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ISGF
India Smart Grid Forum

DISTRIBUTION UTILITY MEET DUM 2023

Session : 6

New Covered Conductor technologies for High Ampacity and reduced Line losses

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Challenges for Utilities in Distribution Lines

Earlier Challenges 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 .)

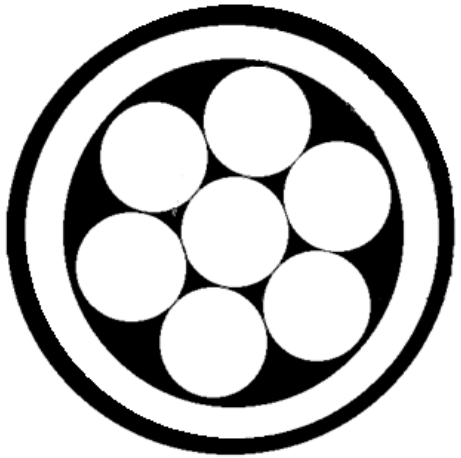
New Challenges after Covered Conductor

Use of AAAC /ACSR MVCC

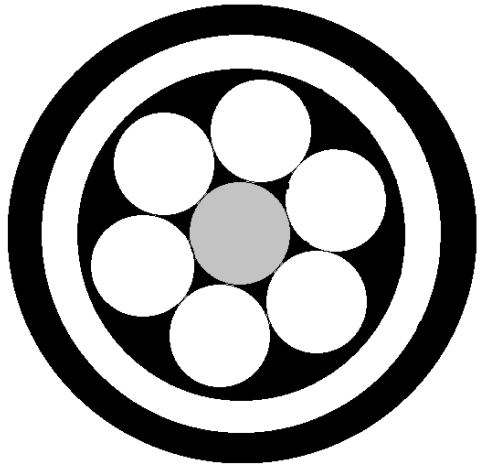
- **Strength of the conductor with insulation wt .**
- **Losses increased**
- **Temperature limitations**
- **Degradation of conductor operational life due to wrong installations**
- **Use of unbranded accessories not as per EN50397-2**

Types of Covered Conductors

AAAC

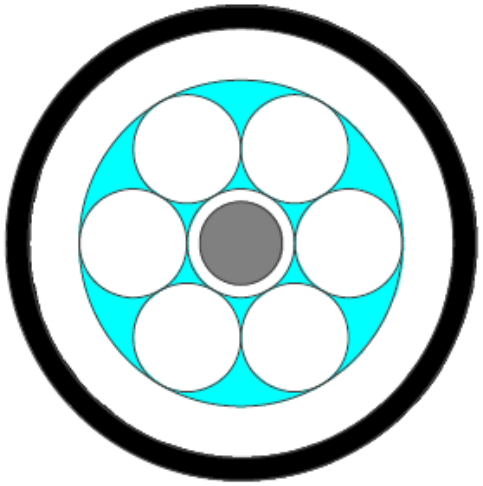


ACSR

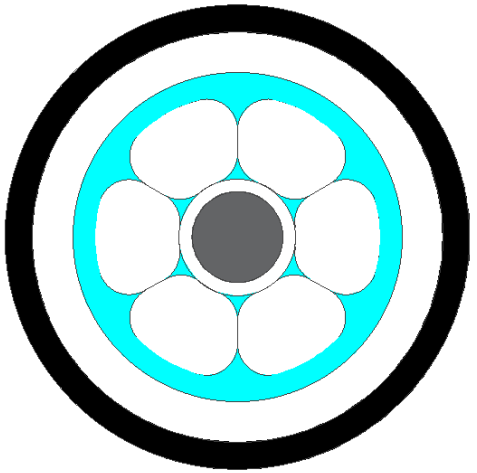


Old Technologies

AL59 ACS



ACSS ACS



New Technologies

AL59 ACS Covered Conductor Construction

High Ampacity and Reduced Line losses

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 :

