



Report of the Committee on Addressing Insulator Failures on Transmission Lines



**Government of India
Ministry of Power
Central Electricity Authority
May, 2026**



FOREWORD

Reliable operation of the power transmission system is essential to ensuring grid security and uninterrupted power supply. Insulators constitute a critical component of overhead transmission lines, ensuring electrical isolation and mechanical integrity under diverse and often harsh environmental conditions. Their performance has a direct bearing on system reliability, and their failures often result in forced outages, increased maintenance efforts, and operational challenges.

2. Analysis of recent transmission line outages across the country, including multiple incidents in EHV corridors, indicates that insulator failures are not sporadic but systemic with a rising trend often compounded by non-uniform practices across utilities, manufacturing and quality inconsistencies, inadequate alignment between insulator selection and site conditions, as well as deficiencies in storage, handling, installation, and maintenance practices. These issues underscore the need for a holistic review of design practices, specifications, and lifecycle management of insulators.

3. This Report presents an overview of various types of insulators, their failure patterns observed across utilities and regions, and the existing technical, quality assurance, and O&M practices. It identifies key gaps and suggests various measures including maintaining a centralised database of insulator failures at utility level for informed decision making, improvements required in the existing technical specifications for eliminating observed gaps in claimed life-times and actual life-times, and better storage & maintenance procedures for achieving assured/ requisite levels of insulators' performance in the field.

4. Implementation of the recommended measures is expected to result in a substantial reduction in transmission line outages, improved grid, optimization of operation and maintenance costs, and enhanced safety of personnel and assets. Their effective implementation by all stakeholders will be crucial in ensuring sustained performance of insulators and overall grid stability.

I commend the efforts of Sh. N.R.L.K. Prasad, Chief Engineer (PSE&TD Division), and his dedicated Team, in bringing out this Report.

(Ghanshyam Prasad)

New Delhi
04 MAY 2026

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Foreword

Insulator strings are essential components in high-voltage overhead transmission lines, providing both vital electrical insulation and mechanical support. As such their health is critical in ensuring that the concerned transmission line (s) remain in service to effect power transfer, and have a direct bearing on reliable grid operation. Further, in view of increasing network expansion into polluted, coastal, desert, and high-altitude regions, proper selection, testing, and operation and maintenance of insulators has become a strategic priority for utilities and policymakers. As such, their failures need to be viewed seriously, and systematic and systemic efforts shall be made to arrest the same.

In this backdrop, considering the Grid-India communication highlighting the issue of a significant number of transmission line outages across various regions in 2025 due to insulator failures, and the gaps noted in the field-level implementation and monitoring by transmission licensees, Central Electricity Authority (CEA) has constituted a Technical Committee to analyse insulator failure incidents across the transmission networks, identify root causes based on field data and stakeholder inputs, and recommend actionable measures to mitigate failures and enhance reliability.

The underlying causes have been identified to include environmental stress, material and manufacturing defects, inadequate electric field control due to improper design or absence of grading and corona rings, and operational issues such as improper installation and inadequate maintenance practices. Importantly, it has been observed that a large proportion of these failures are preventable and can be addressed through targeted interventions in design, specification, and quality assurance.

The report covers key aspects such as the role of insulators in transmission systems, analysis of failure incidents, technical specifications, quality assurance practices, storage & handling, and O&M procedures, along with suggested improvements. Going forward, the Committee recommends adopting a standardized and holistic approach towards selecting insulator technology to enhance the reliability of insulators across EHV transmission systems and to minimize future failures.

(Vijay Kumar Singh)



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Insulator failures have been a cause of concern in transmission networks for they make grid operate with reduced reliability levels due to associated line outages. With India's transmission network spanning lakhs of circuit kilometers across varied climatic zones, the reliability of insulators directly influences grid stability. As such, their failures need to be viewed seriously, and all efforts shall be made to address the root cause of their failures.

In this regard, the Technical Committee constituted under the Chairmanship of Member (Power System), CEA has attempted to address all pertinent aspects considering the ground realities w.r.t. all the available types of insulators. Specifically, it has suggested various measures to fixing the immediate issues concerning failure of composite insulators, for taking various quality control steps to eliminate the gaps between claimed life-times and observed life-times of various insulators, and for basing all decisions regarding selection, use & operation of various types of insulators on data-driven & evidenced-based decision making. Additionally, suitable guidelines have also been suggested in connection with Storage and O&M practices being followed by power utilities for enhancing the life of insulators.

I would like to express my sincere thanks to Grid-India, PGCIL, MPPTCL, MSETCL, and GETCO for sharing various details on Insulator failures, technical specification, quality assurance plans, storage, and O&M practices being followed. My sincere thanks are also extended to various Insulator Manufacturers, viz., M/s Deccan Enterprises, M/s Epsilon Asia Group, M/s Modern Insulators, and M/s Aditya Birla, for providing valuable inputs, and insights on Insulators' usage.

I gratefully acknowledge the contribution of PSE&TD Division Officers – Smt. Kavita Jha, Director, for smooth conducting of the Committee meetings & for providing technical insights, and Smt. Jyoti Singh, Deputy Director, and Sh. Amrendra Pratap Singh, Assistant Director-I, for their priceless contribution in enriching various details and in putting painstaking efforts in compiling the Report.

I am also thankful to Shri Ghanshyam Prasad, Chairperson, CEA and Shri V.K. Singh, Member (Power Systems), CEA for their encouragement, motivation, and invaluable guidance in preparation of this report.

(N.R.L.K. Prasad)



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List of Abbreviations

CEA – Central Electricity Authority
 EHV – Extra High Voltage
 ESDD – Equivalent Salt Deposit Density
 GETCO – Gujarat Energy Transmission Corporation Limited
 ISTS – Inter-State Transmission System
 MMR – Mumbai Metropolitan Region
 MPPTCL – Madhya Pradesh Power Transmission Company Limited
 MQAP – Model Quality Assurance Plan
 MSETCL – Maharashtra State Electricity Transmission Company Limited
 NLDC – National Load Dispatch Centre
 NSDD - Non-Soluble Deposit Density
 O&M – Operation and Maintenance
 OEM – Original Equipment Manufacturer
 PGCIL – Power Grid Corporation of India Limited
 RAISS – Remote Airborne Inspection & Scanning System
 ToR – Terms of Reference

Executive Summary

Insulators are critical components of overhead transmission lines, ensuring electrical isolation and mechanical integrity under diverse and often harsh environmental conditions. With India's transmission network spanning lakhs of circuit kilometers across varied climatic zones, the reliability of insulators directly influences grid stability.

Analysis indicates that insulator failures are not sporadic but systemic with a rising trend of failures with predominant failure modes such as Brittle Fracture, Flashover, Tracking and Erosion, Flash-under, FRP Decay, Shed Damage, Flash-Over, etc. These failures are further aggravated by environmental factors such as pollution, heavy rainfall, lightning, coastal conditions, and fog. The issue is also compounded by non-uniform practices across utilities, absence of standardized performance benchmarks, inadequate alignment between insulator selection and site conditions, manufacturing and quality inconsistencies as well as deficiencies in storage, handling, installation, and maintenance practices. These issues underscore the need for a holistic review of design practices, specifications, and lifecycle management of insulators.

These are also highlighted by Grid-India communication dated 06.10.2025, wherein the issue of a significant number of transmission line outages across various regions in 2025 due to insulator failures, including tripping of major 400 kV lines feeding Mumbai on 30-31 July 2025 on account of widespread polymer insulator failures, and the gaps in the field-level implementation and monitoring by transmission licensees have been pointed out with request to constitute a Committee with various stakeholders to address the issue holistically at national level.

Considering the significance of the matter, a Technical Committee (TC-Insulators) has been constituted vide CEA letter dated 29.10.2025 under the Chairmanship of Member (Power System), CEA comprising representatives from CEA, Grid-India, Power Utilities and OEMs with a mandate to analyse insulator failure incidents across the transmission network, identify root causes based on field data and stakeholder inputs, review prevailing technical specifications, testing, and O&M practices, and recommend actionable measures to mitigate failures and enhance reliability.

The Committee conducted two meetings on 19.12.2025 and 12.02.2026 to deliberate on all pertinent issues. The discussions focused around the Failure Statistics of various types of Insulators, Cross-Comparison of Various Tests generally Prescribed for Composite Insulators, Cross-Comparison of Various Tests generally Prescribed for Porcelain Insulators, Improvements in Technical Specification for Composite Insulators, Improvements in Technical Specifications for Porcelain Insulators, Format for Reporting various details of Insulator Failure Events, and Operation & Maintenance practices/ measures being specifically followed by Utilities to eliminate or reduce Insulator failures.

