



Introduction to High Performance Covered Conductors

for High ampacity with reduced Line losses

PRESENTED BY MANISH PATEL



About – APAR Industries limited

- We are a technology-driven, customer-focused company that delivers – innovative, cost-effective, quality products & services
- We believe that with an innovation-first mind-set, we can find impactful solutions for our customers
- Trusted by major Power Generation, Transmission, Distribution, Automotive, Telecom, Railways and Defence companies globally

Our Strengths

60+

Years of
legacy

10 +

Global Mfg
Facility.

140+

Countries
Exports &
expanding

Trusted Manufacturer and supplier of



Cables



Conductors



Specialty Oil &
Polymers

APAR Industries: Tomorrow's solutions today

#1

Largest global aluminum
& alloy conductors'
manufacturer

3rd

Largest global
manufacturer of
Transformer oils

#1

Exporter of cables from
India

2.3 Bln \$

FY24 Consolidated
Revenue,
5 year CAGR at 25%



Leveraging global network

- Multi-year relationships with Indian & global majors
- Global presence



Leading the innovation curve

- Vast range of technologically advanced products
- All products developed with in-house R&D
- Intellectual Property for most products
- Global leader in key segments

Challenges for Utilities with Bare Conductors

1. Frequent Outages

Bare conductors are prone to **short-circuits caused by vegetation contact**, wildlife interference, and accidental bridging—resulting in unplanned power interruptions.

2. Safety Risks

The absence of insulation increases the risk of **electrical flashovers, fire hazards, and public safety incidents**, especially in densely populated or forested areas.

3. Maintenance Burden

Utilities must perform **frequent tree trimming and line patrols** to maintain clearance distances, significantly increasing operational expenses.

4. Environmental Exposure

Bare conductors are directly exposed to **rain, snow, pollution, and coastal salt**, leading to corrosion, reduced service life, and higher replacement rates.

5. Limited Network Upgrades

In congested or space-constrained areas, existing line corridors cannot easily accommodate larger conductors or higher current ratings due to safety clearance limitations.

6. Climate Vulnerability

Extreme weather—such as **heavy winds, ice loading, and high ambient temperatures**—further stresses bare conductor systems, increasing the risk of faults and line sag.



Challenges with AB Cable

1. Short Lengths

ABC systems are **mechanically weak compared to bare or covered conductors**. Their bundled structure and high self-weight restrict span lengths and make them unsuitable for long rural or hilly routes.

2. Higher Line Losses

Due to the close spacing of phase conductors, **reactance increases** and **power losses are higher**, particularly on long feeders.

3. Complex Installation and Tensioning

Installation requires **special dead-end and suspension fittings**, and maintaining uniform tension across multiple cores can be difficult— leading to sagging or twisting of the bundle.

4. Heat Dissipation Limitations

The bundled design restricts air circulation, resulting in **higher operating temperatures** and **lower current-carrying capacity** than covered conductors.

5. Maintenance Challenges

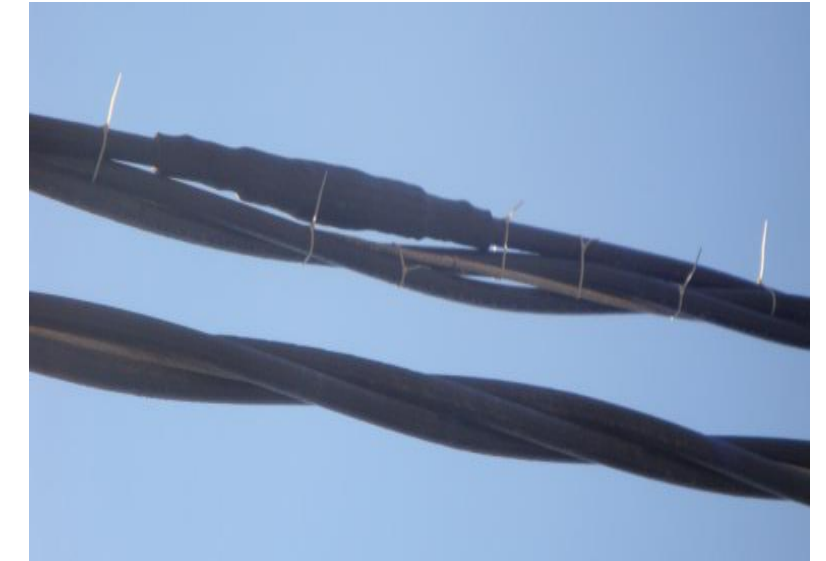
When a single core or insulation is damaged, **entire sections of the cable often need replacement**. Fault detection and repair are more time-consuming and costly compared to single covered conductor.

6. Not Ideal for Harsh Environments

ABC is **more sensitive to UV degradation, bird pecking, and mechanical stress**. It also performs poorly under **ice or snow loading**, making it less suitable for cold or mountainous regions.

7. Aesthetic and Weight Issues

The bulky appearance and heavy weight per span often make ABC **unsuitable for compact urban or retrofitted line corridors** where pole strength or clearance is limited.