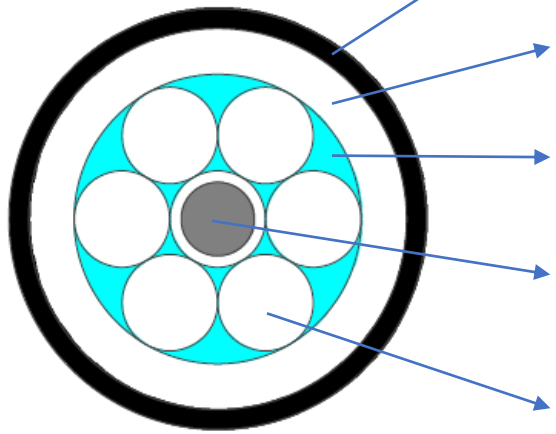
- Reduces stress, transforms strands into a single uniform cylinder
- Extend service life of the covered conductor

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



Technical Comparison of ACSR , AAAC Vs AL59 ACS Dog					
	Parameters	**ACSR CC**	**AAAC CC**	**AL59-ACS**	**Remarks**
1	**Strand/wire dia**	Alu. 6/4.72 + St. 7/1.57	7/4.26	Alu. 6/4.72 + ACS 1/4.72	
2	**Resistivity (Ohm.m)**	2.8264E-08	3.28E-08	2.905E-08	
3	**Conductivity (S/m)**	35380696.29	30487804.88	34423407.92	
4	**Current Carrying capacity**	Current carrying capacity In air at 40°C Ambient Temp. & 75°C max. operating temp will be **285 A**	Current carrying capacity In air at 40°C Ambient Temp. & 80°C max. operating temp will be **282 A**	Current carrying capacity In air at 40°C Ambient Temp. & 90°C max. operating temp will be **344 A**	approx 30% higher current carrying capaity
5	**DC resistance at 20°C (Ohm/Km.)**	0.2792	0.339	0.274	Lower Losses
6	**Continuous operating temp**	75°C	80°C	95°C	AL59 ensures much higher operating temperature and higher current carrying capacity
7	**Breaking Strength**	32.41 kN	29.26 kN	39.56	AL59 has higher in breaking strength . This in turn produces less mechanical tension on cross-arms, poles etc.
8	**Conductor breaking strength to weight ratio**	5.33	6.48	6.9	
9	**AL Cross-section of CC**	104.98 sq.mm.	99.77 sq.mm.	104.98 sq.mm.	
10	**Overall Diameter (100 sq.mm dog)**	Conductor dia 14.15 mm with in sulation overall outer dia approx. 22.00	Conductor dia 12.78 with insulation overall outer dia Approx. 20 mm	Conductor dia 14.16 mm with insulation overall outer dia approx. 21.5	
11	**Weight(100 sq.mm dog)**	620 kg/km.	460 kg/km	620 kg/km	