While porcelain insulators have a long-standing track record, their hydrophilic nature renders them susceptible to pollution-induced flashovers, necessitating their use with RTV coatings in polluted environs. Composite insulators, on the other hand, offer advantages in terms of lighter weight,

superior pollution performance, but their performance is highly dependent on design robustness, material quality, and manufacturing precision. Failures in composite insulators have been observed to be associated with issues such as degradation of the FRP core, loss of hydrophobicity, interface failures, and electric field stress concentration, particularly near end fittings.

Analysis of failure data furnished by NLDC, PGCIL, and various state transmission utilities (MPPTCL, MSETCL, GETCO) reveals clear trends and patterns. A significant proportion of failures—ranging from approximately 60% to 80%—occur during the monsoon period, indicating strong correlation with environmental stress conditions. Failures have been reported across voltage levels, including 220 kV, 400 kV, and 765 kV systems, and across utilities, thereby reinforcing the systemic nature of the issue. The underlying causes have been identified to include environmental stress, inadequate electric field control due to improper design or absence of grading and corona rings, material and manufacturing defects, and operational issues such as improper installation and inadequate maintenance practices. Importantly, it has been observed that a large proportion of these failures are preventable and can be addressed through targeted interventions in design, specification, and quality assurance.

Based on the deliberations held, and all relevant information made available, the Report has been structured to cover various pertinent aspects relating to Insulators in the following Chapters:

- *Usage of Insulators on Transmission Lines:* In this, a general survey w.r.t. their pros and cons of various types of insulators deployed in Indian grid has been presented.
- *Failure Details of Insulators on Transmission Lines:* In this, the general statistics of the insulator failures in the year 2025 as furnished by various Member-Utilities and Grid-India, along with reasons for their failures, and a Standard Format for reporting their failures, have been detailed.
- *Salient features of Technical Specification of various Insulators:* In this, the general technical parameters and associated tests, being followed by Utilities for both composite and porcelain insulators have been brought out.
- *Improving Technical Specification of various Insulators:* Technical specification for insulators define the essential design, material, electrical, mechanical, and environmental parameters required for safe and reliable power transmission, and ensure that the insulator can support conductor loads, prevent leakage currents, provide electrical isolation, and withstand operational voltages and environmental degradation. Therefore, some of the key areas where improvements in technical specifications are typically required for both composite and porcelain insulators have been brought out.
- *Salient features of Quality Assurance Plan for various Insulators:* A well-defined Quality Assurance Plan (QAP) is essential to ensure that Insulators consistently meet specified technical requirements, while also reducing failures, risks and lifecycle costs. It highlights that quality must be ensured from the initial stages through proper design, use of high-quality raw materials, controlled manufacturing processes and skilled workmanship, supported by systematic documentation at every stage. A Model Quality Assurance Plan (MQAP) for Composite Polymer Insulators has also been included for reference and for use by all transmission utilities with appropriate modifications.
- *Use of Corona Rings/ Grading Rings/ Arcing Horns for Insulator:* While Corona rings are used to eliminate corona discharge/noise, grading rings are used to normalize voltage distribution along insulators; further arcing horns are used to provide a safe flashover path to protect insulators

during lightning strikes or surges. Their primary function is to reduce electric stress at critical locations such as metal fittings and the insulator surface, thereby ensuring a more uniform potential distribution and minimizing corona discharge, radio interference, and localized heating. The requirement of corona ring and grading rings at different voltage levels has been clearly stated.

- *Storage & Handling Procedures for Insulators:* After considering the Storage & Handling Procedures being followed by Member-Utilities for various Insulators, the model guidelines, which can be adopted by the Utilities, for safe & reliable storage & handling of various Insulators, have been suggested.
- *Operation & Maintenance Practices for Insulators:* In this, the Operation & Maintenance Practices being followed by Member-Utilities for various Insulators have been considered, and based on the same, a few suggestions have been listed for appropriate consideration by all Utilities.
- *Decisions & Observations of the Committee:* Summing up the work carried out, the following have been addressed by the Committee, with suggestions under each head for implementation:
 - Reporting of Insulator Failures
 - Issues w.r.t. Porcelain Insulators and RTV Coatings and Composite Insulators
 - Factors Influencing Insulator Selection
 - Condition-Based Monitoring Framework
 - Improving Technical Specification of various Insulators
 - Improvements specific to Composite/ Polymer Insulators
 - Improvements specific to Porcelain Disc Insulators
 - Storage, Application, Installation & Handling of various Insulators, and
 - Way-forward

With the implementation of the suggestions given, it is hoped that the immediate issues concerning failure of composite insulators will be fixed, the technologies for various types of insulators are perfected to eliminate gaps between claimed life-times and observed life-times, all decisions regarding selection, use & operation of various types of insulators are based on data-driven decision making, proper Storage and O&M practices are adopted by all Utilities for enhancing the life of insulators.

Implementation of the recommended measures is expected to result in a substantial reduction in transmission line outages, improved grid stability particularly under adverse environmental conditions, optimization of operation and maintenance costs, and enhanced safety of personnel and assets. Overall, the adoption of a holistic and systematic approach to insulator management will play a crucial role in supporting the reliable and efficient operation of the country's expanding high-voltage transmission network.



1. Introduction

1.1 Background

Insulator strings are essential components in high-voltage overhead transmission lines, providing both vital electrical insulation and mechanical support. They safely hold conductors away from metal towers, preventing short circuits to ground. Their modular design (multiple discs) allows them to handle high voltages and heavy mechanical tension. As such their health is critical in ensuring that the concerned transmission line (s) remain in service to effect power transfer, and have a direct bearing on reliable grid operation. Their failures not only result in operating the grid at reduced reliability levels, but also have huge costs as they almost always necessitate taking line outages for longer durations to address the issue including their replacement. As such, their failures need to be viewed seriously, and systematic and systemic efforts be made to arrest the same.

In this connection, Grid-India vide letter dated 06.10.2025 (**Annexure-I**) has highlighted the issue of a significant number of transmission line outages across various regions in 2025 due to insulator failures, including tripping of major 400 kV lines feeding Mumbai on 30-31 July 2025 on account of widespread polymer insulator failures, leading to multiple forced outages and stressed grid conditions in Mumbai Metropolitan Region (MMR). Highlighting the gaps in the field-level implementation and monitoring by transmission licensees, and in their compliance with relevant CEA Regulations, Grid-India has requested to constitute a Committee with various stakeholders to address the issue holistically at national level.

1.2 Committee Constitution

Considering the significance of the matter, a Committee has been constituted vide CEA letter dated 29.10.2025 (**Annexure-II**) under the Chairmanship of Member (Power System), CEA comprising the following members:

1.	Sh. V. K. Singh, Member (Power System), CEA	Chairman
2.	Sh. N.R.L.K Prasad, Chief Engineer (PSE&TD), CEA	Member
3.	Sh. Mohammad Anisur Rahman, DGM (CC/Engg - TL), PGCIL	Member
4.	Sh. Suhas Dambhare, Chief General Manager (SO), Grid India	Member
5.	Sh. Anil Bharsakle, Chief Engineer (Tr.O&M), MSETCL	Member
6.	Sh. Yogesh Chavan, Superintending Engineer (Tr.O&M), MSETCL	Member
7.	Sh. P.R.Vasava, Executive Engineer, GETCO	Member
8.	Sh. Vinay Kumar Parwar, Superintending Engineer, MPPTCL	Member
9.	Sh. Vikas Jalan, MD, M/s Deccan Enterprises	Member
10.	Sh. D. Mukherjee, President, M/s Deccan Enterprises	Member
11.	Sh.Vineeth Pachava, Manager technology, M/s Deccan Enterprises	Member
12.	Sh. Chandan Banerjee, Regional Head South-East Asia & India (North), M/s Aditya Birla	Member
13.	Sh. N.V. Ramkumar, Sr. V.P. (Tech. & Dev.), M/s Modern Insulators	Member
14.	Dr. Sudalai Shunmugam, Jt. Vice President, M/s Modern Insulators	Member
15.	Sh. Ashish Tripathi, Manager- Design, M/s Modern Insulators	Member
16.	Smt. Kavita Jha, Director (PSE&TD), CEA	Convener
17.	Sh. Neelesh Arora, CEO, Epsilon Asia Group	Special Invitee

1.3 Terms of Reference (ToR) of the Committee

ToR of the Committee are as under:

- a) The Committee shall examine the incidents of insulator failures in order to conduct a comprehensive root cause analysis to find out the reasons of insulator failures.
- b) The Committee shall recommend remedial measures to avert such failures in future.