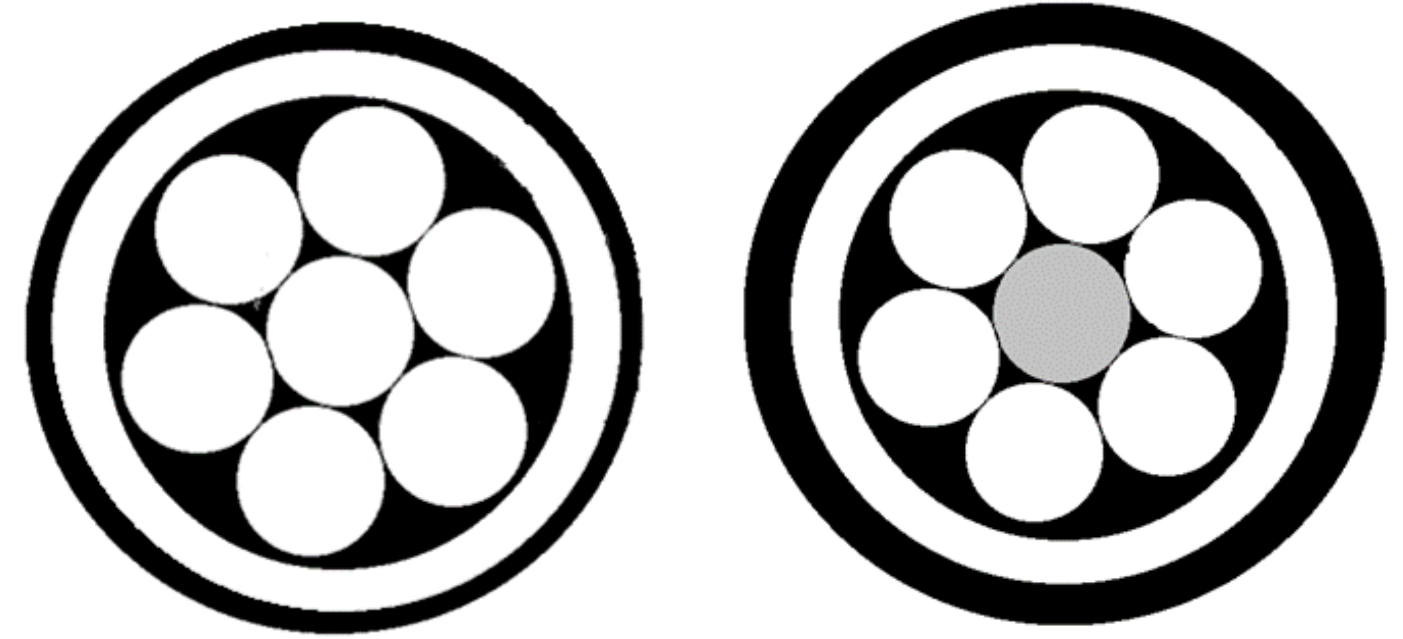


OVERHEATING OF COPPER TAPE
CAUSES BURNING OF OUTER SHEATH



TYPES OF COVERED CONDUCTORS

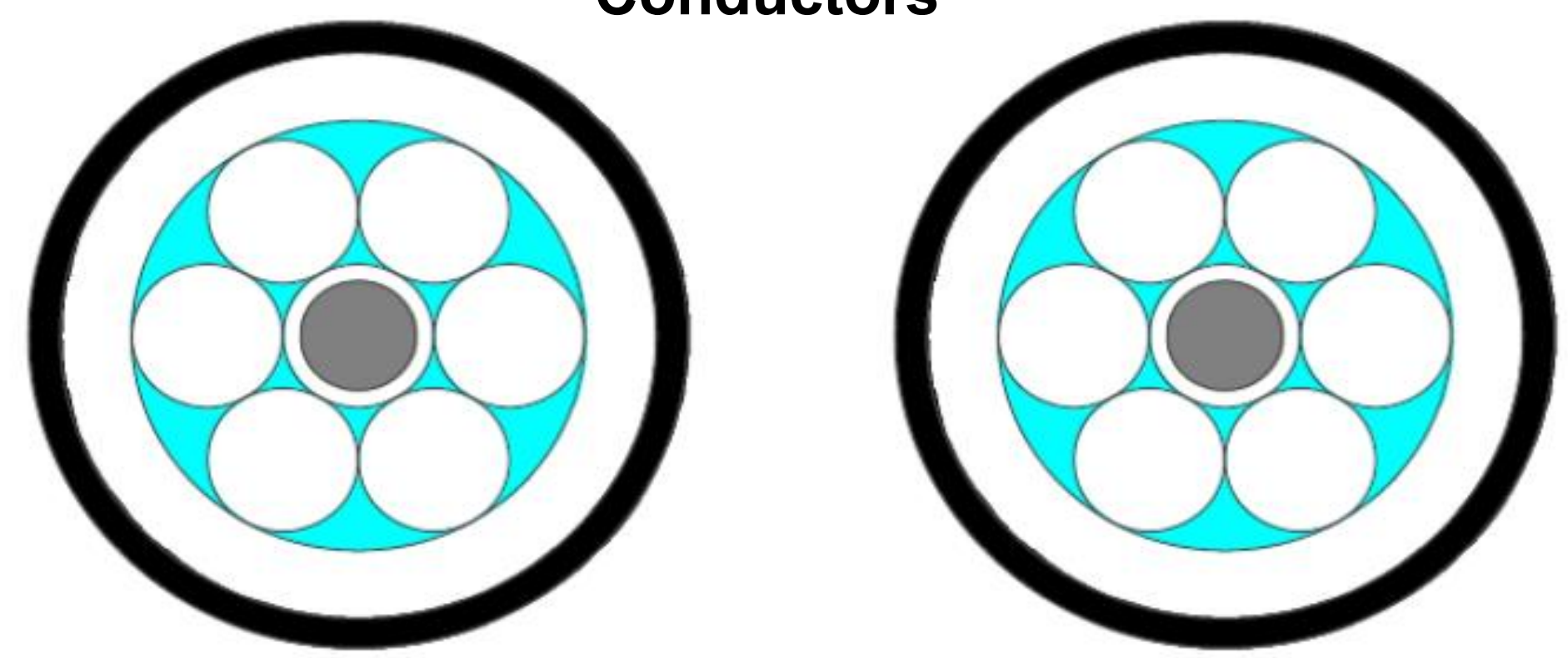
Old Technologies



AAAC

ACSR

New Technologies High Performance Covered Conductors



90°C

AL59 ACS

95°C

Why AL59 ACS 95 °C instead of AAAC & ACSR

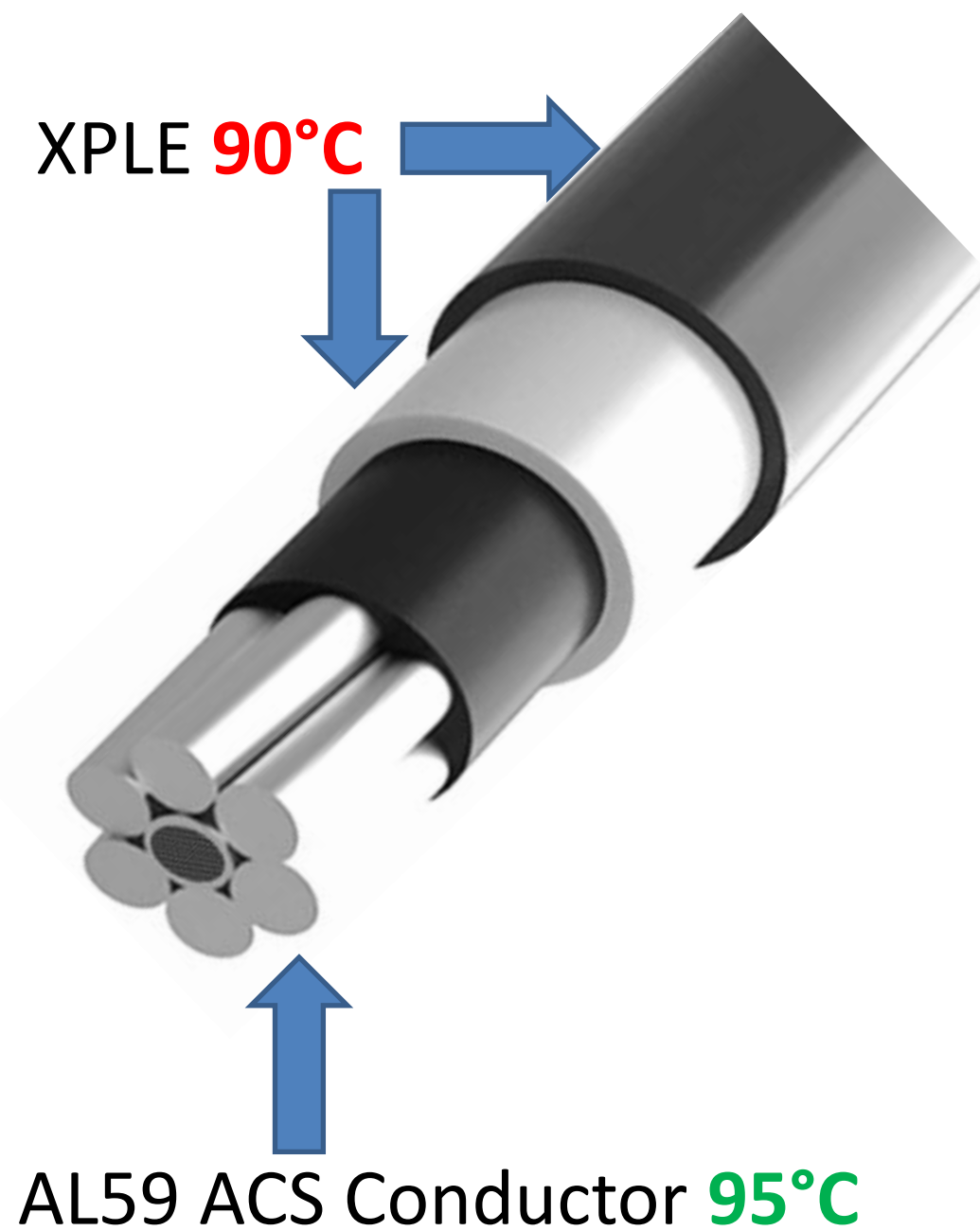
RDSS Requirement :RDSS (Revamped Reforms Based and Results Linked Distribution Sector Scheme) to undertake reforms and improve performance in a time bound manner and to provide consumer 24x7 uninterrupted, quality, reliable and **affordable power supply with lower losses**