PAYBACK CALCULATION SHEET				
Cross Sectional Area		**104.987 sq.mm.**	**99.77 sq.mm.**	**104.987 sq.mm.**
Current Carrying Capacity in Amperes				
IEC 1597 : 1995 Calculation Procedure	**Temp**	**ACSR DOG MVCC**	**AAAC DOG MVCC**	**AL59ACS DOG MVCC**
Assumed Conditions for Calculations :	at 65°C	220	203	223
Ambient Temp = 40°C ,	at 70°C	245	225	247
Solar Absorption coefficient =0.8,	at 75°C	265	245	269
Emissivity Coefficient = 0.45,	at 80°C	285	264	290
Intensity of Solar Radiation = 1045 W/m2,	at 85°C	-	282	309
Wind Speed = 0.56 m/s.	at 90°C	-	-	327
	at 95°C	-	-	344
Power Transfer Capability in MW				
(Assumed Load Factor = 0.95)	**Op. Temp.**	**POWER TRANSFER IN 11KV level**	**POWER TRANSFER IN 11KV level**	**POWER TRANSFER IN 11KV level**
Power Transfer = (√3 * KV * 0.95 * * conductor Ampacity)	at 75°C	4.80	4.43	4.87
	at 80°C	5.16	4.78	5.25
	at 85°C	-	5.10	5.59
	at 90°C	-	-	5.92
	at 95°C	-	-	6.23
NET POWER TRANSFER USING SINGLE CONDUCTOR FOR SAME POWER TRANSFER				
Required Current capacity of conductor	Amperes	282	282	282
Operating temperature of conductor for required current transfer	°C	80	85.00	78.00
AC Resistance at above operating temperature	Ohm/Km	0.37	0.4430	0.3600
Total Units transferred (MWh/annum) = Total MW *No. of hours in a year*Availability factor (0.85)		38410	38410	38410