1.4 Proceedings of the Committee

In order to address the issue holistically and to factor in the views of all stakeholders, the Committee has included as its members the OEMs of both the extremes (Porcelain/ Glass Insulators, Polymer Insulators; and also of RTV Coatings as special invitee), and the following Power Utilities (i) having networks reflective of cross-section of Indian transmission operating conditions, and (ii) the observed failure patterns in whose networks are representative of general operating conditions across India:

- GETCO (Gujarat): Represents coastal and semi-arid inland conditions — high pollution, salt spray, industrial and agricultural environments.
- MSETCL (Maharashtra): Represents industrial, coastal and Deccan plateau environments — diverse pollution profiles.
- MPPTCL (Madhya Pradesh): Represents inland, agrarian and mixed-pollution zones — continental climate extremes.
- PGCIL: Represents the national inter-state transmission backbone — spanning all climate zones across India.
- Adani Transmission and Indigrid: Two leading private TSOs with pan-India presence and significant 400/765 kV exposure.

The Technical Committee constituted to address the issue of frequent transmission line outages on account of Insulator failures (TC-Insulators) conducted two meetings to deliberate on all pertinent aspects.

The first meeting of the Committee was held on 19.12.2025, wherein detailed presentations on the subject matter were made by Grid-India, M/s Deccan, and M/s PGCIL covering issues such as overview of Insulator failure incidents in 2025, analysis & review of technical specification of various insulators, and on the corrective measures to be taken. As all the sought details required to address the insulator failures have not been presented to the Committee, the Member-Utilities and the Member-OEMs have been requested to furnish the required pending details to CEA for appropriate assimilation. Minutes of the meeting issued vide PSE&TD letter dated 26.12.2025 are given at **Annexure-III**.

The second meeting of the Committee was held on 12.02.2026, wherein detailed presentations on the subject matter were made by MPPTCL, MSETCL, PGCIL, Grid-India, M/s Modern Insulators, M/s Epsilon Asia Group (attended as Special Invitee), M/s Aditya Birla, and M/s Deccan. The discussions focused around the Failure Statistics of various types of Insulators, Cross-Comparison of Various Tests generally Prescribed for Composite Insulators, Cross-Comparison of Various Tests generally Prescribed for Porcelain Insulators, Improvements in Technical Specification for



Composite Insulators, Improvements in Technical Specifications for Porcelain Insulators, Format for Reporting various details of Insulator Failure Events, and Operation & Maintenance Practices/ measures being specifically followed by Utilities to eliminate or reduce Insulator failures. After deliberations, the Member-Utilities and the Member-OEMs have been requested to furnish certain additional details to CEA for use in preparing the Draft Report of the Committee. Minutes of the meeting issued vide PSE&TD letter dated 05.03.2026 are given at **Annexure-IV**.

Based on the deliberations held, and all relevant information made available, the Report has been structured to cover the following aspects:

- Usage of Insulators on Transmission Lines
- Failure Details of Insulators on Transmission Lines
- Salient features of Technical Specification of various Insulators
- Improving Technical Specification of various Insulators
- Salient features of Quality Assurance Plan for various Insulators
- Use of Corona Rings/ Grading Rings/ Arcing Horns for Insulator
- Storage & Handling Procedures for Insulators
- Operation & Maintenance Practices for Insulators
- Decisions & Observations of the Committee

Ensuing Chapters discuss the above in sufficient detail.

2. Usage of Insulators on Transmission Lines

2.1 General

In Transmission lines (both inter-state and intra-state), insulators are a fundamental component of the high-voltage overhead network that ensures safe and reliable transfer of electrical power. Insulators primarily serve two functions in the transmission grid:

- **Electrical insulation**- by preventing leakage currents between energized conductors and grounded structures.
- **Mechanical support**- by carrying the weight of conductors and resisting environmental loads such as wind and ice.

Given the breadth of the transmission infrastructure, which spans hundreds of thousands of circuit-kilometers at various voltage levels such as 66 kV, 132 kV (110 kV), 220 kV, 400 kV, and 765 kV, a substantial number of insulator strings are deployed on lattice towers, pole structures, and substation equipment throughout the system. Suspension insulator strings are the most common configuration on transmission lines, with the number of units per string increasing with voltage level to provide appropriate mechanical and electrical performance. However, Tension insulators are installed wherever the conductor is subjected to high mechanical pulling forces, such as angle / deviation towers, dead-end towers, river crossing / long span towers, railway / highway crossing towers, sectioning locations and locations with heavy wind load or high conductor tension, etc.

Based on the materials used, insulators can be categorized into the following three types:

- **Inorganic type:**
 - **Porcelain Insulators, and**
 - **Toughened Glass Insulators**
- **Organic type**
 - **Composite (Polymer) Insulators**

Historically, porcelain insulators have comprised the largest share of the installed base due to their long-standing use, robust dielectric properties, excellent resistance to UV radiation without any additives, and established performance record. Glass insulators, known for their excellent mechanical strength and visible fracture detection are used in specific applications. Further, by employing RTV Coatings, performance of both porcelain and glass insulators can be improved under polluted environs. Composite insulators—which consist of a fiber-reinforced core with hydrophobic polymeric housing—are increasingly used in transmission projects because of their lighter weight, superior pollution resistance, and expected improved performance in coastal and highly contaminated environments.

In service, insulators are subjected to four broad categories of stresses, viz., thermal stresses (temperature cycling, solar heating); environmental stresses (UV exposure, pollution, acid rain, moisture); physical stresses (bird contact, sand storms, vandalism); and mechanical stresses (conductor tension, wind and ice loading, vibration). The suitability of any specific insulator type for a given application is governed by its ability to withstand the combined effect of these stresses over the expected service life.

As each type of insulator has its own advantages and limitations, a general survey w.r.t. their pros and cons is presented in the following paras.

2.2 Porcelain Insulators

Advantages:

- Inorganic material: Ageing / degradation over time is insignificant
- Proven technology (60+ years track record)
- Lesser hydrophobicity degradation concern
- No decapping, cracking issues with porcelain long rod insulators.
- Suitable in clean, low-medium pollution environments and sub-station applications with low deflection values
- High compressive strength for post/station applications
- Resistant to UV and surface tracking
- Visual inspection possible for surface damage
- Self-shattering provides visible failure indication
- Long service life (> 30 years)
- Low replacement and maintenance frequency in Low–Medium pollution areas.
- Predictable mechanical performance; high thermal stability and stable “Useful Life” phase
- Minimal failures under high tensile load.
- Inorganic material and therefore does not undergo ageing from electrical or environmental stress
- Does not react with Non-Soluble Deposit Density (NSDD).

Disadvantages/ Limitations:

- Hydrophilic surface and therefore not ideal for pollution environments.
- 3-3.5 times heavier than composite insulators making it difficult and expensive to install at site
- Frequent washing/ Mandatory RTV coating for use in polluted environs.
- Explosion/shattering risk on overload — severe safety hazard
- Brittle in nature, prone to cracking during transportation and installation
- Susceptible to cement growth and pin corrosion
- Lower vandalism resistance
- De-capping, crack, flashover with porcelain disc insulators. High risk of pollution flashover in H/VH/coastal zones

2.3 Glass Insulators

Advantages:

- Transparent for visual inspection
- Self-shattering on failure (easy faulty unit identification)
- Proven UV stability

Disadvantages/ Limitations:

- Poor hydrophobicity, comparable to porcelain
- Prone to vandalism

2.4 Composite/ Polymer Insulators

Advantages:

- 60% lighter than Porcelain leading to significant Tower, foundation and erection saving
- Superior Hydrophobicity, i.e., excellent self-cleaning, transfers to pollution layers
- High mechanical strength to weight ratio
- Lesser maintenance- eliminating the need for frequent washing, RTV coating
- Compact Design, high tensile strength and good dielectric performance
- Vandal resistant, i.e., fiberglass core resists impact
- No explosion/ brittle shattering
- Good seismic performance due to low weight and flexibility
- Claim to possess service life of 25 years
- Multiple Indian manufacturers with competitive pricing to meet the transmission line and sub-station targets of India

Disadvantages/ Limitations:

- Organic material: Prone to ageing and degradation
- Susceptible to tracking, erosion and hydrophobicity loss over time
- Difficult to assess condition visually and therefore for surface condition monitoring requires UV camera or leakage current meter
- Silicone sheath integral to SRI housing. Silicone EOL will result in insulator destruction
- Highly dependent on manufacturing quality, including material formulation, bonding, and process control
- Not recommended for mechanical loads above 420 kN without special design
- Requires proper end-fitting and grading ring design to control electric field and prevent corona discharge
- Handling, Storage and installation are critical—improper practices can cause internal defects (e.g., micro-cracks) leading to brittle fracture of the FRP core

