APAR INDUSTRIES LTD.

Introduction to Covered Conductors

PRESENTED BY MANISH PATEL

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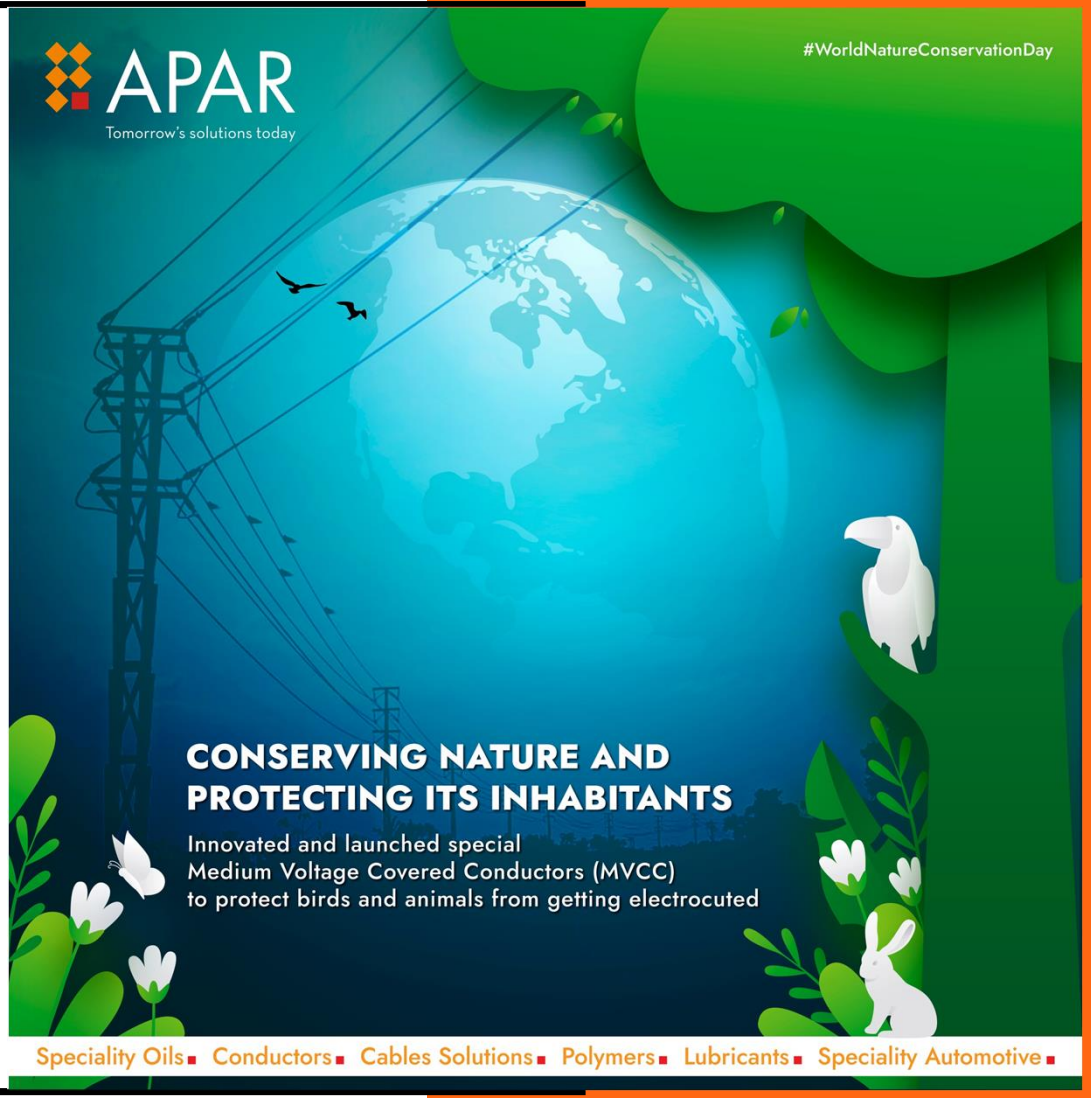
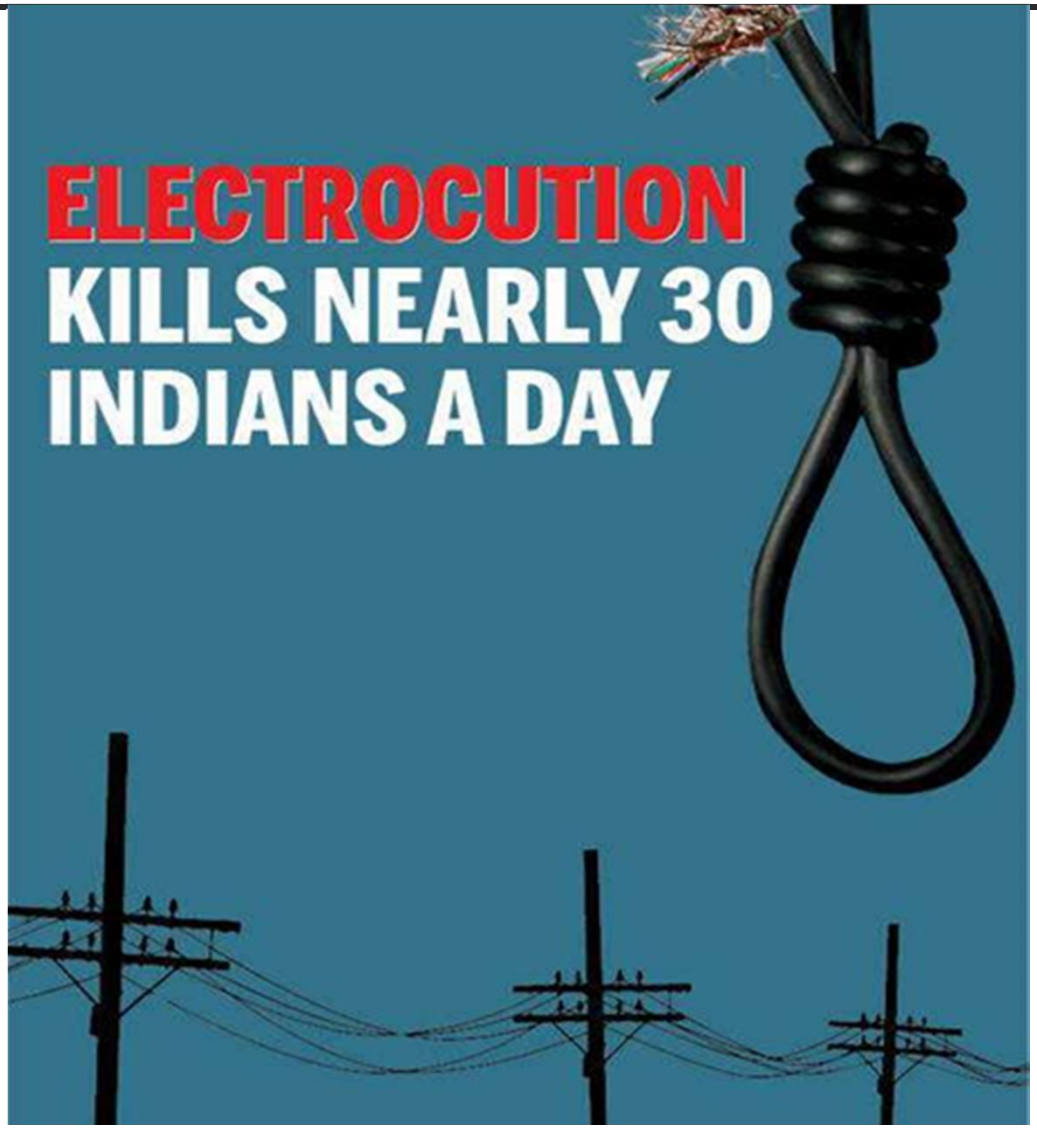