Power Loss kW/km = I^2*R (R= AC Resistance at max. operating temperature)		88.272	105.687	85.886
Power Loss MWh/km (per Anum) (With 85% Availability Factor)		657.27	786.95	639.51
Reduction in Power Loss MWh/km (per Anum)		0.00	-129.68	17.76
Additional revenue generation (in Rs./Km/Annum) due to saving in Power loss (1 unit = Rs.4.00)		**0**	**-518711**	**71056**
NET POWER TRANSFER AND ADDITIONAL REVENUE GENERATION USING SINGLE CONDUCTOR				
Operating temperature of conductor for required current transfer	°C	80	85.00	95.00
AC Resistance at above operating temperature	Ohm/Km	0.37	0.4430	0.3600
Total Units transferred (MWh) = Total MW *No. of hours in a year*Availability factor (0.85)		38410	38006	46362
Power Loss kW/km (per Anum)= I^2*R (R= AC Resistance at max. operating temperature)		90.160	105.687	127.803
Power Loss MWh/km (per Anum) (With 85% Availability Factor)		671.33	786.95	951.62
Total Power loss for 10 KM line (MWh)		6713.3	7869.5	9516.2
Net power transmission (MWh)		31696.7495	30136.2	36845.4
Additional power transfer in % w.r.t ACSR Conductor.		**100.0%**	**95.1%**	**116.2%**

Applicable Standards for Covered Conductors (CC) System

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 for Covered Conductors (CC) System

- 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 .

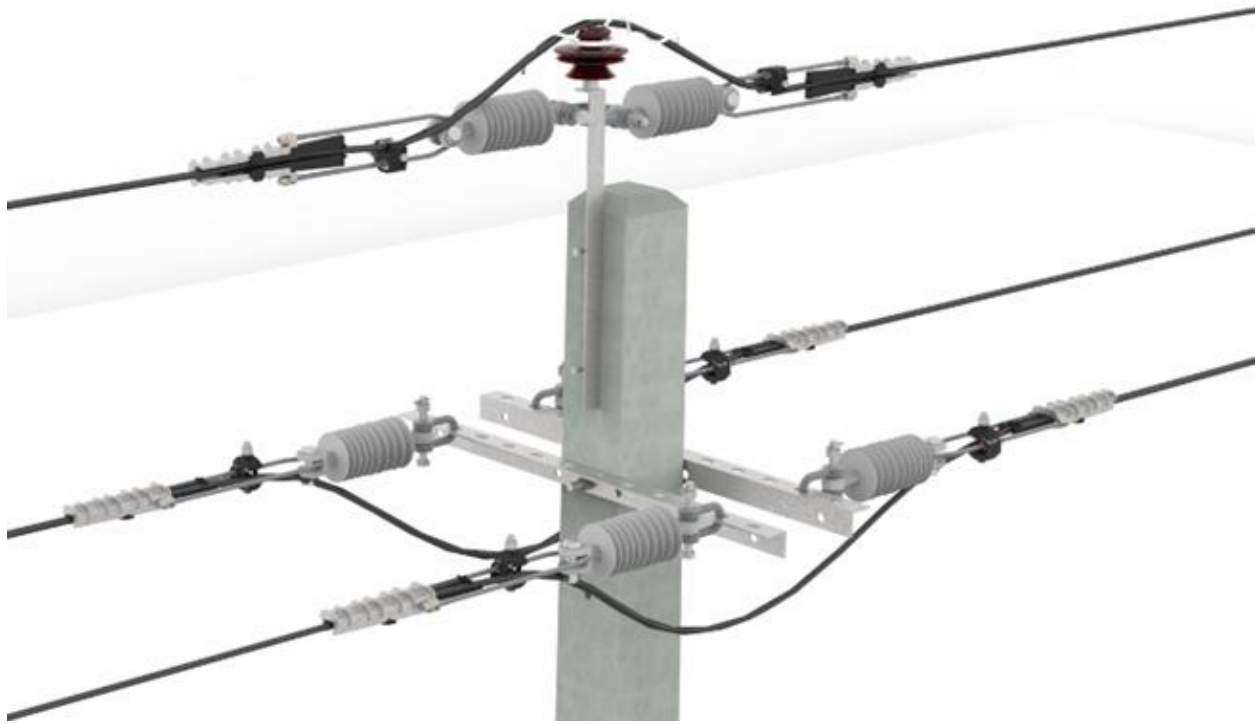
Advantages of AL59 ACS over conventional MVCC