2.5 Comparative Details of Various Types of Insulators

Parameter	Composite (Polymer) Insulators	Porcelain Insulators	Glass insulators
Material	Organic: Prone to ageing and degradation	Inorganic: Ageing / degradation over time is insignificant	Inorganic: Ageing / degradation over time is insignificant
Weight	Very light (~60% lighter than porcelain)	Heavy (3-3.5 times heavier than composite)	Heavy (similar to porcelain)
Tower/ Foundation Requirement	Lower tower loading - savings in tower, foundation & erection	Higher loading - higher tower/ foundation cost	Similar to Porcelain
Pollution Performance	Excellent due to hydrophobic surface	Poor due to hydrophilic Surface	Poor (similar to porcelain)
Hydrophobicity	High, self-cleaning and transfers to pollution layer	Nil / poor (hydrophilic)	Nil / poor (hydrophilic)

Flashover Risk in Coastal / Industrial Zones	Low	Relatively High	Relatively High
Maintenance Requirement	Claimed to be Low (no frequent washing / RTV)	High (frequent washing + Mandatory RTV coating)	High (washing required)
Service Life claimed	~25 yrs	30–40 yrs	30–40 yrs (typically)
Mechanical Strength	High strength-to-weight ratio, but limitations above 420 kN without special design	High, suitable for heavy mechanical loads	Very high mechanical strength
Failure Mode	No shattering	Can shatter under overload	Self-shattering
Safety (Personnel Risk)	High safety (no explosion/shattering)	Safety risk due to shattering	Moderate (self-shattering, but risk of fragments)
Vandalism Resistance	Good (fiberglass core resists impact)	Moderate resistance	Highly prone to vandalism
Condition Monitoring	Difficult visually: needs UV camera / leakage current monitoring	Visual inspection possible	Very easy due to transparency and self-shattering
Corona / Hardware Sensitivity	Needs careful hardware design to avoid corona	Comparatively less sensitive	Comparatively less sensitive
Tracking	Susceptible to tracking, aging, hydrophobicity loss	Resistant to UV and surface tracking	UV stable, but pollution performance poor
Transportation/ Handling Risk	Can be damaged if mishandled (core/sheath damage)	Brittle, prone to cracking	Brittle, prone to breakage
Installation	Easier than ceramic but requires care during handling to prevent damages	Difficult: Requires careful handling especially when parallel strings	Difficult: Requires careful handling especially when parallel strings
Creepage Requirements per kV	Compact design, shorter string possible	Requires longer string	Similar to porcelain
Life Cycle Cost (LCC)	Lower costs over its claimed full life time	Higher costs in harsh zones	High (similar to porcelain)
Initial Cost	Moderate	High	Moderate to high
Availability / Supply Chain in India	Many manufacturers, good availability	Limited suppliers, longer lead time	Limited and selective usage
Recycling / End-of-Life	Recycling ecosystem still developing	Mature disposal practices	Mature disposal practices



Best Application	Suitable		
	Coastal, industrial, desert, heavy pollution zones	Clean/low and medium pollution zones, substations, station post applications. Special insulator profiles & insulators with RTV coatings are suitable for highly contaminated environment	Selective use where visual defect detection is preferred

3. Failure Details of Insulators on Transmission Lines

As insulators are important building blocks of transmission infrastructure, statistics w.r.t their failures need to be captured in sufficient detail to enable data-driven and evidence-based decision making w.r.t. their procurement, installation (replacements), operation & maintenance, etc. that have a bearing on their life cycle costs.

In this connection, the general statistics of the insulator failures in the year 2025 as furnished by various Member-Utilities and Grid-India, along with reasons for their failures, and a Standard Format for reporting their failures, are detailed in the subsequent paras.

3.1 General Statistics

The details of Insulator failures in the year 2025 at various voltage levels as reported by Member Utilities and Grid-India for the networks under their respective jurisdiction are as follows:

- **Grid-India:** NLDC furnished their inputs with respect to the Insulator Failure Analysis pertaining to transmission line outages caused due to insulator failures in the networks of IndiGrid & Adani. A total of 68 incidents reported during 2025 were analyzed. The salient points of the same are summarized below:
 - 58 incidents (85%) pertained to 765 kV lines and rest 10 incidents (15%) pertained to 400 kV lines.
 - 42 incidents (62%) occurred during the monsoon period.
 - In terms of reasons of failure, insulator puncture/tracking and broken insulators constituted a significant share of 24% of the incidents, while cases of FRP-rod brittle fracture were also observed.
- **PGCIL:** PGCIL furnished details of total of 79 nos. of line outages caused due to insulator failure in their ISTS grid for the year 2025 (**Annexure-V**). The salient points of the reported incidents are as under:
 - 16 incidents (20%) pertained to 765 kV lines, 59 incidents (75%) pertained to 400 kV lines and 4 incidents (5%) pertained to 220 kV lines
 - 65 incidents (82%) reported during the rainy season.
- **MPPTCL:** MPPTCL furnished details of total of 155 nos. of line outages caused due to insulator failure in the transmission system under their jurisdiction for the year 2025 (**Annexure-VI**). The salient points of the reported incidents are as under:
 - 7 incidents (4%) pertained to 400 kV lines and 49 incidents (32%) pertained to 220 kV lines and 99 incidents (64%) pertained to 132 kV lines
 - 86 incidents (55%) pertained to porcelain insulators and 69 incidents pertained to composite insulators
 - 109 incidents (70%) reported during the monsoon season.
 - Cumulative composite insulator failures during 2015–2025 were reported as 176 Nos., of which nearly 39% occurred in 2025.

- **MSETCL:** MSETCL furnished details of total of 241 nos. of line outages caused due to insulator failure in the transmission system under their jurisdiction for the year 2025 (**Annexure-VII**). The salient points of the reported incidents are as under:
 - 45 incidents (18.4%) pertained to 400 kV lines and 180 incidents (73.8%) pertained to 220 kV lines, 4 incidents (1.6%) pertained to 132 kV lines, 9 incidents (3.7%) pertained to 100 kV lines and 6 incidents (2.5%) pertained to 500 kV lines.
 - 213 failures of porcelain (87.3%), 30 failures of composite insulators (12.3%), 1 incident pertained to glass insulator.
 - 137 incidents (56%) reported during the monsoon/ rainy season.
- **GETCO:** GETCO furnished details of total of 274 nos. of line outages caused due to insulator failure in the transmission system under their jurisdiction for the year 2025 (**Annexure-VIII**). The salient points of the reported incidents are as under:
 - 37 incidents (14%) pertained to 400 kV lines and 233 incidents (85%) pertained to 220 kV lines, 2 incidents pertained to 132 kV lines and 2 incidents pertained to 66 kV lines
 - 24 incidents (9%) pertained to porcelain insulators and 250 (91%) incidents pertained to composite insulators
 - 189 incidents (77%) reported during the monsoon/ rainy season.

3.2 Reasons for Insulator Failures

Considering the details of Insulator failure furnished by various utilities, and their analysis carried out in the 2nd meeting of the Committee held on 12.02.2026 (Minutes at **Annexure-IV**), possible reasons of insulator failure for different categories of Insulators are noted as follows:

3.2.1 Composite/ Polymer Insulators

A summary of the reported reasons of failure in Composite/ Polymer Insulators is given below:

- Raw Material & Manufacturing defect
- Improper design w.r.to climatic conditions
- Loss of hydrophobicity of silicone housing
- Decay like fracture characterized by surface pulverization of the core rod, fiber-matrix debonding and a brittle wood like texture at the fracture site
- Electric Field Stress & Hardware- Insulator Incompatibility
- Flash-under/rod break
- Stress corrosion cracking (SCC) of glass-fiber core due to acid ingress through degraded end-fitting seals or housing-core interface.
- Loss of end fitting by pullout
- Severe climatic conditions such as heavy rain, dense fog conditions,
- Pollution & Moisture
- Cyclonic environmental conditions
- Lightning & External Overvoltage

- Storage related issues
- Application, Installation & Handling Errors

It is observed that most of the failures are associated with identifiable and preventable causes linked to specification gaps or deviations in implementation. Failures are primarily associated with improper material selection, non-adherence to SoP, inadequate systems & procedures. The Committee has noted that environmental factors such as rainfall, lightning and pollution play a significant role in influencing insulator performance. It has been further emphasized that the integrity of the interface between the FRP rod, housing and end fitting is critical to the long-term reliability of composite insulators, and that electric field stress concentration near the high-voltage end requires focused design attention.

3.2.2 Porcelain Insulator

A summary of the reported reasons of failure in Porcelain Insulators is given below:

- Insulator disc flashover
- Failure of insulator strings
- Manufacturing defects
- De-capping
- Bird-related faults, and
- Ageing effects

3.3 Standard Format for Reporting Insulator Failures

It has been observed that presently there exists no standard format for reporting insulator failure events, in which all required failure details are captured. Accordingly, a uniform format for reporting insulator failures has been proposed to ensure uniformity, clarity, and completeness of information across utilities and regions. A standardized format for reporting insulator failures is essential to ensure uniformity, clarity, and completeness of information across utilities and regions. It enables systematic documentation of failure details such as location, type of insulator, environmental conditions, and mode of failure, which facilitates effective root cause analysis.