APAR AT A GLANCE **Turnover (Rs. 8000 Cr) over USD 1 Billion**

	Speciality Oils	Conductors	Cables
Products	• Largest Indian player in the Power Transformer segment, especially in EHV segment (220 KV to 765KV) • Successful manufacturing & distribution tie-ups in South Africa, Australia & Turkey • Exports of Transformer Oils and White Oils to over 65 countries • License agreement with ENI to manufacture world famous AGIP lubricants	• Amongst the top 3 conductor manufacturer in the world.. With a Presence in over 100 countries • Vertically integrated producer of Aluminium Rod, Alum Alloys including 8000 series Rods • Complete range of ACSR and AAAC up to 1200 KV • Leader in High Temperature conductors • Catenary & Contact Wires • OPGW	• Manufacturer of widest range of cables in the world • Electron Beam Irradiation facility (1.5 MeV, 2.5 MeV & 3.0 MeV) • Electrical Cables • Light Duty Cables (LDC) & Wires • Elastomer & E-Beam Cables • Fiber Optic Cables • Specialty Cables & Services
Plant Locations	**Rabale, Silvassa & Hamriyah** **Total Capacity 450,000 KL**	**Silvassa, Athola & Jharsaguda** **Total Capacity over 200,000 MT**	**Umbergaon & Khatalwada** **Annual Capacity** **30,000 MT Aluminum &** **10,000 MT Copper**

The Fact



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PROBLEM AT HAND

Five electrocuted after Ganesha immersion

BANGALORE: A pall of gloom descended on Kanaswadi village in the Doddaballapur taluk of Bangalore Rural district where five young men were electrocuted while returning after immersing a Ganesha idol late on Saturday night.

Around 20 people were returning to the village on a tractor trailer after immers-

THE TIMES OF INDIA Jaipur

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18 electrocuted after live wire falls on bus in Rajasthan; toll likely to rise

7 Elephants Electrocuted In Odisha While Passing Through A Village

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NATIONAL - KARNATAKA

Updated: April 26, 2012 13:15 IST

28 elephants electrocuted in the last two ye

Seven elephants came in contact with an 11-KV sagging electric wire.

15 peacocks electrocuted due to improper conservation

— By FP NEWS SERVICE Ujjain | Apr 07, 2013 01:00 am

Ujjain: The National Bird peacock seems to be in great danger with the steep fall in their population. More than a dozen peacocks were electrocuted in last couple of days in urban and rural areas of the district. This is a matter of concern and administration seems to be in lackadaisical state in regard to this issue.

Union government ...s formed ...veral rules protect ...rds under

Over 30 Flamingos Electrocuted in Bhavanagar, Gujarat

Rushi Pathak

Fire Hazards

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Challenges for Utilities with Bare Conductors

- Conductor clashing leading to outages
- Conductor slashing due to corrosion
- Outages due to temporary tree contact
- Corrosion at joints
- Wide Right of Way (ROW)
- Electromagnetic field effect on electronic surveillance
- Safety (Road /Rail/River crossings etc .)
- Emergency Restoration System

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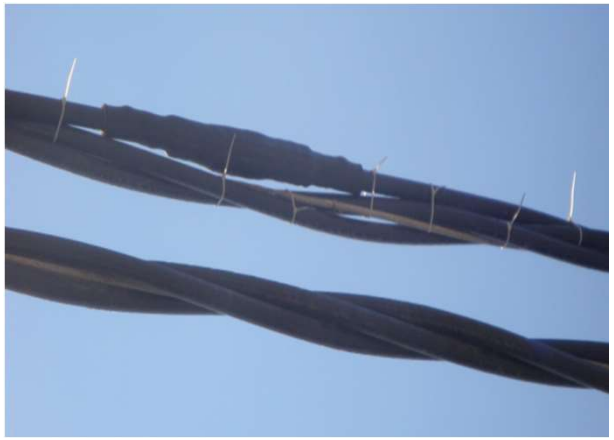
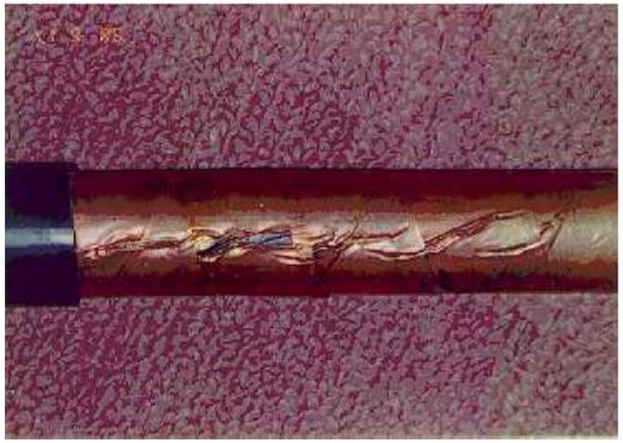
Challenges with AB Cable

- Smaller Spans resulting in increased no. of poles
- Cracks on outer surface of ABC
- Loose Contact / Local Heating / Sheath Discontinuity
- Copper metallic screen damage
- Burnt outer sheath due to animal bites
- Dislodged straight through joints





