drum may get damaged</p>
	
<p>Cable drums can be lifted with a shaft extending through the flanges</p>	<p>Use spreader bar to avoid bending of the cable drum flange and meshing of cable</p>
	
<p>Place spacers between the reels and under the flange to create space for forklift</p>	<p>As far as possible avoid placing reels horizontally</p>
	
<p>Empty the reels from the truck careful</p>	<p>Never allow rough surfaces or forks to touch the cable surface</p>
	
<p>Always secure the drums on flange edges</p>	<p>Never drop the reels</p>



## Material Storage

Udey Pyro's very large, long, or heavy cables, like their armoured cables, are supplied in bulk with the cable wound onto either a metal, or more commonly, a wooden drum. This allows for ease of handling, transportation, delivery and ultimately for installation.

It is important that everyone involved with handling the cable keeps it in prime condition so that they perform as intended, which means that care needs to be taken with the drum's storage and handling. Here is what Udey Pyro would recommend for the long-term storage of cables on drums:

- \* The cable drums should be stored on a suitably-drained hard standing.
- \* The cable ends should remain sealed to prevent the ingress of moisture
- \* The wooden drum battens/ plastic sheet on steel drums should remain fixed to the drum to shield the cable sheath from excessive temperatures and UV light. For this reason, damaged wooden battens & plastic sheets should be replaced.
- \* Drums should be stored upright (like a wheel) with wedges used to prevent them rolling.
- \* If a cable is stored in a space which is at a lower temperature than the temperature recommended for its installation, then care should be taken to prevent the cable being damaged by bending or impact
- \* Inspect the cable drums regularly, if a drum has been damaged then the cable should be rewound onto a replacement drum.
- \* A drum should be rotated by 90° every six months
- \* The identification label, which confirms its credentials should remain fixed to the drum

If a wooden/ steel drum is handled and/or stored properly as described in this document, Udey Pyro gives warranty for stability and usability for a period of up to 18 months after delivery. In case wooden drums/ steel show signs of damage from handling and/or storage any warranty obligation given for cable drums and any subsequent cable problems resulting from it are null and void.



## Cable Laying Guidelines

### Installation Temperature

The permissible temperature range must be complied with at all times. This value is the value of the cable and not the ambient temperature. In case of low temperature it may be necessary to preheat the cable before the installation.

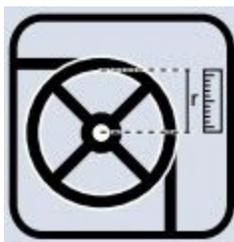
Type of Cable	Min. Temperature	Max Temperature
Cable with PVC sheathing	-5 °C	50 °C
Cable with Oil resistant PVC sheathing	5 °C	50 °C
Cable with XLE insulation and PE sheathing	-20 °C	50 °C
Cable with LSZH sheathing	-5 °C	50 °C

During installation when the sheath temperature is greater than 50 °C, LSZH sheaths are more susceptible to cracks and other damage caused by mechanical stress. The risk of damage increases with rise in temperature.

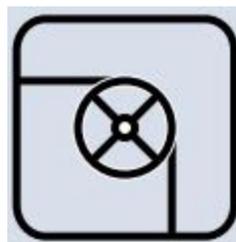
### Bending Radius

The cable must never be bent around smaller than the specified values. All the rollers, sheaves and sheave assembly must not have smaller bending radii than specified.

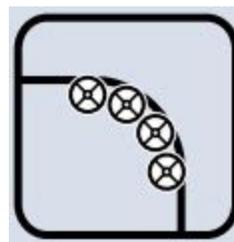
Type of Cable	Bending Radius
Cable with Armour	12 x OD
Cable without Armour	8 x OD
Cable with lead covering	15 x OD



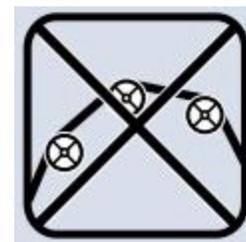
The real bending radius of the wheel is the distance between tread to center



Avoid excessively small bending radius



Instead of one big wheel a set of small wheels can be used for achieving the relevant bending radius



Avoid turn-backs

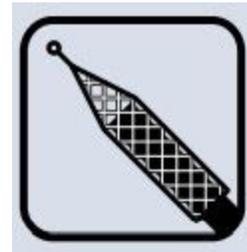
## Tensile Load

During mechanical pulling of cables, particular care must be taken to ensure that permissible tensile load is not exceeded.

Pulling must be done using either pulling eye or wire mesh.



Pulling Eye



Wire Mesh

Please note the first few meters (1-3m) may become unusable or damaged after installation due to use of pulling eye or cable grips and may have to be cut off.

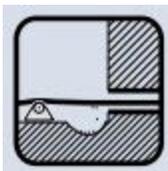
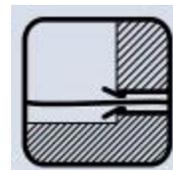
## Other things to consider



- \* Unwinding direction of the cable depends on the position of the duct.
- \* Avoid back turns



- \* Cable should enter the duct in a straight line only.
- \* Provide a funnel shaped bore guide
- \* Lubrication must be used if necessary



- \* A capacity in front of the duct prevents stones from entering the duct
- \* Place a cushion layer under the cable after pulling.

