APAR INDUSTRIES LTD.

Introduction to Covered Conductors

PRESENTED BY MANISH PATEL
## APAR AT A GLANCE

### Turnover
(Rs. 8000 Cr) over USD 1 Billion

## Products

### Speciality Oils
- 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

### Conductors
- 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

### Cables
- 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

<table>
<thead>
<tr>
<th>Speciality Oils</th>
<th>Conductors</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rabale, Silvassa &amp; Hamriyah</strong>&lt;br&gt;Total Capacity 450,000 KL</td>
<td><strong>Silvassa, Athola &amp; Jharsaguda</strong>&lt;br&gt;Total Capacity over 200,000 MT</td>
<td><strong>Umbergaon &amp; Khatalwada</strong>&lt;br&gt;Annual Capacity 30,000 MT Aluminum &amp; 10,000 MT Copper</td>
</tr>
</tbody>
</table>
The Fact

ELECTROCUTION KILLS NEARLY 30 INDIANS A DAY
Five electrocuted after Ganesha immersion

PROBLEM AT HAND

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

7 Elephants electrocuted in Odisha while passing through a village

15 peacocks electrocuted due to improper conservation

Over 30 Flamingos electrocuted in Bhavanagar, Gujarat
Fire Hazards
• 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

Challenges for Utilities with Bare Conductors

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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
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.

**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
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.
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
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
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
Type Test requirement as per EN 50397-1: 2006

<table>
<thead>
<tr>
<th>Construction requirements</th>
<th>Type Test on Insulation Ref: EN 50397-1:2006 Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conductor</strong></td>
<td>Aluminium alloy or steel reinforced aluminium</td>
</tr>
<tr>
<td></td>
<td>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)</td>
</tr>
<tr>
<td></td>
<td>the conductors may be compacted or non-compacted</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td><strong>Covering</strong></td>
<td>Basic material XLPE 90 Deg C Operating</td>
</tr>
<tr>
<td></td>
<td>Mechanical Properties: Before &amp; After Aging Test for Elongation and Tensile Strength as per (EN 60811-1-2)</td>
</tr>
<tr>
<td></td>
<td>Physical and chemical properties tested for hot set test, pressure test at high temperature, water absorption, shrinkage test, Shore D hardness.</td>
</tr>
<tr>
<td></td>
<td>Electrical tests comprising of High voltage test, Spark test on the covering, Leakage current, Tracking resistance</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>
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.
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.
• 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
• 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:**

<table>
<thead>
<tr>
<th>Voltages</th>
<th>Leakage current on surface of MVCC in mAmps</th>
<th>Maximum permitted Leakage current as per EN 50397 in mAmps</th>
<th>Maximum a human being can withstand without affecting heart in mAmps</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 KV</td>
<td>0.12</td>
<td>1.0</td>
<td>10.0</td>
</tr>
<tr>
<td>33KV</td>
<td>0.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>66KV</td>
<td>0.80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• 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.
• **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.
Covered Conductor Accessories

REFERENCE 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

Tension Clamps With Tracking resistance
Alignment Ties
Insulated Suspension Clamps
Insulation Piercing Connector
Mid Span Joint

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REFERENCE STANDARD: EN 50397 - Part 2

TENSION CLAMPS

WEDGE TYPE TENSION CLAMPS

- Tracking protection
- Polymeric Padding

Cable Insulation Damage while using metallic clamps
REFERENCE STANDARD: EN 50397- Part 2

INSULATED TIES FOR LINE ALIGNMENT

Pin hole Insulation Damage while using metallic Ties

Tracking effect on Cable.
REFERENCE STANDARD: EN 50397- Part 2

INSULATION PIERCING CONNECTORS
(FOR BRANCHING / NETWORKING)

Tracking Analysis

Insulated to Insulated

Bare to Insulated
Insulation Piercing Connectors

REFERENCE STANDARD: EN 50397- Part 2

INSULATED TERMINATION

INSULATED MID SPAN JOINTS

DROP OFF / TEMPORARY EARTHING
REFERENCES STANDARD: EN 50397- Part 2

Tension Side

Line alignment

Suspension Side

Tension Side with arrestors
**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.

<table>
<thead>
<tr>
<th>Test Voltage</th>
<th>11 kV CC</th>
<th>22 kV CC</th>
<th>33 kV CC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insulation Thickness</td>
<td>Insulation Thickness</td>
<td>Insulation Thickness</td>
</tr>
<tr>
<td></td>
<td>Inner XLPE : 1.2 mm</td>
<td>Inner XLPE : 1.32 mm</td>
<td>Inner XLPE : 2.43 mm</td>
</tr>
<tr>
<td></td>
<td>Outer XLPE : 1.1 mm</td>
<td>Outer XLPE : 1.1 mm</td>
<td>Outer XLPE : 1.2 mm</td>
</tr>
<tr>
<td>(mA)</td>
<td>(mA)</td>
<td>(mA)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.025</td>
<td>0.01</td>
<td>0.022</td>
</tr>
<tr>
<td>3</td>
<td>0.037</td>
<td></td>
<td>0.031</td>
</tr>
<tr>
<td>5</td>
<td>0.064</td>
<td>0.03</td>
<td>0.051</td>
</tr>
<tr>
<td>6.5</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.7</td>
<td>0.105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>0.131</td>
<td>0.2</td>
<td>0.119</td>
</tr>
<tr>
<td>15.4</td>
<td>0.237</td>
<td></td>
<td>0.172</td>
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<tr>
<td>19</td>
<td></td>
<td></td>
<td>0.224</td>
</tr>
<tr>
<td>20</td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>0.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.1</td>
<td></td>
<td></td>
<td>0.266</td>
</tr>
</tbody>
</table>
Energized at 12 kV

Observations

• No arcing

• No damage to the covered conductor

• No damage to the tree branch
Testing Test of simulated clashing of conductors

80Min Testing No Arcing and Damage to Covered Conductors

Conductor Clashing

Simulating Animal
In House Testing Facilities Available (NABL Accredited Lab)

- HV Test SetUP
- Track Resistance Test SetUP
- Resistivity Test Setup/ Hot Air Ovens
- Xenon Weathering Test chamber
- Tensile Testing Machine
- Chemical Testing SetUP
- 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.
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
- MPMKVCL
- 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
Prominent installations

BESCOM
Prominent installations

APDCL – Assam
Prominent installations

TSSPDCL – Telangana
Prominent installations

MPMKVVCL – Bhopal
Prominent installations

KSEB – Kerala 66KV
Prominent installations

Tata Projects – Poolwadi Wind Farm –
Prominent installations

PGVCL- Mangrol
Prominent installations

MSEDCL- Wasim near Akola
Prominent installations

Torrent

Wind power evacuation 33KV 100sqmm – Bhavnagar
Thank You

CONTACT US

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