OVERHEATING OF COPPER TAPE CAUSES BURNING OF OUTER SHEATH

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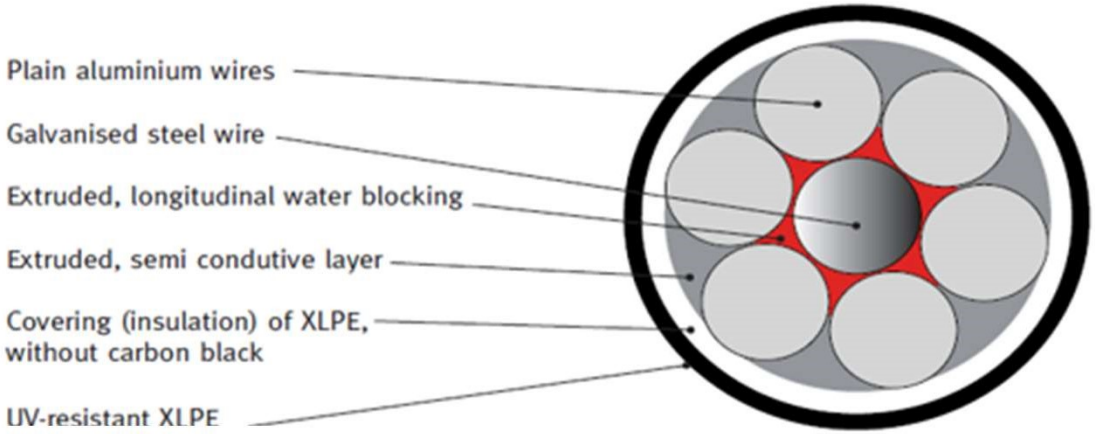
COVERED Conductor Construction

Covered conductors consist of a conductor insulated by a covering made of insulating material(s) as protection against accidental contacts with other covered conductors and with grounded parts such as tree branches, etc.



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A Solution for 11 /22 / 33 KV system with Triple Extrusion

A – Semiconducting Layer
B – XLPE Insulation
C – UV Protected & Track Resistant Covering

Semiconducting Layer :

- Reduces stress, transforms strands into a single uniform cylinder
- Extend service life of the covered conductor

Inner Insulating Layer –XLPE Insulation

- More flexible
- High impulse strength: protect from phase-to-phase and phase-to-ground contact
- Crosslinking properties helps in retain its strength and shape even when heated

Outer Insulation Layer – XLPE insulation with UV and Track resistant Properties

- Abrasion and Impact Resistant; Stress-Crack Resistant
- Provides effective UV and best track resistance

Why Water tight Conductor ?

If water seeps into a non water tight Covered Conductor through an open
end or by any means, water that entered into the CC will travel to the sag point and will remain there.

As water will not evaporate out due to the covering, it will eventually corrode the conductor and cause an early conductor break.

Longitudinally Water Tight conductor will not allow water to penetrate inside the conductor.

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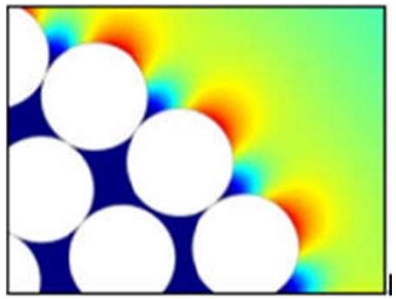
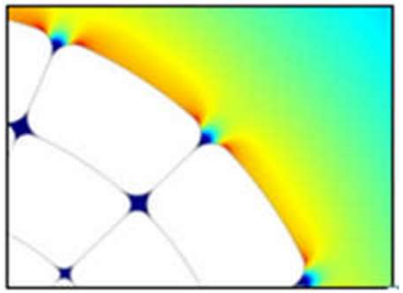
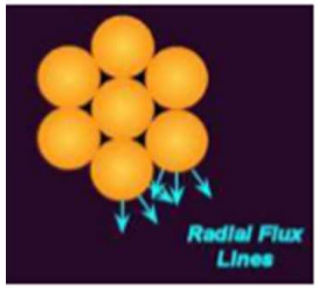
Importance
of Semiconducting conductor screen &
Anti-tracking outer covering

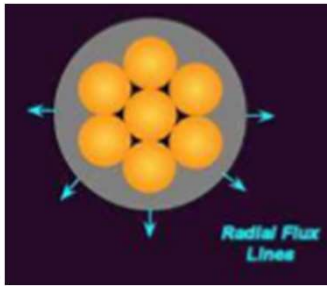


Circular Strand Electrical Stress



Trapezoidal Strand Electrical Stress





Uniform stress distribution with semiconducting layer

Surface tracking & polymer Erosion due to High Voltage

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Solution for Snow loading on the lines

- Snow loading is a common phenomenon on bare power lines and due to which the line got tripped and due to weight of snow on cold conductor, it eventually snaps
- **With the installation of Covered Conductor**

a. Power remains live as insulation prevents any shorting in cross arms or conductor due to snow.
b. Since power remains there at operating temperature it prevents the excess of snow loading at conductor and prevents snapping.
c. Life of conductor increases significantly
d. Minimal maintenance required
e. Power reliability 24/7

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Applicable Standards for Covered Conductors (CC) System

CENELEC THE EUROPEAN COMMITTEE FOR ELECTRO TECHNICAL STANDARDIZATION HAS RECENTLY ISSUED THREE STANDARDS FOR COVERED CONDUCTORS FOR OVERHEAD LINES AND THE RELATED ACCESSORIES FOR RATED VOLTAGES ABOVE 1 KV AC AND NOT EXCEEDING 36 KV AC

- SS-EN 50397-1- PART 1: COVERED CONDUCTORS
- SS-EN 50397-2- PART 2: ACCESSORIES.
- SS-EN 50397-3- PART 3: INSTALLATION OF MVCC

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Type Test requirement as per EN 50397-1: 2006

Construction requirements	Type Test on Insulation Ref: EN 50397-1:2006 Specification
Conductor	Aluminium alloy or steel reinforced aluminium
	Nom. cross-section: 35 mm^2 to 240 mm^2 (aluminium alloy), 50 mm^2 to 150 mm^2 (total cross-section for steel reinforced aluminium)
	the conductors may be compacted or non-compacted
	The stranded conductor may be longitudinally watertight by means of adequate measures as e.g. filling with an adequate mass. The filling mass or other materials for obtaining the longitudinal water tightness, shall be compatible with the conductor material and the material of the covering
Covering	Basic material XLPE 90 Deg C Operating
	Mechanical Properties : Before & After Aging Test for Elongation and Tensile Strength as per (EN 60811-1-2)
	Physical and chemical properties tested for hot set test, pressure test at high temperature, water absorption, shrinkage test, Shore D hardness.
	Electrical tests comprising of High voltage test, Spark test on the covering, Leakage current, Tracking resistance
	Non-Electrical tests on the covering comprising of Mechanical properties ,Carbon black content, Resistance to UV rays, Test of compatibility, Thermal properties of the covering, Test of the longitudinal water tightness, Slippage test.

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Maintenance for Covered Conductors (CC) System

NO Additional Maintenance Required

- Occasional Tree Cutting for maintaining the ROW
- Tree Falling OR Branch Touching – Line will not Trip if Phase to Phase get shorted , but Line should be switched off during next inspection & tree can be cut /removed
- In the event of Conductor Snapping , use Mid Span Joints OR Tension Clamps to Join the two end of Covered conductor after stripping the insulation Jacket .