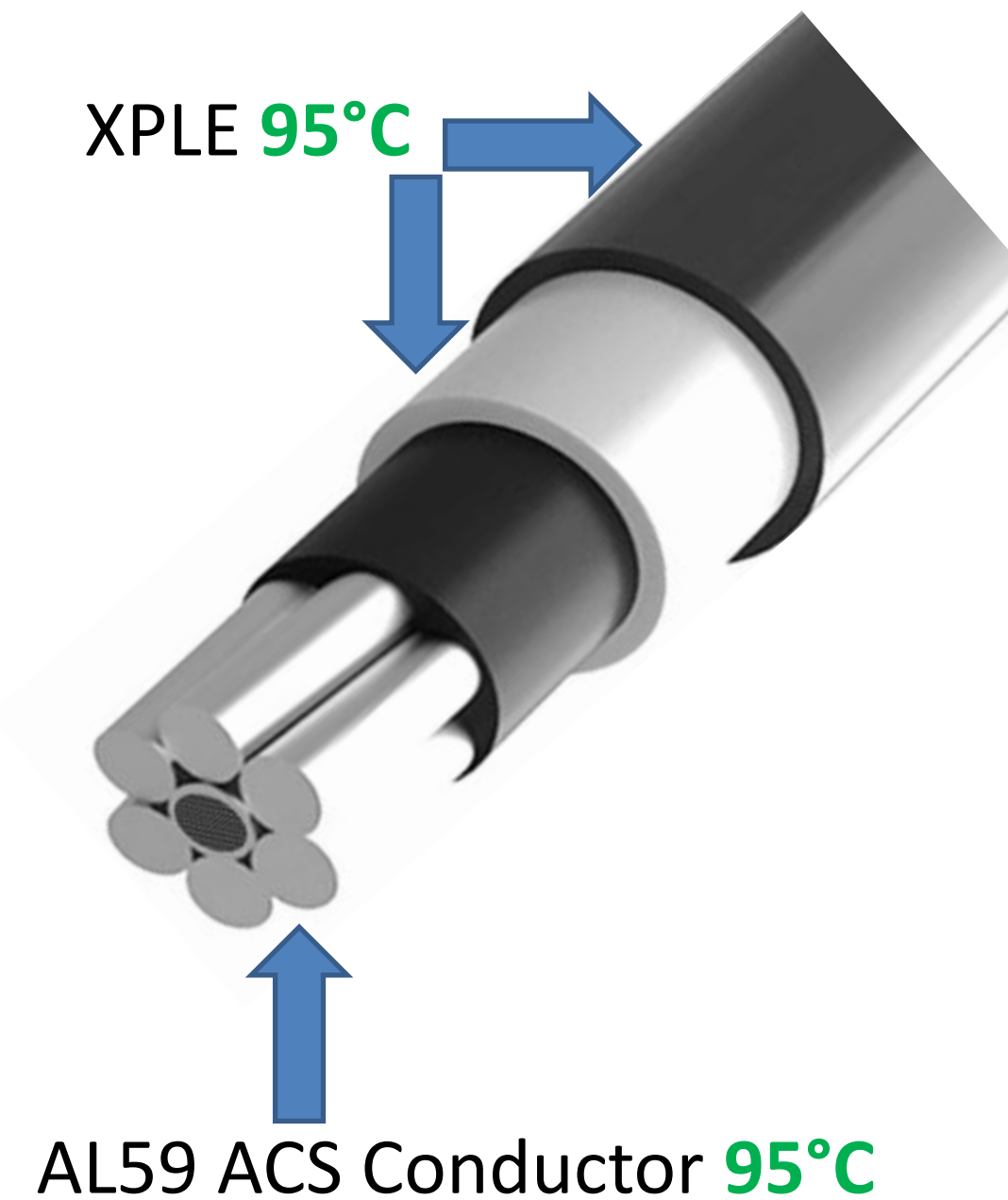
Parameter	AL59ACS Covered Conductor	AAAC Covered Conductor	ACSR Covered Conductor
Conductor Material	AL59 alloy with ACS core	All Aluminium Alloy (AAAC)	Aluminium + Galvanised Steel Core
Operating Temperature	Up to 95°C	~75–80°C	~75–80°C
Current Carrying Capacity	Highest (due to low resistivity & high temp.)	Moderate	Moderate
Sag Performance	Excellent – low thermal expansion	Higher sag at load & temp	Higher sag due to steel creep
Mechanical Strength	High – ACS core provides strong tensile capacity	Lower than AL59ACS	Moderate, but core corrodes
Corrosion Resistance	Superior (ACS core, Al-clad)	Good (no steel)	Poor – galvanized steel prone to corrosion
Line Losses (I^2R)	Lowest (resistivity 2.82 $\mu\Omega/\text{cm}$)	Higher (3.28 $\mu\Omega/\text{cm}$)	Moderate
Reliability Under Short Circuit	High withstand capability	Moderate	Moderate
Lifespan & Durability	Longest (low creep, high fatigue resistance)	Shorter	Prone to corrosion, shorter
Maintenance Needs	Low – fewer tree faults, trimming, outages	Higher	Higher
Overall Economics	Best Lifecycle Cost (low loss + long life)	Lower capex, but higher O&M	Lower capex, but high O&M & replacement
Suitability	Preferred for RDSS / modern high-reliability networks	For short spans, low-cost rural use	Legacy use, declining adoption