Such a format also supports the creation of a centralized database, helping in identifying recurring issues, manufacturing defects, or design inadequacies. This, in turn, aids in improving quality control, maintenance planning, and selection of appropriate insulators for specific operating conditions. Additionally, consistent reporting enhances coordination among utilities, manufacturers, and regulatory bodies, leading to improved reliability and safety of the transmission system.

In this regard, a Standard Format for reporting Insulator failures, incorporating above requirements, is given at **Annexure-IX** for use by all Transmission Utilities.

4. Salient features of Technical Specification of various Insulators

Insulators used in transmission lines are designed to provide **high electrical insulation, mechanical strength, and environmental durability**. Technical specifications for insulators (porcelain, glass, or polymeric) should comprehensively cover electrical performance, mechanical strength, material quality, environmental resistance, and testing standards. Key requirements include voltage ratings, creepage distance, tensile/cantilever load ratings, galvanization standards, and conformity to international standards such as IEC 60383, IEC61109, IEC 60720, etc.

4.1 Composite/ Polymer Insulators

4.1.1 General

- The Polymer insulator shall be suitable for a three phase 50 Hz, effectively earthed transmission system. They shall be ball and socket type.
- They shall be capable of sustained operation in polluted atmosphere typical of the areas in which they are proposed to be used.
- Polymer Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc., and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC-60815/IS : 13134
- Dimensional Tolerance of Composite Insulators- The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with-IEC 61109:

$\pm (0.04d + 1.5)$ mm when $d \leq 300$ mm

$\pm (0.025d + 6)$ mm when $d > 300$ mm with a maximum tolerance of +10 mm

Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be. However, no negative tolerance shall be applicable to creepage distance.

4.1.2 Principal Technical Parameters

(i) Up to 400 kV Transmission Line:

SN	Particulars	Value					
		400 KV POLYMER INSULATORS		220 KV POLYMER INSULATORS		132 KV POLYMER INSULATORS	
		Suspension	Tension	Suspension	Tension	Suspension	Tension
i	Power frequency one minute dry withstand voltage kV (rms)	720	720	510	510	325	325
ii	Power frequency one minute wet withstand voltage kV (rms)	680	680	460	460	275 (140 for 66 kV)	275 (140 for 66 kV)
iii	Visible discharge Test voltage kV (rms)	266	266	154	154	105	105
iv	Minimum dry impulse withstand voltage 1.2x50 micro second wave, positive and negative k V (Peak)	1550	1550	1050	1050	650 (350 for 66 kV)	650 (350 for 66 kV)

v	Dry Arcing distance (mm)	3050	3050	1800	1800	1200	1200
vi	Corona extinction Voltage (kV rms)	320	320	176	176	105	105
vii	Maximum RIV for complete string Including corona Ring, arcing horn, clamp etc. at 1.1 times max. line to Ground Voltage (microV)	500	500	500	500	-	-

(ii) 765 kV Transmission Line

Sl. No.	Description	Unit	Standard Technical Particular Value			
			Double 'I' Suspension	Single 'I' Suspension Pilot	Single Tension	Quadruple Tension
1.0	No. of Insulator Units	Nos.	2 x 2	1 x 2	1 x 2	4 x 2
2.0	pf withstand voltage under wet condition	kV (rms)	830			
3.0	Switching withstand voltage (dry)					
a)	Positive (Peak)	kVp	1550			
b)	Negative (Peak)	kVp	1550			
4.0	Impulse withstand voltage (dry)					
a)	Positive (Peak)	kVp	2400			
b)	Negative (Peak)	kVp	2400			
5.0	Dry Arcing distance	mm	5100			

Note:

The values given above are minimum which apply to all cases. Specified withstand and flashover voltages are referred to standard atmospheric conditions.

4.1.3 Associated Tests

- The typically used Type Tests, Acceptance Tests, and Tests carried out during Manufacturing on Composite long-rod Insulator units are as under:

(i) Type Tests:

SN	Test Name
	On Composite Insulator Units
1	Tests on interfaces and connections of metal fittings
2	Assembled core load time test
3	Damage limit proof test and test of tightness of interface between end fittings and insulator housing.
4	High Pressure washing test
5	Brittle fracture resistance test
6	Dye penetration test
7	Water diffusion test
8	Tracking and erosion test
9	Hardness test
10	Accelerated weathering test

11	Flammability test
12	Silicone content test
13	Recovery of Hydrophobicity test & Corona test
14	Torsion test
15	Ozone Resistance test
16	Water diffusion test followed by pull-off test
17	Shear Test
	On the complete Composite Long Rod Insulator String with Hardware Fittings
17	Power frequency / DC voltage withstand test with corona control rings/grading ring and arcing horns under wet condition
18	Switching surge voltage withstand test under wet condition (applicable for 400kV & above voltage level)
19	Impulse voltage withstand test under dry condition
20	Corona (AC/ DC) and RIV test under dry condition (applicable for 400kV & above voltage level)
21	Mechanical Strength test
22	Vibration test
23	AC Salt-fog pollution withstand test/ DC Pollution withstand test

(ii) Acceptance Tests:

SN	Test Name
1	Verification of dimensions
2	Galvanising test
3	Verification of end fittings
4	Recovery of Hydrophobicity
5	Verification of tightness of interface between end fittings and insulator housing and of specified mechanical load
6	Tests on interfaces and connections of metal fittings
7	Silicone content test
8	Brittle Fracture Resistance Test
9	Dye Penetration Test
10	Water Diffusion Test
11	Hardness test
12	Water diffusion test followed by pull-off test
17	Shear Test

(iii) Tests during Manufacturing:

SN	Test Name
1	Chemical analysis of zinc used for galvanizing
2	Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.
3	Chemical analysis hardness tests and magnetic particle inspection for forgings
4	Tracking and erosion test on insulating material

4.2 Porcelain Insulators

4.2.1 Principal Technical Parameters for Porcelain Disc/ Porcelain Long-Rod Insulators up to 400 kV

SN	STRING TYPE (→) PARTICULARS (↓)	N- Nor- mal; AF- Anti- Fog	SUSPENSION			TENSION		
			400 KV	220 KV	132 KV	400 KV	220 KV	132 KV
1	Switching Surge Withstand Voltage (Dry & Wet) (kVp)	N	1050	--	--	1050	--	--
		AF	1050	--	--	1050	--	--
2	Dry Lightning Impulse Withstand Voltage (kVp)	N	1600	1050	650	1700	1050	675
		AF		1080	670		1110	690
3	50% Lightning Impulse flashover voltage (kVp)	N	1650	1100	680	1770	1100	710
		AF		1130	700		1125	720
4	Dry Power frequency withstand voltage (kV ms)	N	740	510	335	740	550	375
		AF		520	365		570	380
5	Wet Power frequency withstand voltage (kV rms)	N	690	460	300	690	500	350
		AF		480	330		520	360
6	Corona extinction Voltage (kV rms)	N	320	176	105	320	176	105
		AF	320	176	105	320	176	105
7	Maximum RIV for complete string Including corona Rings, arcing horns, clamps etc. at 1.1 times max. Line to Ground Voltage (micro Volts)	N	500	500	--	500	500	--
		AF	500	500	--	500	500	--
8	Maximum voltage across any disc	N	9%	13%	--	10%	13%	--
		AF	9%	13%	--	10%	13%	--

4.2.2 Standard Technical Particulars for Standard Disc Insulators for 765 kV line

SN	Description	Unit	Standard Technical Particular value		
			120 KN Disc Insulator	160 KN Disc Insulator	210 KN Disc Insulator
1.0	General				
a)	Size and Designation of pin ball shank	mm	20 as per IS 2468/ IEC 120	24 as per IS 2468/ IEC 120	24 as per IS 2468/ IEC 120
2.0	Dimensions				
a)	Diameter of disc	mm	255/ 280	280	280
b)	Tolerance on Diameter	± mm	11.0 / 13.0	13.0	13.0
c)	Ball to ball spacing between Disc	mm	145	170	170
d)	Tolerance on spacing	± mm	4	5	5
e)	Minimum nominal creepage distance of single disc	mm	370	370	370
3.0	Materials				
a)	Colour of glaze of finished porcelain insulator		Brown	Brown	Brown
b)	Type of Porcelain in case of porcelain insulator with % Alumina contents(min)		Alumina: 30 %	Alumina: 30 %	Alumina: 30 %
4.0	Electromechanical Strength of disc	KN	120	160	210
5.0	Minimum electrical values				
a)	Power frequency Flashover voltage DRY / WET	kV (rms)	75 / 45	78 / 48	78 / 48
b)	Power frequency Withstand voltage DRY / WET	kV (rms)	70 / 40	72 / 42	72 / 42
c)	Impulse Flashover test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV (peak)	115 / 120	120 / 125	120 / 125
d)	Impulse Withstand test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV (peak)	110 / 110	115 / 115	115 / 115
e)	Steepness of impulse voltage (steep wave front test)	kV/us	2500	2500	2500
6.0	Power frequency puncture voltage	kV (rms)	120	125	125
7.0	Minimum Visible discharge voltage of single disc (dry)	kV (rms)	18	18	18
8.0	Maximum RIV at 1 MHZ and 10kV AC (rms) voltage of single disc	Micro-volts	50	50	50