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Applications of Covered Conductor

- On the HVDS systems where lines right up to consumer's small single phase transformers are run at medium voltage.
- On the Rural Distribution Lines specially which passes through forest areas
- In urban areas on the towers which are near to high rise residential or commercial establishments

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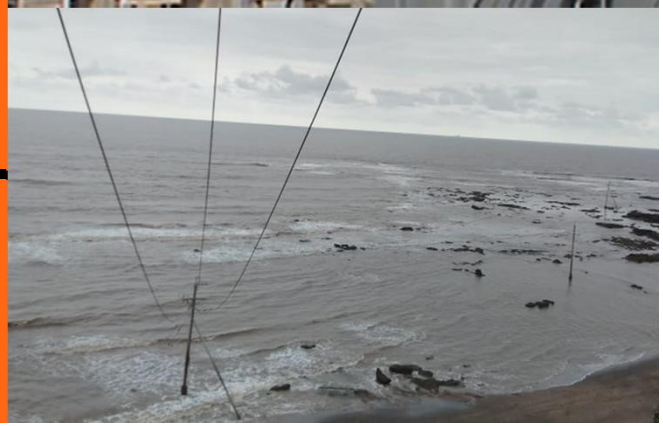
Applications of Covered Conductor



- Ideal and safer solution for installations over RIVER / LAKE / RAILWAY / ROAD CROSSINGS and in polluted areas.
- Can be used as Jumpers from LV/MV distribution lines to transformer
- In Costal areas or polluted areas, conductor corrosion is prevented because of covering. Therefore no adverse increase in power loss over a period of time

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ADVANTAGES of Covered Conductors

- No Interruptions by contact of tree branches or creepers.
- The clearing of the lane from growing trees is more seldom. Branches or trees can be cut and moved away under live working conditions.
- No faults due to clashing of phase conductors during wind and stormy conditions.
- Phase to Phase conductor distance can be reduced which can reduce the tower related costs.

Leakage Current on surface of the Covered Conductors:

Voltages	Leakage current on surface of MVCC in mAmps	Maximum permitted Leakage current as per EN 50397 in mAmps	Maximum a human being can withstand without affecting heart in mAmps
11 KV	0.12	1.0	10.0
33KV	0.59		
66KV	0.80		

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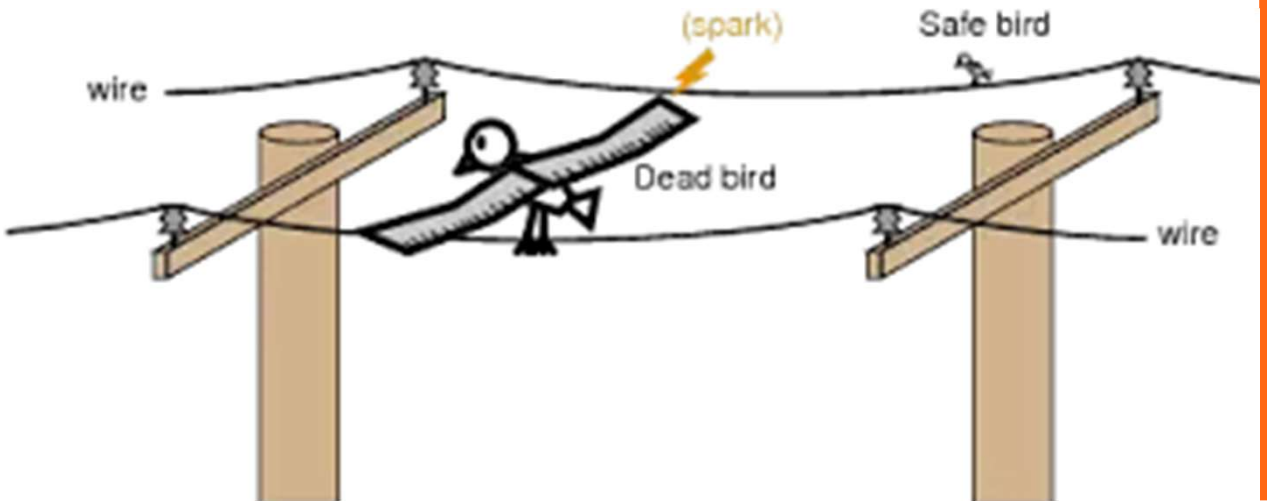
ADVANTAGES of Covered Conductors

- Protect big birds and animals : Peacocks, Flamingos, elephants etc, Ideal for installation in forest areas and bird sanctuaries.
- Better reliability under bad weather conditions like heavy snow fall, windy or stormy conditions.
- Reduce power interruptions and outages: thus increasing the power distribution network reliability.
- WIDTH OF RIGHT OF WAY CAN BE REDUCED.



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ADVANTAGES of Covered Conductors

- Lower operation and maintenance cost. Lower total cost of ownership over the life cycle compared to underground cables or Aerial Bunched cables.
- Cheaper in Life cycle cost to underground cables and ABC cables : Especially in difficult terrain and in densely populated areas. The pole span of ABC cables are short, as the full cable weight has to be carried by a single messenger conductor whereas each covered conductor is self-supporting and can have pole spans of 50 to 70 meters.
- Reduced right of way : Since covered conductors need less phase to phase clearance, it allows for. This also enables to build a higher voltage level line in the same corridor of an old bare overhead line using covered conductors.