Why AL59 ACS 95 °C instead of AL59 ACS 90°C

Wrongly **Purchased** with lower Insulation Temp Resistance



Correctly should be Purchased with same Temp Resistance



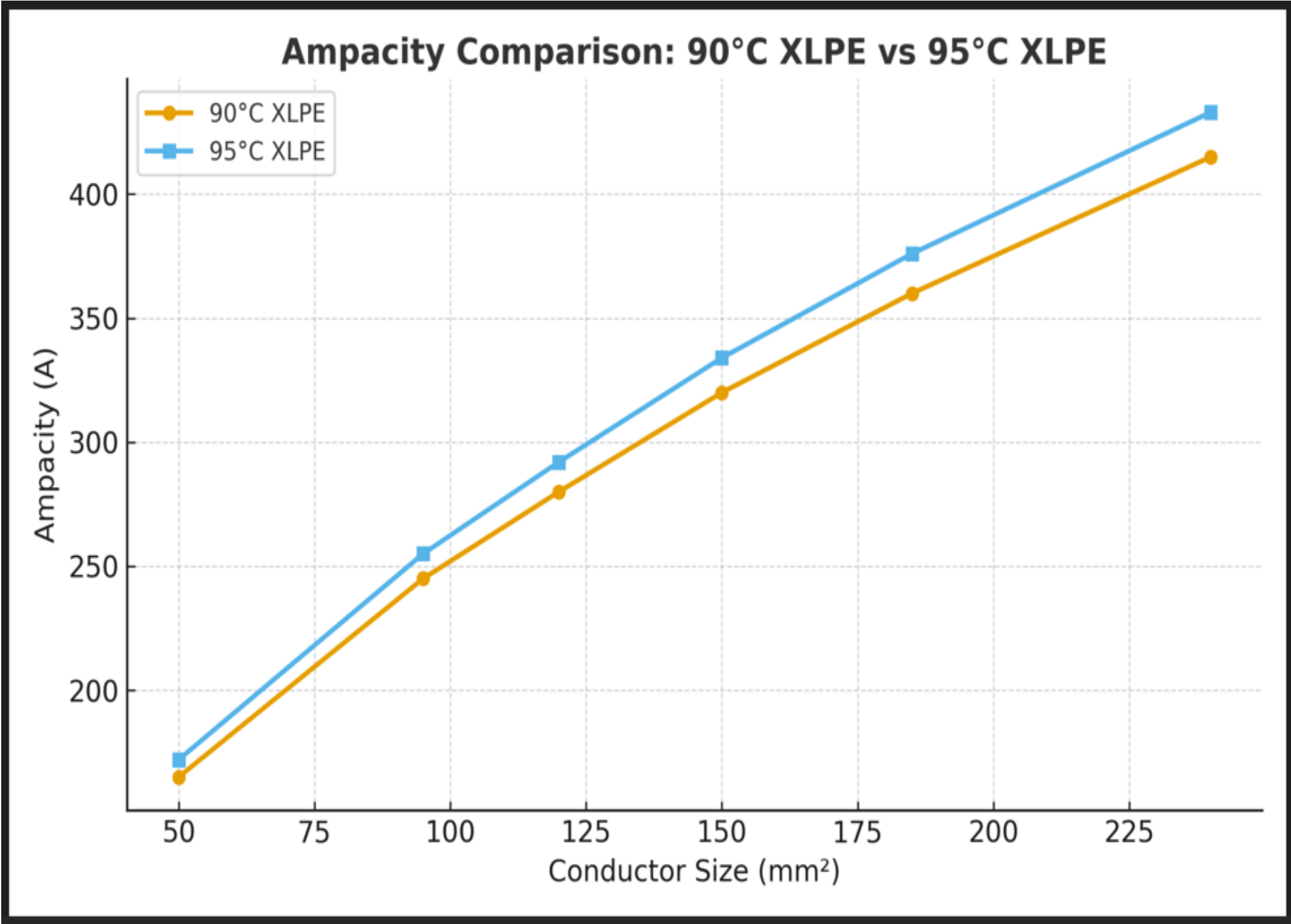
Comparison of AL59 ACS 90°C Vs 95°C

Parameter	90°C XLPE	95°C XLPE
Maximum Continuous Operating Temperature	90°C	95°C
Thermal Class	Standard XLPE	Enhanced thermal stability XLPE
Insulation Material	Conventional cross-linked polyethylene	Modified/compounded XLPE with improved thermal resistance
Current Carrying Capacity	lower	5% higher (due to higher allowable conductor temperature)
Service Life at overloading	Typically 4-5 years at 95°C	30-40 Years , but material must be thermally stabilized to ensure longevity at 95°C
Typical Application	Standard distribution having lower loads without increasing in future	High-load areas, higher ampacity systems, or elevated ambient conditions
Thermal Aging Margin	Lower margin for overload	Higher margin—can tolerate higher conductor temperatures during overloads
Cost	Slightly lower	Slightly higher (due to improved polymer and cross-linking additives)