SN	Description	Unit	Standard Technical Particular value		
			120 KN Disc Insulator	160 KN Disc Insulator	210 KN Disc Insulator
9.0	Eccentricity of disc				
a)	Max. radial run out	mm	7.65/ 8.4	8.4	8.4
b)	Max. axial run out	mm	10.2/ 11.2	11.2	11.2

4.2.3 Associated Tests

- The typically used Type tests, Acceptance Tests and the Tests carried out during Manufacturing on Porcelain Disc Units/ Porcelain Long-Rod Insulators are as under:

(i) Type Tests:

SN	Test Name
	On Unit Disc Insulators
1	Verification of dimensions
2	Power frequency voltage withstand and flashover test under (i) dry & (ii) wet condition
3	Impulse voltage withstand and flashover test (dry)
4	Visible Discharge test (dry)
5	RIV test (dry)
6	Impact Test (For Disc Insulators only)
7	Thermal mechanical performance test
8	Residual strength Test (For Disc Insulators only)
9	Steep wave front Test (For Disc Insulators only)
	On Complete Insulator String
10	Power frequency voltage withstand test with corona control rings/grading ring and arcing horns under wet condition
11	Switching surge voltage withstand test under wet condition (for 400 kV & above voltage level line only)
12	Impulse voltage withstand test under dry condition
13	Voltage distribution test (for disc insulators only)
14	Corona and RIV test under dry condition (for 400 kV & above voltage level line only)
15	Mechanical Strength test
16	Vibration test
17	Power Arc Test (for 400 kV voltage level line only)

(ii) Acceptance Tests:

SN	Test Name
1	Visual examination
2	Verification of dimensions
3	Temperature cycle test
4	Galvanising test
5	Mechanical performance test
6	Test on locking device for ball and socket coupling
7	Eccentricity test
8	Residual Strength Test (for disc insulators only)
9	Metallurgical Test (For metal fittings only in black condition)

10	IR Measurement (for disc insulators only)
11	Impact Test (for disc insulators only)
12	Steep Wave front test (for disc insulators only)
13	Thermal Mechanical performance test
14	Electro-mechanical strength test (for porcelain disc insulators)
15	Porosity test (for porcelain insulators)
16	Puncture test (for porcelain disc insulators only)

(iii) Tests during Manufacturing:

SN	Test Name
1	Verification of dimensions
2	Power frequency voltage withstand and flashover test under (i) dry & (ii) wet condition
3	Impulse voltage withstand and flashover test (dry)
4	Visible Discharge test (dry)
5	RIV test (dry)
6	Impact Test (For Disc Insulators only)
7	Thermal mechanical performance test
8	Residual strength Test (For Disc Insulators only)

- It shall be ensured that the following details are specified in test report & verified by testing agency/ Laboratory (Values shall be tabulated in type test report as a part of Dimension measurement) for validation of design).
- For all Mechanical/Design Type tests – Drawing shall contain length & Dia. of end fitting along with detailed drawing of end fittings, rod & housing diameter, material for end fitting, crimping length etc.
 - For Electrical /Design Type tests- Drawing shall contain actual Creepage distance, actual Dry arc distance, nos. of (Big & Small/intermediate) sheds, and distance from end fittings to first shed, Corona ring dimensions & placement marking distance of test sample.

For above tests, the profile parameters shall be identical to offered profile.

5. Improvements in Technical Specification of various Insulators

5.1 General

Improvement in the technical specifications of various type of insulators (Composite/ Polymer Insulators, Porcelain Insulators etc.) is particularly associated with increasing reliability, durability, and performance under subjected electrical & mechanical stresses (weather, voltage, pollution, etc.).

It is noted that the technology for Composite/ Polymer Insulators is relatively new compared to that of Porcelain Insulators. While the technology for the latter is well established and mature, that for the former appears to have not reached the required maturity levels due to which the actual in-service life is observed to be different from (lower than) the claimed one. However, since Porcelain Insulators on their own are not suited for use in highly polluted environments, there is a need to develop & improve alternative technologies. Since special profile porcelain insulators as well as porcelain insulators with RTV Coatings, and Composite/ Polymer Insulators claim to offer this solution, it is appropriate that these technologies are perfected to achieve convergence between their claimed life times & actual life times in the field.

Since technical specification for insulators define the essential design, material, electrical, mechanical, and environmental parameters required for safe and reliable power transmission, and ensure that the insulator can support conductor loads, prevent leakage currents, provide electrical isolation, and withstand operational voltages and environmental degradation, they need to capture & include all that is required, if not already done, to vouch for the technologies being used are matured enough so that the claimed performance translates into the expected field performance. In this regard, it is also emphasized the said improvements cannot on the basis of trial and error, but shall be based on solid scientific findings that such (proposed) additions will lead to significant improvements, and are aimed at eliminating the observed gaps in their performance.

Considering the long life span of the transmission system, the tower design should be able to accommodate insulators, hardware, conductors of the present technology as well as anticipated improvements/ changes to these technologies happening in the future. Accordingly, the design of the transmission towers across all voltage ranges should be capable of supporting all types of insulators (porcelain disc / long rod / glass disc / composite long rod insulators). Accordingly, the towers should be designed considering the use of 31mm/kV porcelain disc / long rod insulators, irrespective of the type of insulators to be used in the transmission lines.

Based on the information provided and deliberations held, some of the key areas where improvements in technical specifications are typically required are detailed in the following paras.

5.2 Composite/ Polymer Insulators

5.2.1 Design Improvements

- The following design improvements have been proposed to be included in the technical specification for Composite Polymer Long-rod Insulators:

SN	Aspects	Justification
1	Sheath thickness to be increased to 5 mm	Improved resistance to tracking and erosion, better protection against bird bites and mechanical damage, increased longevity of hydrophobicity, and mitigation of manufacturing defects, such as eccentricity during FRP rod coating
2	Shed root ≥ 6 mm; Shed tip ≥ 2.5 mm	Inadequate shed geometry is a primary cause of dry-band arcing in coastal and heavy pollution zones. Thin shed tips erode under partial discharge within 3–5 years, reducing effective creepage distance. Root thickness ≥ 6 mm ensures mechanical robustness under combined wind and ice loading. Shed tip ≥ 2.5 mm minimizes localized corona and erosion at the shed edge, a commonly observed degradation path in field-failed insulators.
3	Silicone rubber water absorption < 0.25%	High water absorption in silicone compound compromises hydrophobicity recovery. Moisture uptake beyond 0.25% accelerates PDMS chain degradation, leading to permanent hydrophobicity loss (HC5–HC6) under high humidity/monsoon conditions.
4	Over moulding design for preventing moisture ingress in End Fittings	The FRP rod–end fitting interface is the most failure-prone zone. In crimped/grouted fittings without over moulding, capillary moisture ingress occurs at the metal–polymer interface under thermal cycling, leading to hydrolytic degradation and interface delamination. Over moulding provides a sealed silicone encapsulation over the crimp zone, eliminating ingress paths. This is critical at ≥ 400 kV where electric field stress concentration is highest.
5	Glass Transition Temperature (T _g) for FRP rod to be increased to 140 degree centigrade.	The FRP rod is the primary load-bearing member. Above T _g , epoxy matrix softens, reducing mechanical strength and promoting micro-cracking under sustained load. In HVDC and high ambient conditions, temperatures may reach 90–110°C. T _g $\geq 140^\circ\text{C}$ ensures retention of $\geq 90\%$ SML (specific Migration Limits) across service conditions and prevents creep failure
6	Higher galvanization for coastal/ polluted regions	Standard galvanization (~ 86 μm per IS 2629) degrades within 5–8 years in coastal environments. Enhanced galvanization ≥ 100 μm or additional protective coatings (epoxy/zinc-rich) is required for Pollution Level C/D zones as per IEC 60815, to prevent pitting corrosion and reduction in load-bearing cross-section.
7	Project-specific Electric Field Management (EFM)	Site-specific Electric Field Modelling (EFM) with actual tower and hardware geometry is essential, as generic EFM calculations may not capture localized field enhancement at fittings, leading to premature corona degradation. Hardware design standardization by the end user is essential to

		eliminate variations across lines and ensure consistent electric field performance.
8	Provision of Grading Ring	At ≥ 132 kV, electric field stress at the HV end without grading ring exceeds ~ 4.5 kV/mm, above corona inception. Grading rings reduce peak stress to < 1.8 kV/mm, preventing corona-induced degradation. At ≥ 400 kV, rings are mandatory at both ends. Ring design (diameter, position) should be validated through simulation for each voltage level and tower configuration.