- Lower operation and maintenance cost.
- Cheaper in Life cycle cost to underground cables and ABC cables
- Higher Mechanical Strength in comparison of AAAC & ACSR type conductor.
- AL59 ACS gives better Corrosion resistance as ACS Steel wire is protected by thick EC grade aluminium covering.
- AL59 ACS is having Higher operating temperature up to 95 °C for same Sag and to give better performance and upto 20-30 %higher current carrying capacity.
- AL59 ACS has less working tension as compared to AAAC and ACSR.
- AL59 ACS has lower power loss and higher power transfer capacity as compared to AAAC and ACSR

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



Tension Clamps
With Tracking resistance

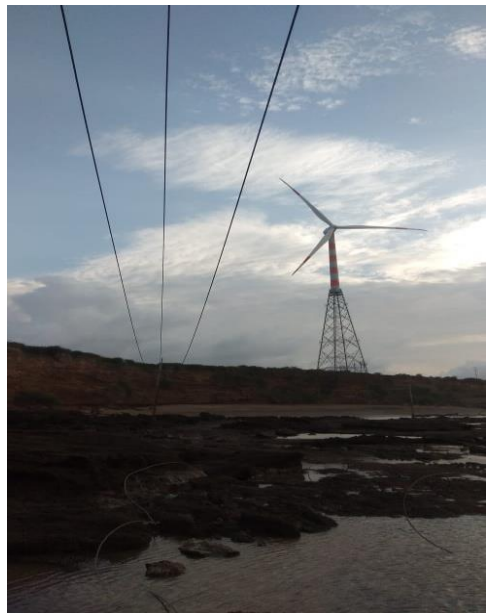
Alignment
Ties

Insulated
Suspension Clamps

Insulation Piercing
Connector

Mid Span
Joint

Snapshots of Challenges During MVCC Project Work

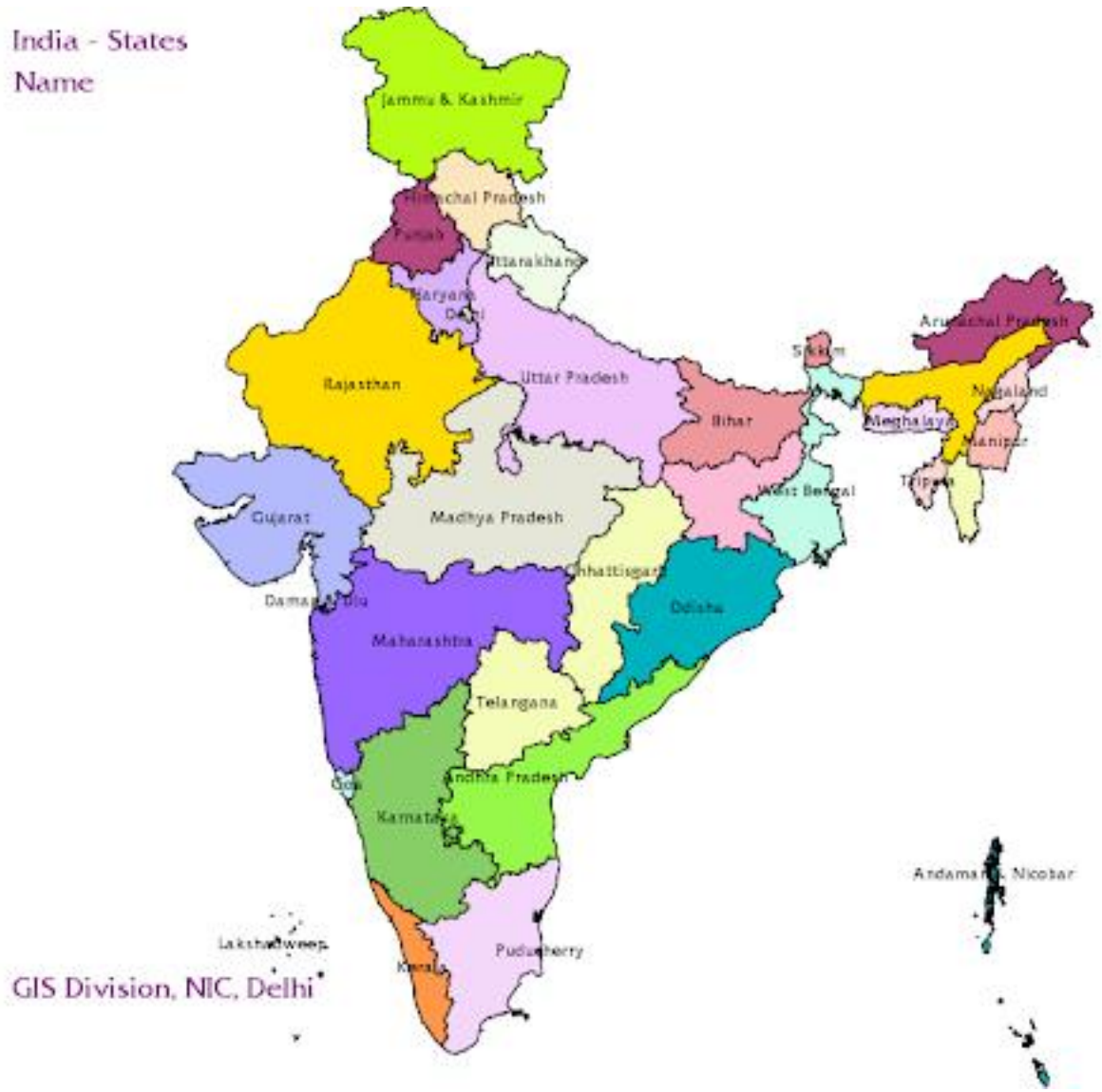


Highly Congested & Illegal Colonies

MVCC 66KV Installations

Below EHV Lines

MVCC Market Presence



MVCC Approved Descom

- TSECL
- APDCL*
- UPCL*
- SBPDCL*
- NBPDCL*
- MSEDCL
- MPMKVVCL*
- TSSPDCL
- TSNPDCL
- 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 *
- JKPDCL

THANK YOU

For discussions/suggestions/queries email: ***manish.patel@apar.com***

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Links/References (If any)

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THANK YOU

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Links/References (If any)