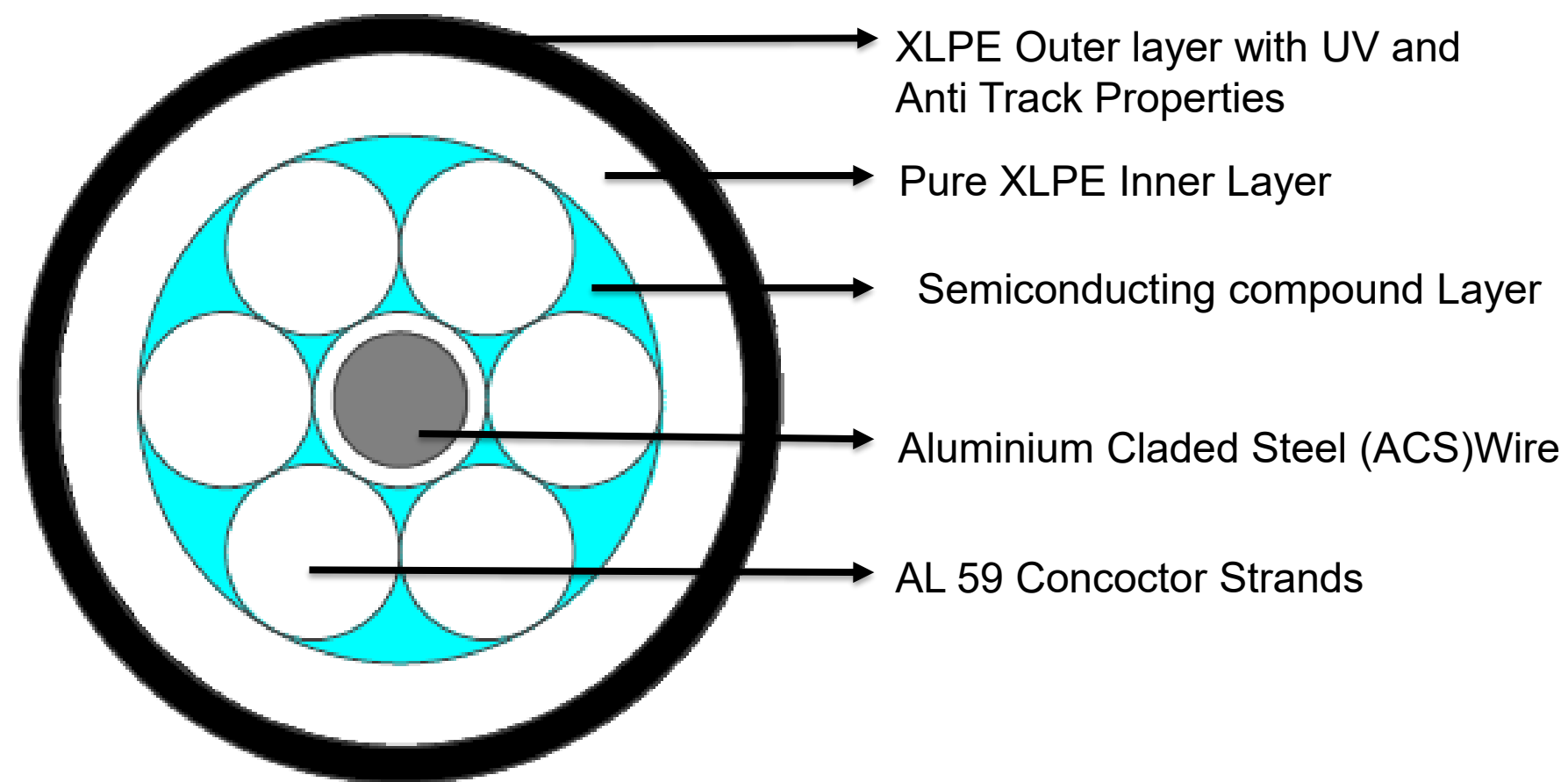
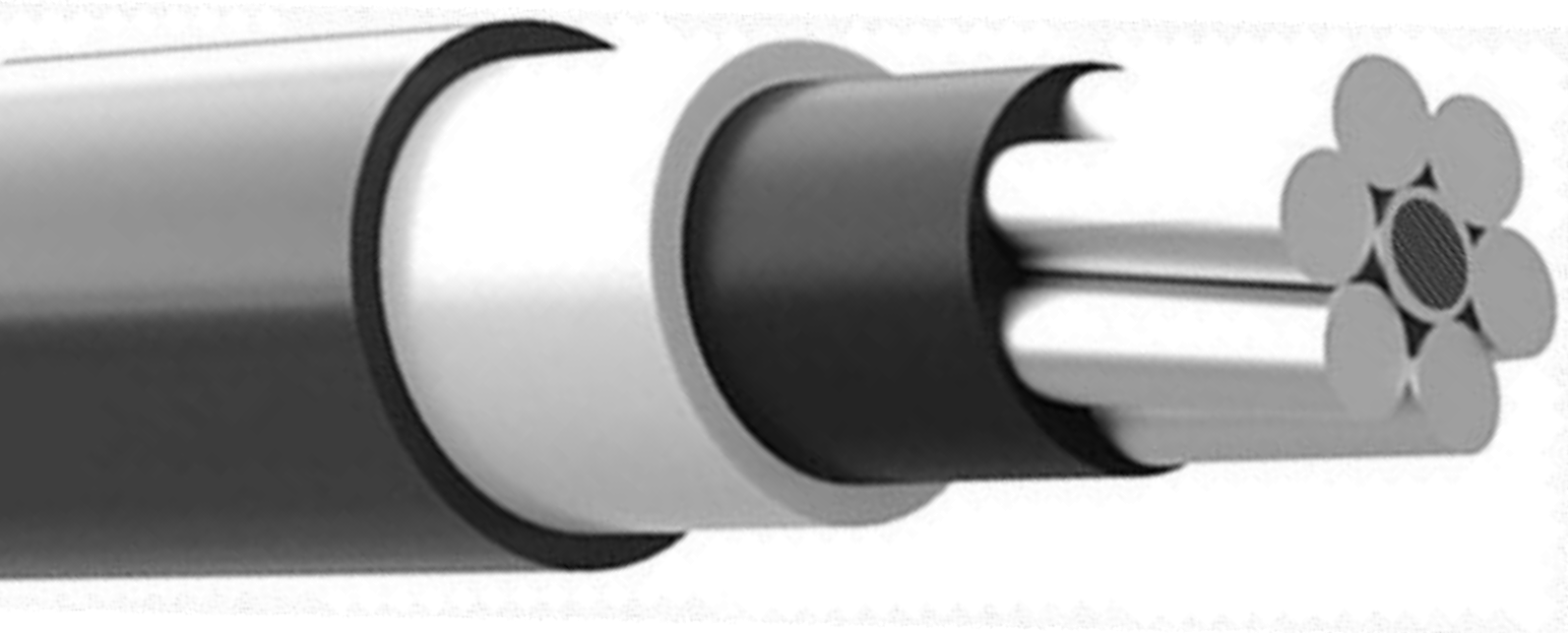
Practical Implication

- A **95°C-rated XLPE** cable can carry **more current** for the same conductor size, or alternatively, you can use a **smaller conductor size** for the same current rating.
- The **insulation compound** used in 95°C XLPE has better **thermal oxidative stability** which **retains dielectric strength** at higher temperatures.
- However, the **95°C rating must be supported by type test validation** (as per **IEC 60502** and **EN 50397** standards for covered conductors).

AL59 ACS Ampacity chart



AL59 ACS 95°C COVERED Conductor Construction for high ampacity and reduced Line losses

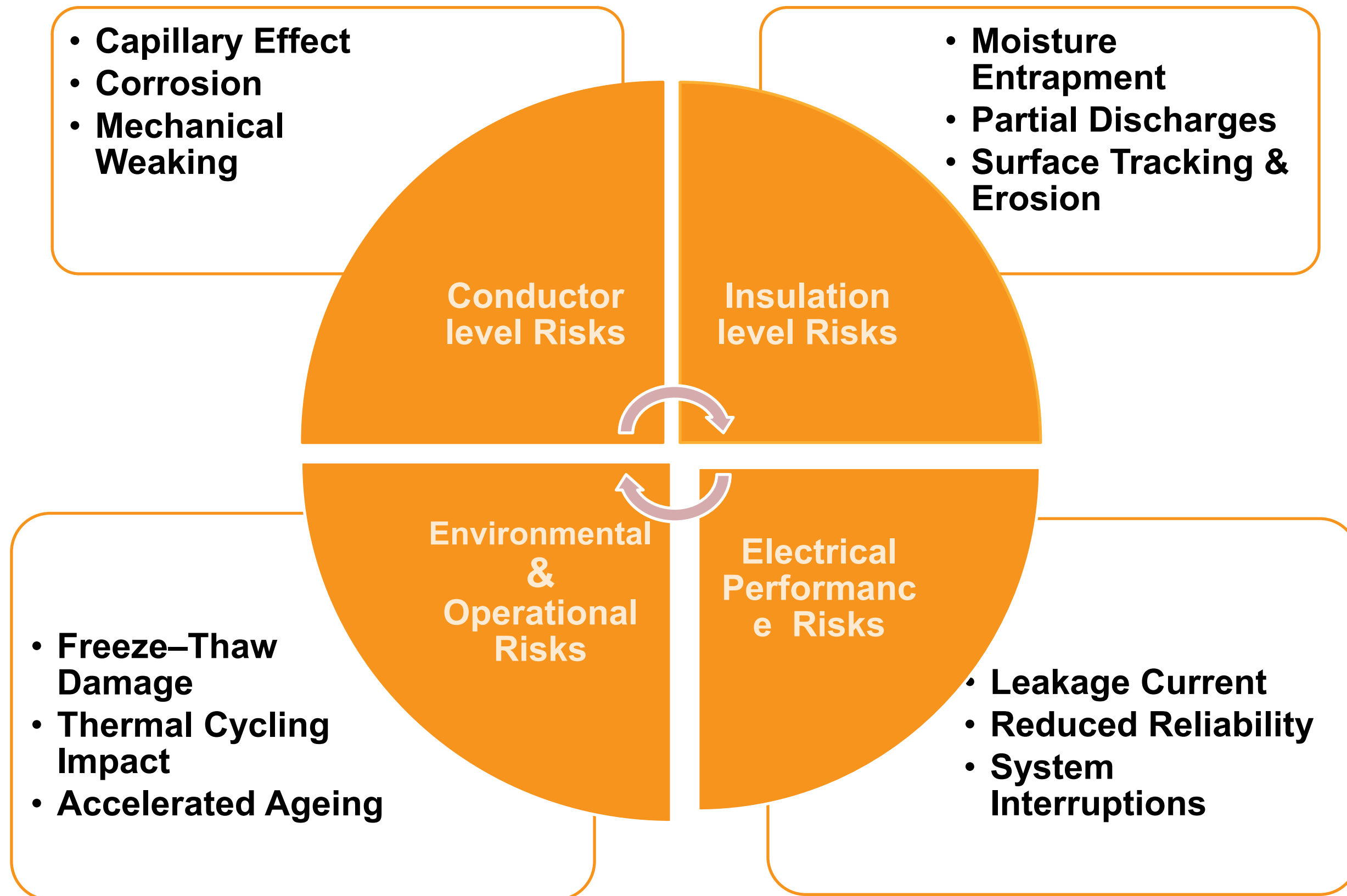


Semiconducting Layer – Provides shielding and minimizes electrical stress around the conductor.