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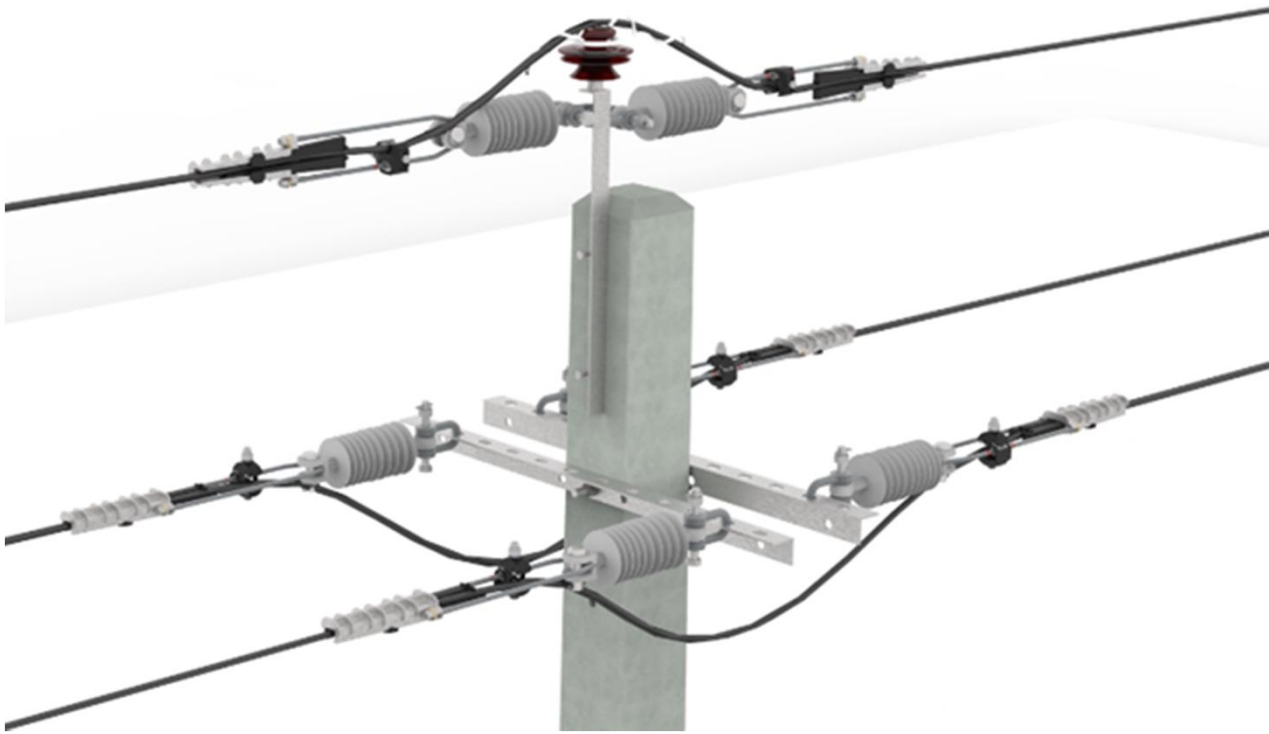
Covered Conductor Accessories

REFERNCE STANDARD :
EN 50397- PART 2



- Proper Accessories as per EN 50397 – Part 2 a Must
- Qualification of accessories with MV CC is a necessity
- Any “Jugad” can collapse the system

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Tension Clamps
With Tracking resistance

Alignment
Ties

Insulated
Suspension Clamps

Insulation Piercing
Connector

Mid Span
Joint

Tension Clamps

REFERNCE STANDARD : EN 50397- Part 2

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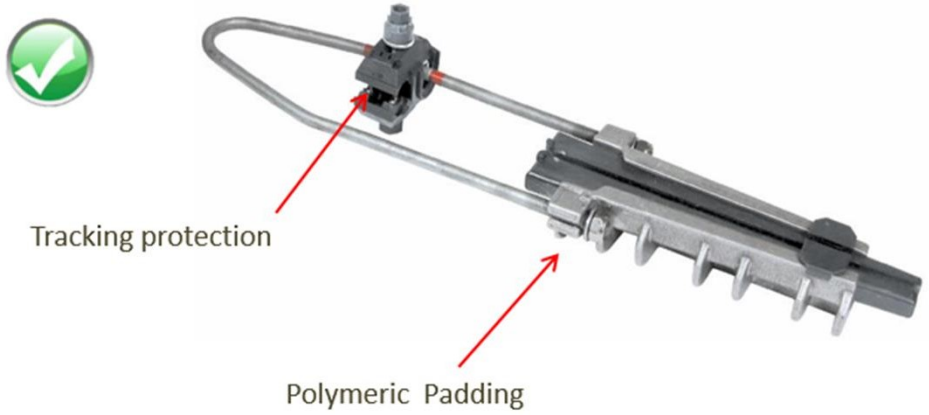
WEDGE TYPE TENSION CLAMPS

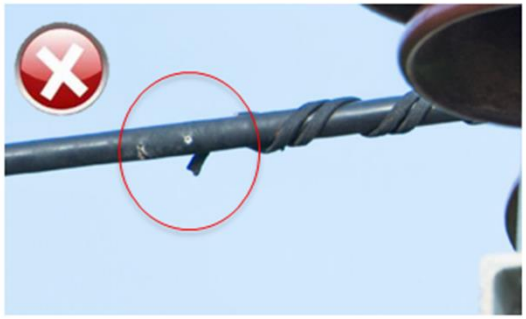


Cable Insulation Damage while using metallic clamps

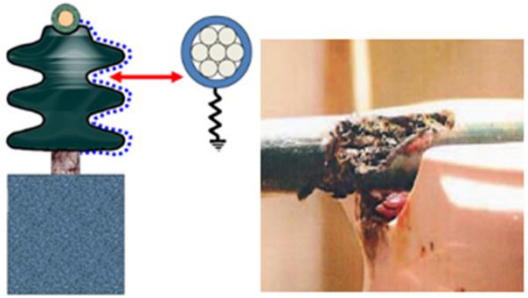
Alignment Ties

REFERNCE STANDARD : EN 50397- Part 2

INSULATED TIES FOR LINE ALIGMENT



Pin hole Insulation Damage while using metallic Ties



Tracking effect on Cable.

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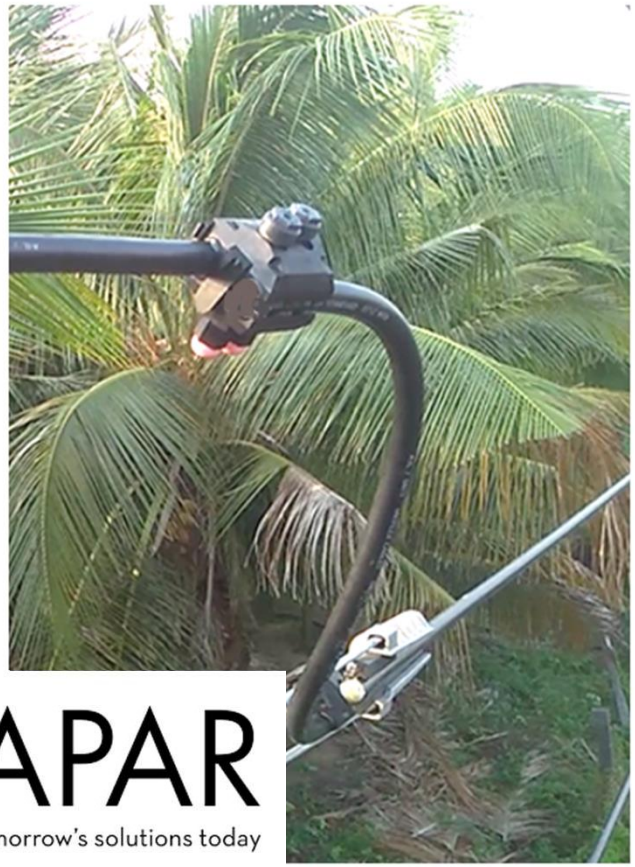
Insulation Piercing Connectors