5.2.2 Additional Tests

The following tests have been proposed to be additionally included in the technical specification for Composite Polymer Long-rod Insulators:

(i) Type Tests & Acceptance Tests:

- Ozone resistance test as per IEC 61854, Clause 7.6.4 to be included in Type test.
- Recovery of hydrophobicity test and Corona test as per relevant IEC/IS.
- Tests on FRP rod and silicon rubber compound
- Accelerated ageing test of 5000 Hrs as per relevant IEC/IS

(ii) Tests during Manufacturing:

- Dry Power Frequency Test (DPFT): 250 kV/1,000 mm/15 minutes, hotspot rise $< 1^\circ\text{C}$ — detects interface bonding failures and corona hotspots invisible to standard visual inspection
- Dye penetration with housing: ≥ 20 minutes, no penetration — detects FRP micro-porosity that enables water ingress and long-term dielectric degradation
- Peel-off test: after every cold start and mould change — ensures consistent interface bonding at production temperature transitions

(iii) Acceptance Testing:

- Water Diffusion + Peel Test (96 hours boiling): validates long-term moisture resistance at the FRP-silicone interface — the single most common failure locus
- Sheath thickness ultrasonics on 100% of units: detects thin-wall sections that pass visual inspection but fail under field pollution conditions
- Arc Resistance > 240 seconds: validates housing performance under sustained fault-arc conditions

5.2.3 Brief Description of the Tests

(i) Type Tests & Acceptance Tests:

- **Ozone resistance test:** The test to be carried out as per IEC 61854 (on thin rectangular test strip clamped at a static elongation of 20%).
- **Recovery of hydrophobicity test and Corona test as per relevant IEC/IS:** The test shall be carried out as under:

- The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the Hydrophobicity classification. Dry the sample surface.
 - The sample shall be subjected to mechanical stress by bending the sample over a ground electrode. Corona is continuously generated by applying 12 kV to a needle like electrode placed 1mm above the sample surface. The test shall be done for 100 hrs.
 - Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic, with an HC value of 6 or 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.
 - Allow the sample to recover and repeat the hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.
- **Tests on FRP rod and silicone rubber compound:** SEM (Scanning Electron Microscopy) analysis with EDS (Energy Dispersive Spectroscopy) on the FRP rod cross-section, along with surface analysis using optical spectrograph and FTIR signature analysis, shall be carried out in accordance with internationally recognized procedures for these tests. The detailed test methodology, sampling, and acceptance criteria shall be as discussed and mutually agreed upon between the Supplier and the Purchaser under the Quality Assurance Program.
 - **Accelerated ageing test:** Accelerated ageing test of 5000 hours is to be carried out as per IEC 62730. It is a comprehensive multi-stress validation method that simulates long-term field conditions within a shorter time frame. Successful completion indicates that the polymer insulator can maintain its mechanical strength, electrical integrity, and surface properties over extended service life.

(ii) Tests during Manufacturing:

- **Dry Power Frequency Test (DPFT):** The test shall be conducted on finished insulators in accordance with IEC 61109:2008. No hotspots shall be permitted, and the acceptable temperature rise shall be within 0.2–0.6°C. The test is intended to assess the uniformity and integrity of interface bonding, as well as to detect any inherent inconsistencies in the FRP rod that may not be revealed through other standard tests.
- **Dye penetration with housing:** The test shall be conducted in accordance with IS 16784 and IEC 62217:2012, with the duration extended to a minimum of 20 minutes (as against the standard 15 minutes). This extended duration enables more effective assessment of interface bonding quality and facilitates detection of FRP rod porosity that may not be identified under shorter test durations.
- **Peel-off test:** The test shall be conducted at ambient temperature on the production line and shall be triggered after every cold start, mould change, and insert change, and at a minimum frequency of twice per week. The acceptance criterion shall be that the peel strength exceeds the tear strength. This test provides early detection of bonding inconsistencies and enables continuous validation of sheath-to-core adhesion throughout the production process.

(iii) Acceptance Testing:

- **Water Diffusion + Peel Test (96 hours boiling):** The test to be carried out as per IS 16784 validates long-term moisture resistance at the FRP-silicone interface — the single most common failure locus
- **Sheath Thickness Ultrasonics on 100% of units:** Sheath thickness shall be measured using an ultrasonic tester on each insulator, with the minimum thickness specified as 5 mm (as against 3 mm in the earlier technical specification). This 100% non-destructive testing (NDT) ensures elimination of sub-standard units prior to entry into final product inspection.
- **Arc Resistance >240 seconds:** The test demonstrates the ability of the housing material to withstand sustained fault-arc conditions without tracking, erosion, or puncture. Arc resistance tests for composite insulators evaluate the material's ability to withstand high-voltage, low-current arcs, ensuring they do not form conductive paths or suffer severe erosion under fault conditions. Arc resistance of polymer insulators shall be verified to be greater than 240 seconds.

5.3 Porcelain Insulators

5.3.1 Design Improvements

- Porcelain Insulators are proven and robust technology (60+ yr track record) in the Indian transmission grid. However, due to hydrophilic surfaces, their performance degrades in the polluted area. Therefore, in order to improve the performance in polluted areas, they be used in conjunction with RTV Coatings.
- Even though such combination is already being used, the period for which such coatings will be effective needs special attention as ensuring claimed service-life matches with the expected service life in the field will pave way for their adoption on a larger scale.

5.3.2 Additional Tests

- The following tests have been proposed to be additionally included in the technical specification for Porcelain Disc Insulators:

SN	Aspects	Justification
1	Power Arc Test (as per IEC 61467)	Verifies the ability of the insulator string to withstand high fault currents and power arc exposure without catastrophic failure. During system faults, arcs can subject discs and fittings to severe thermal shock and electrodynamic forces, leading to cracking or shattering. This test confirms the mechanical integrity of the string, coupling security, and absence of dangerous fragmentation, thereby enhancing personnel safety and system reliability. It also ensures that post-fault, the string maintains sufficient integrity to avoid cascading outages.
2	Thermal Mechanical Performance Test (as per IEC 60575)	Assesses the insulator's performance under combined thermal cycling and mechanical loading, simulating real service conditions such as

		day–night temperature variation, solar heating, and conductor load fluctuations. Repeated thermal expansion and contraction can induce micro-cracking, cement degradation, and loss of mechanical strength over time. This test ensures long-term durability, retention of mechanical strength, and stability of interfaces (porcelain–cement–metal) under cyclic stresses, reducing the risk of in-service failures.
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5.3.3 Brief Description of the Tests

➤ **Power Arc Test (as per IEC 61467):**

The Power Arc Test for porcelain insulators per IEC 61467:2008 evaluates the ability of insulator strings/sets to withstand the high-temperature electric arcs caused by short-circuit currents on overhead lines. It involves applying a high-power AC arc—typically 6 kA to 40 kA for short durations—to simulate faults. The goal is to ensure the insulator does not part or lose mechanical integrity, with tests tailored to the insulator's position on the line (e.g., towers, substations).

➤ **Thermal Mechanical Performance Test (as per IEC 60575)**

The Thermal Mechanical Performance Test (TMPT) as per IEC 60575 evaluates the reliability of porcelain insulators by subjecting them to simultaneous high-temperature, low-temperature, and mechanical tensile loading, typically at 60% of their specified electromechanical or mechanical failing load. It simulates long-term service conditions, ensuring that thermal expansion/contraction of metal fittings does not crack the porcelain shell.

6. Salient Features of Quality Assurance Plan for various Insulators

CEA has published “Guidelines for Model Quality Assurance Plan (MQAP) for Major Equipment of Power Sector” in January, 2026, with the objective of bringing uniformity, efficiency and reliability in quality assurance practices across the power sector. The guidelines emphasize that a well-defined Quality Assurance Plan (QAP) is essential to ensure that equipment such as insulators consistently meet specified technical requirements, while also reducing failures, risks and lifecycle costs. It highlights that quality must be ensured from the initial stages through proper design, use of high-quality raw materials, controlled manufacturing processes and skilled workmanship, supported by systematic documentation at every stage.