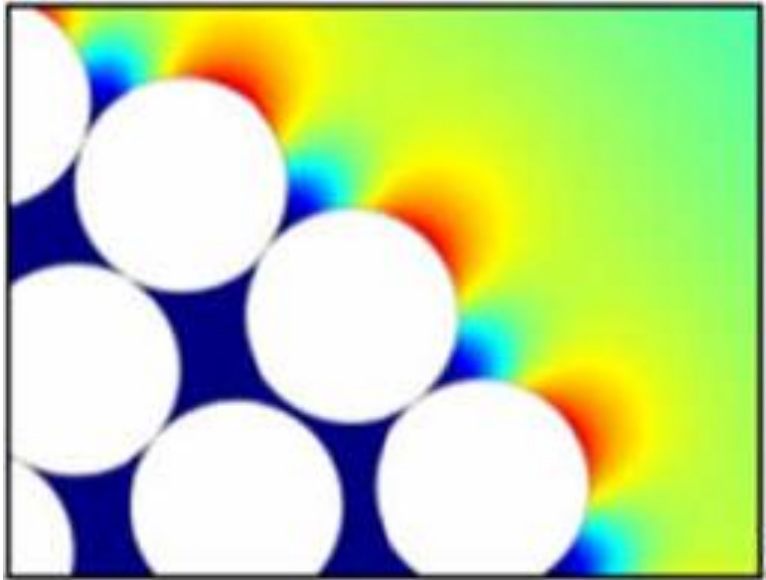
Inner Insulating Layer (XLPE Insulation) – Ensures high dielectric strength, heat resistance, and long-term reliability.

Outer Insulation Layer (XLPE with UV & Track-Resistant Properties) – Protects against UV radiation, surface tracking, and harsh environmental conditions for extended service life.

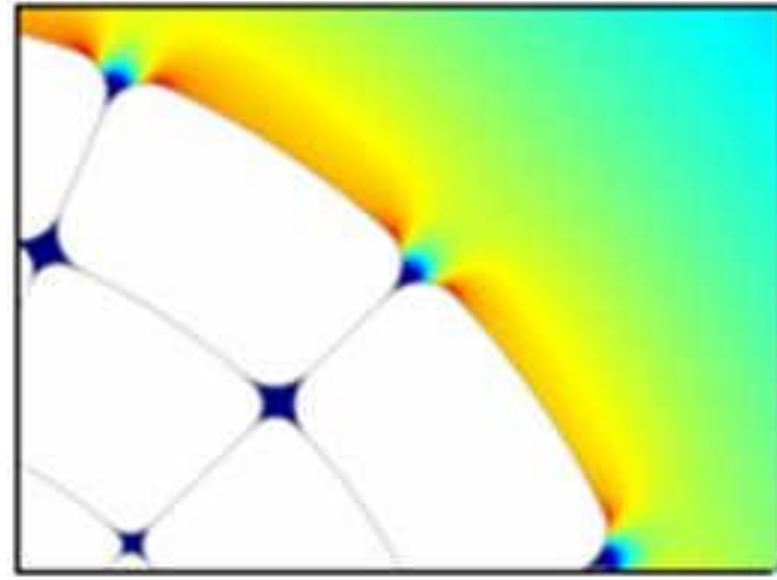
Why Water tight Conductor ?



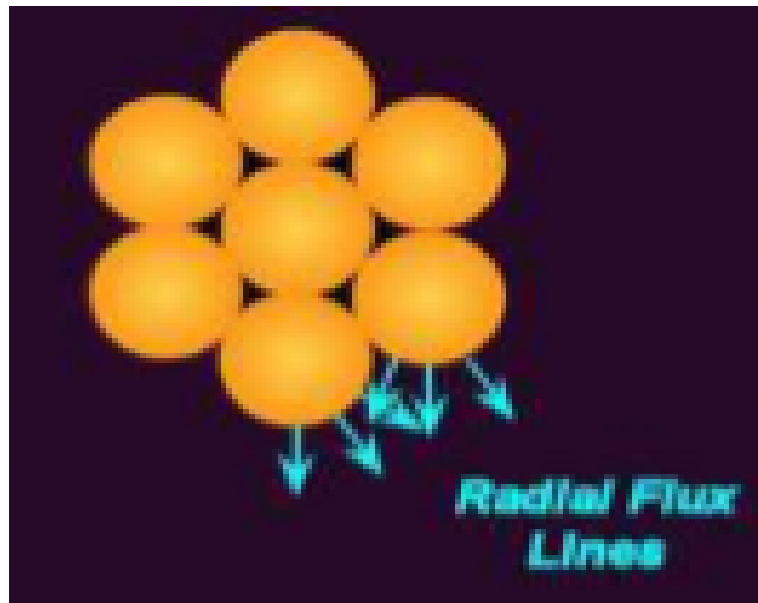
Importance of Semiconducting conductor screen & Anti-tracking outer covering