REFERNCE STANDARD : EN 50397- Part 2



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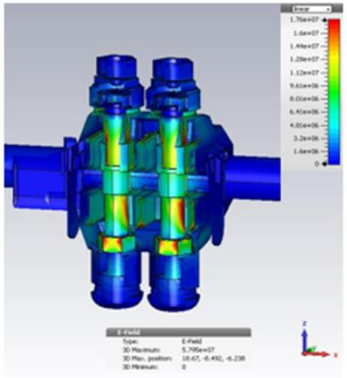
INSULATION PIERCING CONNECTORS (FOR BRANCHING / NETWORKING)



Tracking Analysis

Insulated to Insulated

Bare to Insulated

Insulation Piercing Connectors

REFERNCE STANDARD : EN 50397- Part 2

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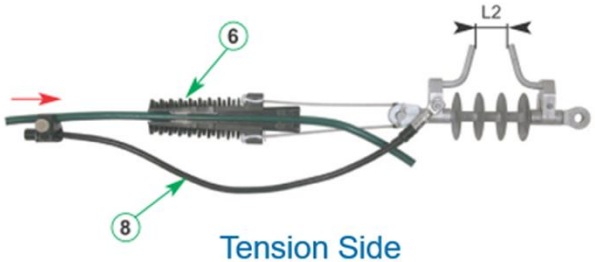
INSULATED TERMINATION

INSULATED MID SPAN JOINTS

DROP OFF / TEMPERORY EARTHING

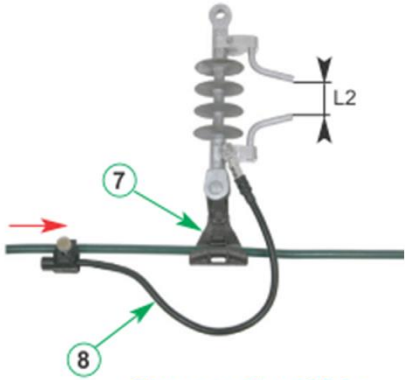
ARC PROTECTION ARRANGMENTS

REFERNCE STANDARD : EN 50397- Part 2

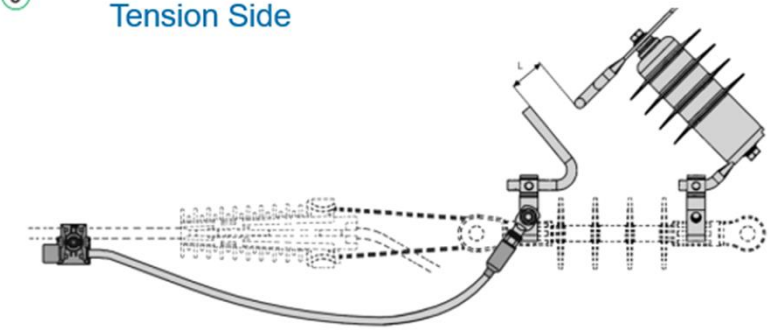


Tension Side

Line alignment



Suspension Side



Tension Side with arrestors

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Additional test on MVCC

Leakage current Test

The below Yellow mark indicate the result of Leakage current as per SS EN 50397 : 2006, the Test Voltage will be 0.7U & Test procedure as per SS EN 50397:2006
Used Multimeter to measure the reading on below arrangement. .

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Test Voltage	11 kV CC	22 kV CC	33 kV CC
	Insulation Thickness Inner XLPE : 1.2 mm Outer XLPE : 1.1 mm	**Insulation Thickness Inner XLPE : 1.32 Outer XLPE :1.1 mm**	**Insulation Thickness Inner XLPE : 2.43 mm Outer XLPE : 1.2 mm**
	(mA)	**(mA)**	**(mA)**
2	0.025	0.01	0.022
3	0.037		0.031
5	0.064	0.03	0.051
6.5	0.09		
7.7	0.105		
10		0.15	
11	0.131	0.2	0.119
15.4		0.237	0.172
19			0.224
20		0.32	
22		0.52	
23.1			0.266

Tree Branch contact

Energized at 12 kV

Observations

- No arcing
- No damage to the covered conductor
- No damage to the tree branch

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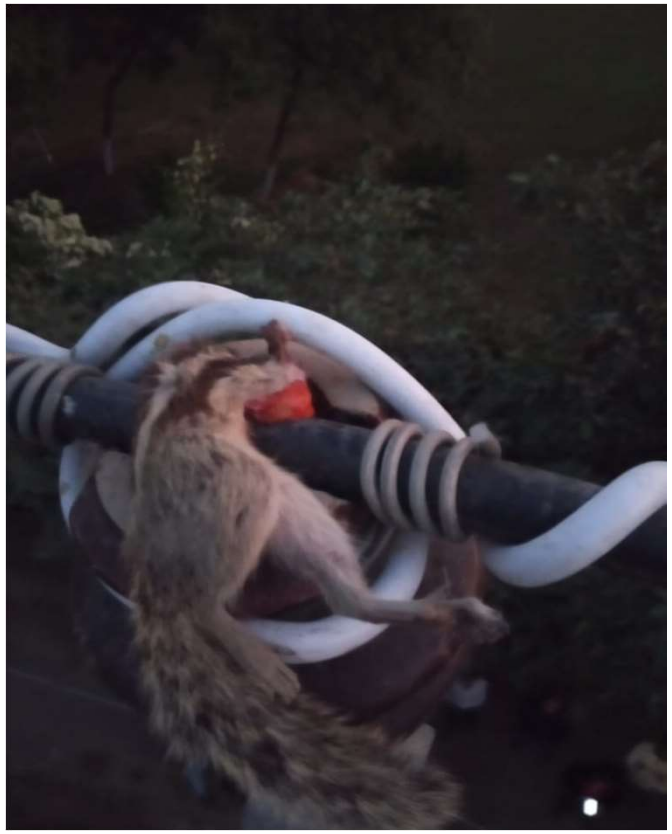
Testing Test of simulated clashing of conductors

80Min Testing No Arcing and Damage to Covered Conductors

Conductor Clashing

Simulating Animal



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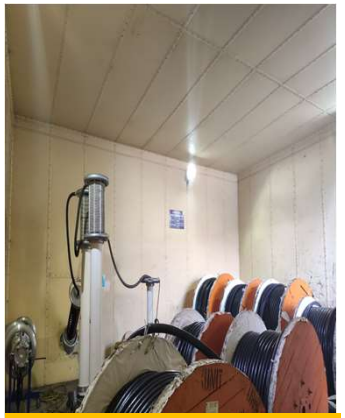
In House Testing Facilities Available (NABL Accredited Lab)



HV Test SetUP

Chemical Testing SetUP

Track Resistance Test SetUP

Resistivity Test Setup/ Hot Air Ovens

Xenon Weathering Test chamber

Tensile Testing Machine

CR meter & Stand

Spark Test SetUP

Carbon Black Test SetUP

Adhesion Test Setup/ Slippage Test Setup

Relevance of MVCC Experience in Indian Condition

- MVCC without type testing from CPRI/ERDA and relevant field experience is dangerous to install, as it will not serve the desired life span and also not safe for Human /Wild life.
- In India the pollution level is very high which attracts the pollutants to stay over conductor outer surface and allows the current to track . In all the grades of MVCC anti tracking in must in India .
- Since MVCC is going to stay in network for 30++ Years , High ampacity conductors like AL59 ACS needs to be taken into consideration to cater the future load demand .
- Ground Clearance is compromised due to Urbanization, improvement/elevation of roads, illegal acquirement by hutments/shops/houses. There are several temporary/unplanned arrangements (Jugad) on T/L during maintenance.
- Indian Utilities are constrained to provide limited shut down Re-conductoring of bare lines with MVCC is fast and easy without much changes in existing lines except few line hardware's
- MVCC can be used as Jumpers in Sub Station to minimize the wildlife accidents
- MVCC ensures the 24/7 power reliability to consumers and bring down the line losses considerably
- MVCC works perfectly under bad weather condition like high wind , heavy rains , snow , storms etc

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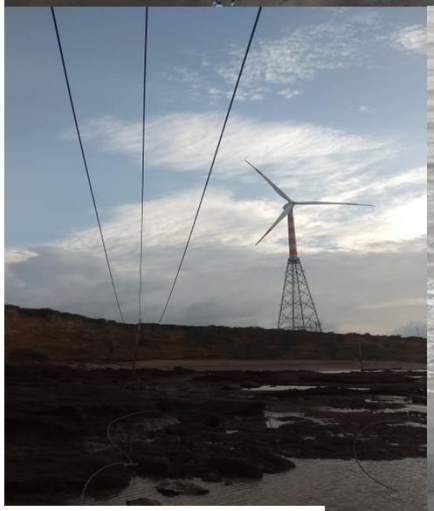
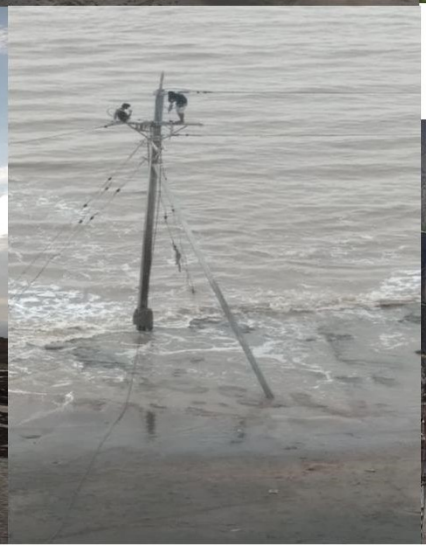
Snapshots of Challenges During MVCC Project Work

Working in Sea/Ocean



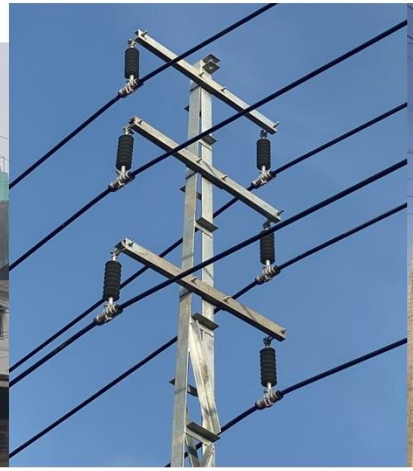


Coconut Grooves - Kerala

Forest Areas

Highly Congested & Illegal Colonies

MVCC 66KV Installations



Below EHV Lines

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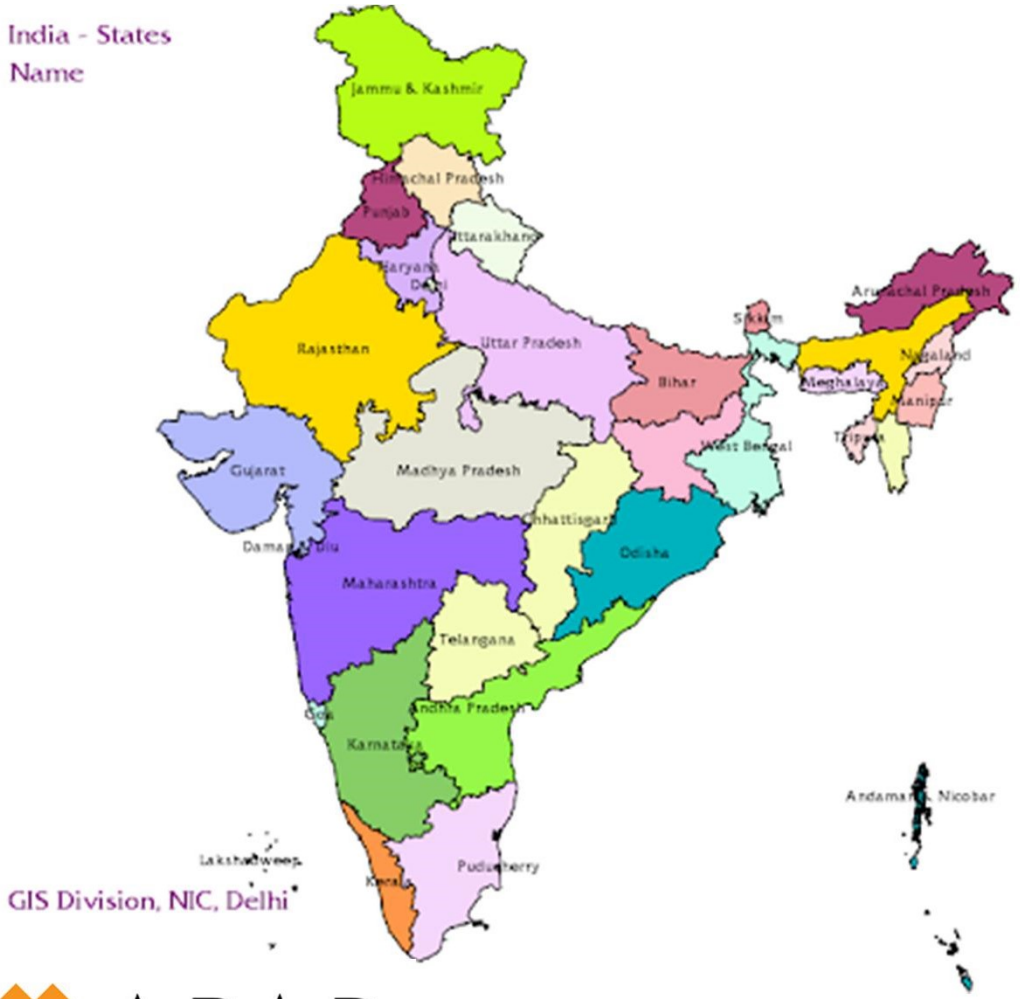
MVCC – Market Presence