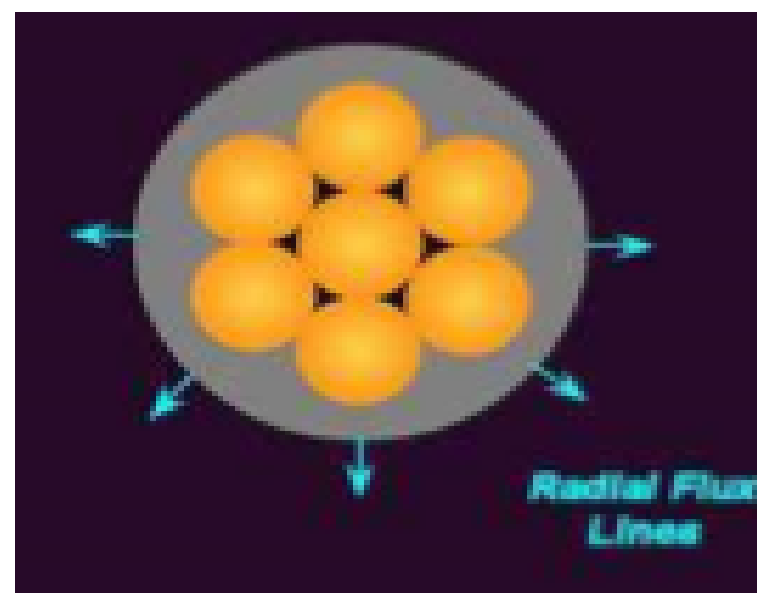
Circular Strand Electrical Stress



Trapezoidal Strand Electrical Stress



Uniform stress distribution



Surface tracking & polymer

VOLTAGE LEVEL - 11 KV MVCC						
Sr. No.	TECHNICAL PARAMETERS		Unit	AAAC-DOG	AL59ACS-DOG	Remarks
1	Cross sectional Area		sq.mm.	100	104.98	
2	Strand / dia		No/mm	7/4.26	ALU. 6/4.72 + ACS 1/4.72 (20SA)	
3	DC resistance at 20 ^o C		Ω/km	0.339	0.268	AL59 ACS has 20% lower losses
4	Breaking Load of conductor		kN	29.26	39.56	AL59 ACS has 35% higher breaking strength
5	Conductor diameter		mm	12.78	14.16	AL59 ACS Conductor dia is 10% larger
6	Approx weight of bare conductor		Kg/km	272.86	403	Al59 ACS is 47% heavier
7	Thickness of semiconductive layer		mm	0.3	0.3	
8.i	Thickness of Inner XLPE layer		mm	1.2	1.2	
10	Overall diameter of MVCC		mm	18.50 ± 1	20.00 ± 1	
11	Approx Overall weight		Kg/km	450	600	Al59 ACS is 33% heavier
12.a	AC Resistance at 85°C		Ω/km	0.4813	0.3727	
12.B	AC Resistance at 95°C		Ω/km	-----	-----	
	CURRENT CARRYING CAPACITY					
13.i	Solar Absorption coefficient =0.8, Emissivity Coefficient = 0.45, Intensity of Solar Radiation = 1045 W/m2, Wind Speed = 0.56 m/s. .	Ambient Temp = 25°C Continuos temp. 85°C	Amp	325	365	AL59 ACS is 12% higher electric Current
13.ii		Ambient Temp = 30°C , Continuos temp. 85°C	Amp	308	347	
13.iii		Ambient Temp = 40°C , Continuos temp. 85°C	Amp	272	306	AL59 ACS is 13% higher electric Current
14.i		Ambient Temp = 25°C , Continuos temp. 95°C	Amp	-----	390	AL59 ACS is 20% higher electric Current
14.iii		Ambient Temp = 40°C , Continuos temp. 95°C	Amp	-----	345	AL59 ACS is 26% higher electric Current

1	SAG CALCULATION CHART AT NO WIND			
	Operating Temp (Max)	°C	85	95
	Ruling Span	m	30 / 45 / 55	30 / 45 / 55
	Sag at null point	m	0.32 / 0.55 / 0.72	0.28 / 0.50 / 0.67
2	AC Power Losses ($I^2 R$) at max operating Temp	MW/km	0.050837	0.05668767
3	Maximum Operating Temperature	°C	85	95
17	AVERAGE OHMIC LOSS CALCULATION			
	Line Length	Km	30	30
	No. of Phase	No.	3	3
	Power Factor	-	0.9	0.9
	Loss Load Factor	-	0.6	0.6
	Power Transfer	MW/Ckt	5.572710	6.687252
	Average Ohmic loss @ max operating temp =Loss Load Factor X No. of sub-conductors per phase X Line Length X No. of phases X (Continuous operating current under normal conditions) ² X AC Resistance corresponding to continuous operating current	MW/Ckt	2.7	3.1

Applicable Covered Conductor Standards



CENELEC THE EUROPEAN COMMITTEE FOR ELECTRO TECHNICAL STANDARDIZATION HAS RECENTLY ISSUED TWO 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

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.

Maintenance required for Covered Conductors

1. Minimal Vegetation Management

2. Visual Inspection

3. Periodic Accessory Checks

Line accessories such as **insulators, connectors, and terminations** should be **inspected and maintained** to ensure proper mechanical tension and electrical contact.

4. Cleaning in Polluted Areas

In regions with **high industrial pollution or coastal salt deposits**, occasional **cleaning of insulators and fittings** may be required to maintain surface insulation resistance.

5. Thermographic Monitoring

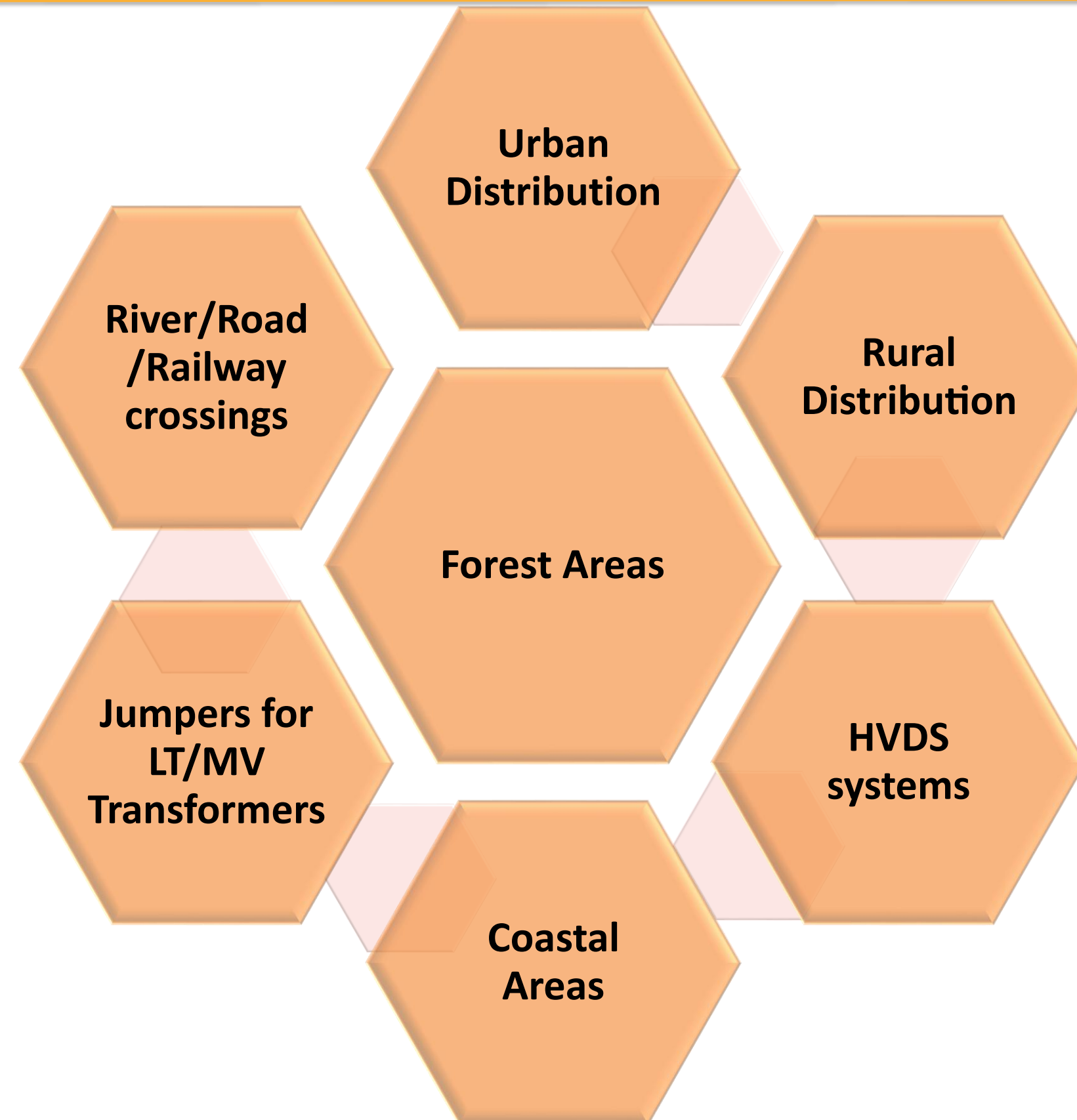
Optional **infrared or thermal imaging** can help detect hot spots at joints or clamps—useful for **predictive maintenance** and optimizing service reliability.