MVCC Approval in Hand:

- TSECL
- APDCL
- MSEDCL
- MPMKVVCL
- TSSPDCL
- KSEB
- PGVCL
- GUVNL
- HPSEBL
- BESCOM
- MESCOM
- PSEB
- UJVNL
- DNHPDCL
- GED
- CSPDCL
- DHBVN
- BSES Rajadhani
- BSES Yamuna Power
- TPDDL
- Power Dept. Sikkim

MVCC Approval In-process:

- MePDCL
- N-E Region

MVCC Approval in Hand (Exports):

- South America
- North America
- Africa
- Myanmar
- Australia

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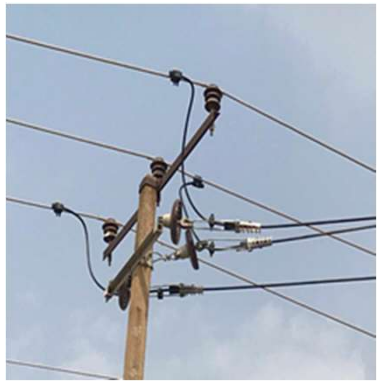
Prominent installations

BESCOM



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Prominent installations

APDCL –Assam

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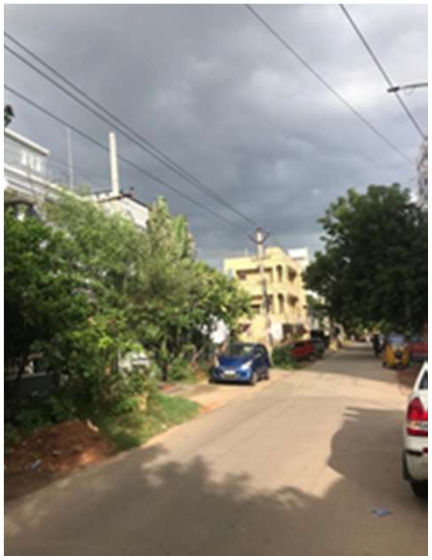
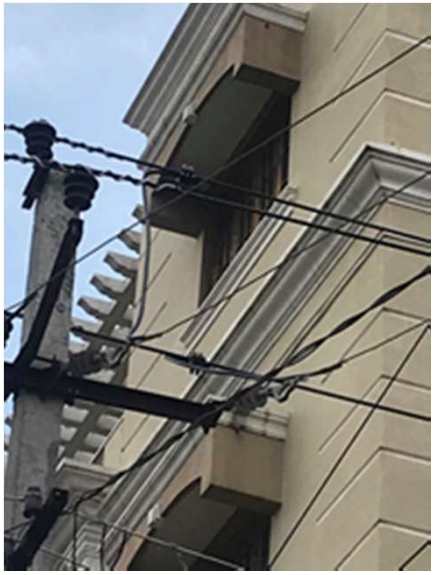
Prominent installations

TSSPDCL –Telangana





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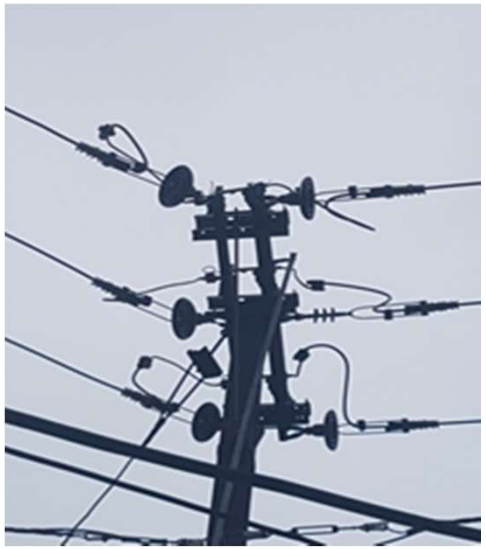
MPMKVVCL –Bhopal



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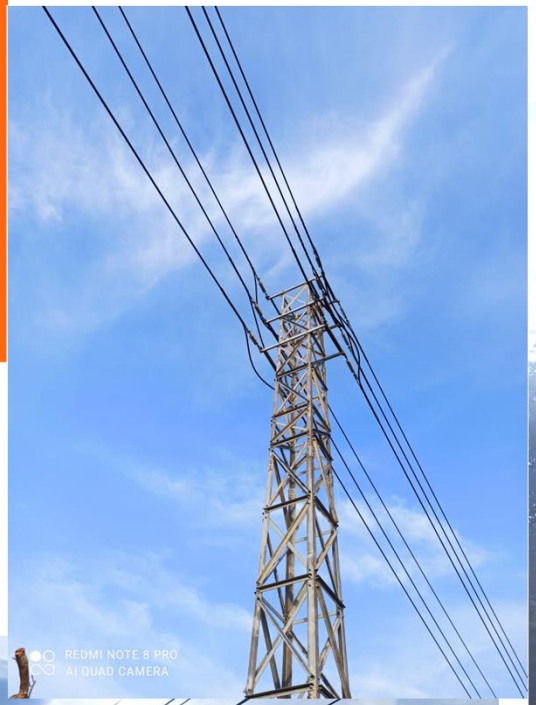
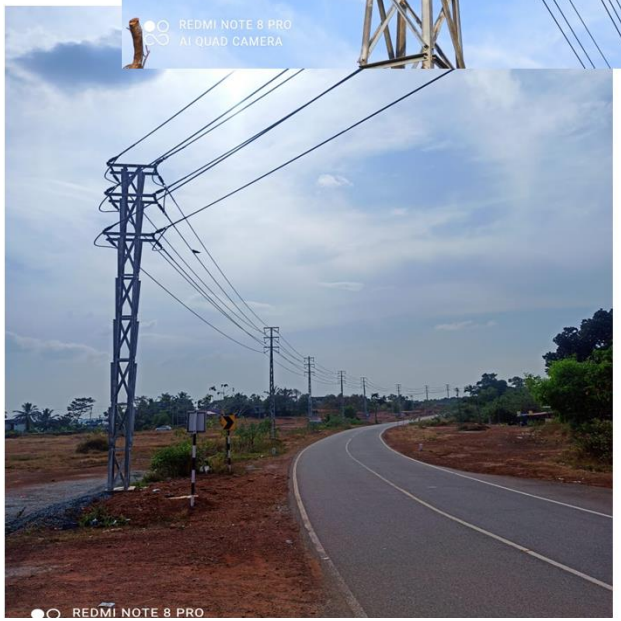
KSEB –Kerala 66KV





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Tata Projects –Poolwadi Wind Farm –TN

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PGVCL- Mangrol

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MSEDCL- Wasim near Akola

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Torrent

Wind power evacuation 33KV 100sqmm –

Bhavnagar

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Thank You

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