6. Replacement Intervals

When installed and operated within rated temperature limits (e.g 95°C XLPE), covered conductors typically **require no major replacement for decades**, providing excellent lifecycle economy.



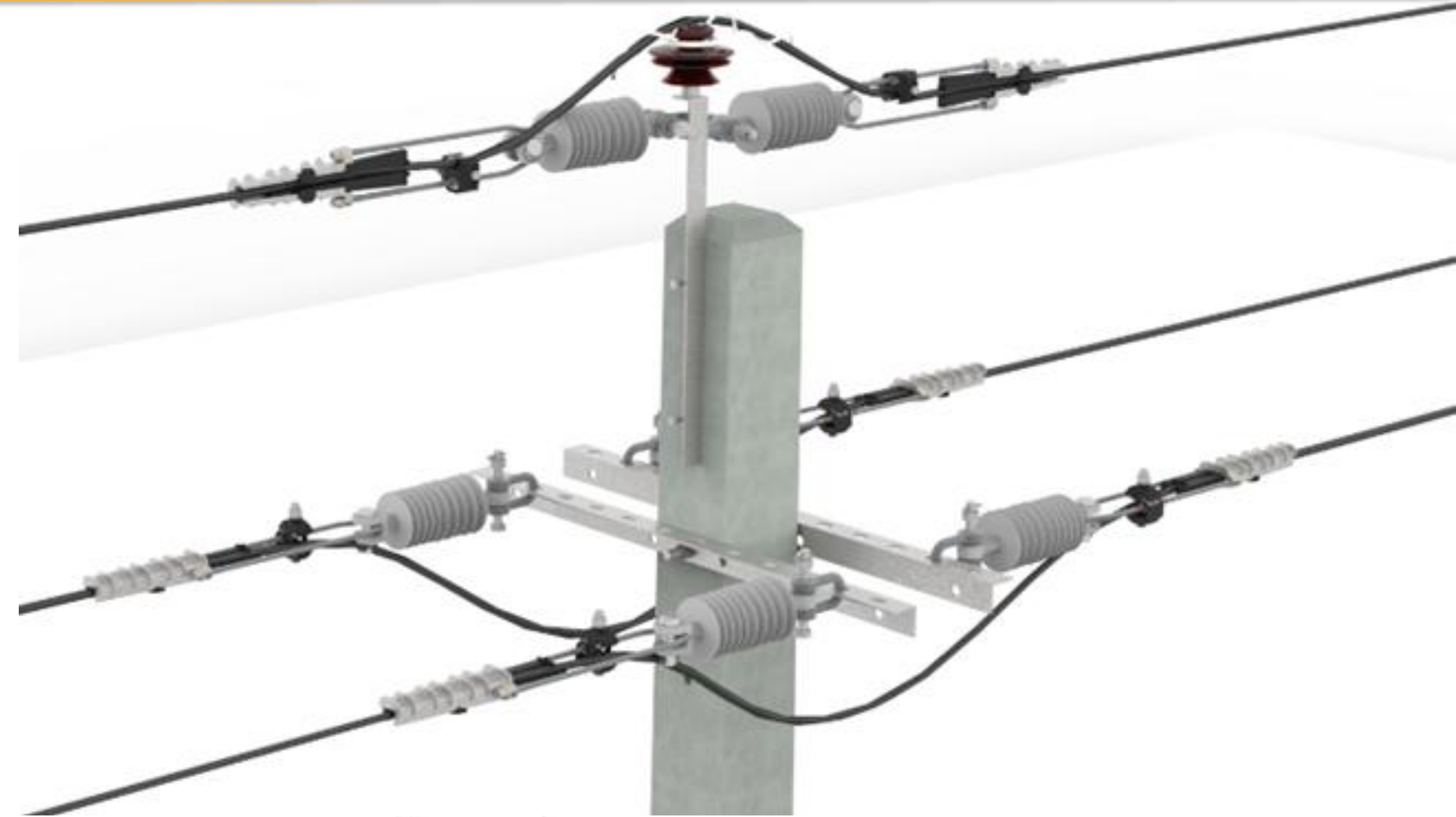
Applications Covered Conductors



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**

In House Testing Facilities Available (NABL Accredited Lab)



HV Test SetUP



Track Resistance Test SetUP



Chemical Testing SetUP



Resistivity Test Setup/ Hot Air Ovens



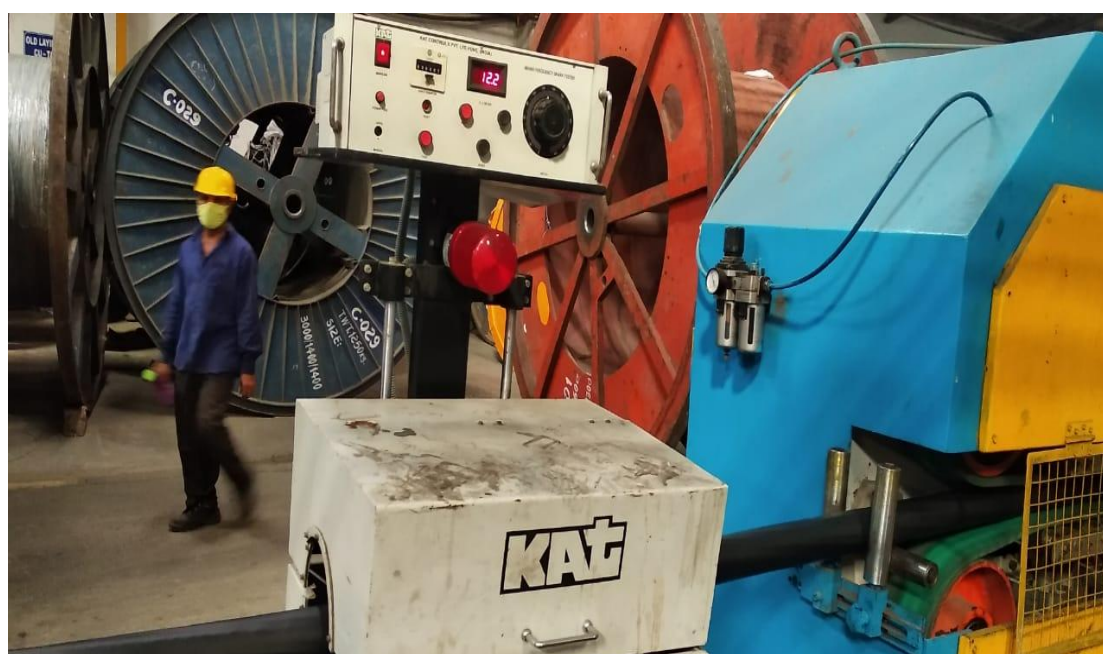
Xenon Weathering Test chamber



Tensile Testing Machine



CR meter & Stand



Spark Test SetUP



Carbon Black Test SetUP



Adhesion Test Setup/ Slippage Test Setup

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



MVCC – Market Presence

India - States
Name



GIS Division, NIC, Delhi

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
- MePDCL
- N-E Region

MVCC Approval in Hand (Exports):

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

Thank You

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