The MQAP provides a structured and comprehensive framework of testing, broadly classifying tests into type tests, routine tests and special tests. Type tests are conducted on prototype or representative units to validate the design and confirm that the equipment meets intended performance requirements. Routine tests are carried out on each unit or production lot to ensure conformity with specified standards and verify operational performance. Special tests are additional tests conducted as per contractual or purchaser-specific requirements to obtain further information related to performance or maintenance. These tests are further categorized based on the stage of execution, namely factory acceptance tests (FAT) conducted at the manufacturer’s works prior to dispatch to verify compliance with specifications, and site acceptance tests (SAT) conducted at site during erection and commissioning to ensure proper functioning under actual operating conditions and to check for any damage during transportation.

A key feature of the MQAP is the standardization and optimization of testing procedures, including defined sampling criteria and reduction of redundant tests, which helps in minimizing cost and time while ensuring adequate quality coverage. The plan also incorporates customer hold points (CHPs) for critical inspection stages, while allowing certain non-critical parameters to be accepted based on review of test certificates, thereby improving inspection efficiency. Further, it mandates complete documentation and traceability of all stages, including raw material testing, in-process inspections and final testing, along with verification prior to dispatch. Calibration of all testing and measuring instruments as per NABL guidelines and compliance with relevant IS/IEC standards and CEA regulations are also essential requirements.

With specific reference to Porcelain Insulators, the QAP shall emphasize rigorous raw material inspection, including physical and chemical testing of materials such as alumina, feldspar, clay and glaze constituents, along with defined sampling plans and acceptance criteria. It shall also prescribe incoming inspection of metal components such as caps, pins and hardware for dimensional accuracy, mechanical strength and galvanization quality. In addition, continuous in-process quality control shall also be ensured through monitoring of parameters during body preparation, slurry formation and glazing, thereby maintaining consistency in manufacturing. A clear responsibility matrix is also to be defined among manufacturer, customer and sub-vendors for performance, verification and witnessing of tests ensuring accountability at every stage.

The QAP for Composite/ Polymer Insulators shall also be defined on similar lines. Specifically it shall include raw material related checks (for Silicone Rubber Compound, FRP Rod, Metal Fittings, Bonding Agent, Split Pin, Grading Rings & Clamps) at both the Supplier’s works and Composite

Insulator Manufacturer's works, and In-process related checks covering End Fitting Crimping Process & Injection Moulding, and required Routine Tests and Acceptance Tests.

The utility-specific QAPs further reinforce these provisions. As per MPPTCL, detailed information regarding raw materials, manufacturing facilities, testing capabilities and quality control practices is required at the bidding stage, followed by submission of a detailed QAP with defined inspection hold points after award of contract. The supplier is required to implement the QAP across manufacturing, testing, packing and dispatch stages, and ensure that materials are dispatched only after approval of acceptance test reports, along with maintenance of comprehensive test records and calibration certificates. Similarly, PGCIL Manufacturing Quality Plans emphasize procurement from approved sources, complete traceability from raw material stage to finished product, calibration of testing instruments as per ISO/IEC 17025 standards, proper identification and marking of insulators, robust packing for safe transportation and systematic segregation of rejected materials. For disc insulators, detailed raw material acceptance norms including chemical composition and physical characteristics are also specified to ensure uniform product quality.

In this regard, a Model Quality Assurance Plan (MQAP) for Composite Polymer Insulators is given at **Annexure-X** for reference and for use by all transmission utilities with appropriate modifications.

7. Use of Corona Rings & Grading Rings & Arcing Horns for Insulators

Corona rings, grading rings, and arcing horns are all high-voltage protective devices, but they serve different purposes - corona rings eliminate corona discharge/noise, grading rings normalize voltage distribution along insulators, and arcing horns provide a safe flashover path to protect insulators during lightning strikes or surges. Their primary function is to reduce electric stress at critical locations such as metal fittings and the insulator surface, thereby ensuring a more uniform potential distribution and minimizing corona discharge, radio interference, and localized heating.

The combined use of grading rings and corona control rings is particularly critical for composite polymer insulators. Unlike porcelain disc strings, which inherently exhibit a relatively uniform electric field distribution due to their geometry, composite long-rod insulators experience non-uniform electric field concentrations, especially near end fittings. Further, composite insulators are made of organic materials such as silicone rubber, which are susceptible to degradation under high electric stress, leading to tracking, erosion, and loss of hydrophobicity. In contrast, ceramic materials are inorganic and do not undergo similar degradation mechanisms. Consequently, grading and corona rings are essential for composite insulators to ensure long-term reliability, whereas for ceramic insulators, grading rings are generally not required up to 245 kV and are typically introduced only at higher voltage levels.

The requirement of grading and corona rings increases with voltage level and environmental severity.

- At 132 kV (110 kV), a grading ring on the high-voltage side may be provided under conditions of high pollution or altitude, while corona rings are generally not required.
- At 220 kV, a grading ring on the high-voltage side becomes mandatory, with corona rings being optional depending on pollution severity and string configuration.
- At 400 kV, grading rings are mandatory on both line and tower sides, and corona rings are also mandatory, with their design validated through site-specific electric field modelling.
- At 765 kV and above, both grading and corona rings are indispensable, and two-sided corona protection is required to control the electric field along the entire insulator length and protect the first shed from hardware-origin corona.

The design of corona and grading rings must adhere to established electric field limits and should be validated through detailed modelling considering actual tower geometry, conductor configuration, and hardware arrangement. Critical design parameters such as ring diameter, tube size, and placement are required to ensure that electric field intensity remains within permissible limits, particularly at the metal surface, polymer housing, and the triple junction of air, housing, and metal fitting. Proper positioning of the rings, including extending beyond the triple point and coordinating hardware corona rings with insulator grading rings, is essential to achieve optimal field control and prevent localized stress concentrations.

Field observations have demonstrated that the absence or improper design of grading and corona rings leads to concentration of electric stress at specific locations, particularly near the end fittings and initial sheds of the insulator. This results in localized corona activity, causing progressive degradation of the silicone housing, increased leakage currents, and ultimately premature failure of the insulator. Therefore, correctly specified and properly installed rings do not merely serve as

auxiliary components but are fundamental to achieving the intended service life of composite insulators.

With regard to arcing horns, these devices are intended to provide protection against lightning and switching surges by diverting fault arcs away from the insulator string. However, they do not contribute to the control of electric field distribution and are not effective in mitigating pollution-related flashover or surface degradation. In the case of composite insulators, conventional arcing horns are not recommended, as they tend to concentrate arc energy on the polymer surface, leading to irreversible carbonization and damage. Instead, arc-quenching ring assemblies are preferred, particularly at voltage levels of 400 kV and above, as they effectively divert the arc away from the insulator housing and enhance system reliability.

In the case of RTV-coated ceramic insulators, it is noted that the RTV coating improves surface hydrophobicity but does not influence the electric field distribution. Accordingly, the requirement of corona or grading rings remains governed by standard ceramic insulator practices, and no additional provisions are necessitated solely due to the application of RTV coating.

8. Storage & Handling Procedures for Insulators

Proper storage and handling of transmission line insulators are crucial to maintain their mechanical strength, electrical dielectric integrity, and longevity. Improper procedures cause damage such as cracks, chips, or contamination, leading to flashovers, surface tracking, and premature failure.

In this regard, the Storage & Handling Procedures being followed by Member Utilities for various Insulators have been considered, and based on the same, a few model guidelines have been suggested to ensure safe & reliable storage and handling practices are adopted.

8.1 Utility-specific Storage & Handling Procedures

Storage & Handling procedures being followed by various Member-Utilities are as under:

PGCIL:

PGCIL specifies that porcelain and glass insulators are generally received in wooden crates and must be inspected for any physical damage prior to storage. For long-term storage, crates are required to be kept under covered areas on raised platforms (minimum 300 mm above ground level or above HFL), with sand filling to prevent weed growth and chipping. In cases where covered storage is not feasible, open storage is permitted with adequate sand cushioning. Stacking of crates is to be limited (generally 3–4 layers) depending on packing condition, and proper identification markings (make, EMS value, etc.) must be maintained for traceability. Loose insulators, if any, are to be repackaged and stored systematically. Polymer insulators require additional precautions, including storage in original manufacturer packing, protection against rodents and birds through enclosure (wire mesh and polythene covering), and avoidance of unpacking until installation. Periodic condition monitoring is prescribed, including visual inspection for physical damage at regular intervals and insulation measurement (for porcelain disc insulators) annually. FIFO principles are to be followed, and dismantled insulators from field replacement are to be stored separately as per prescribed procedures.

MPPTCL:

MPPTCL pitches for having a detailed and comprehensive SOP covering the entire lifecycle from packing to installation. At the supplier stage, insulators are required to be packed in suitable protective enclosures (PVC/plastic tubes or wooden crates) with adequate cushioning and markings, and the supplier is held responsible for any damage due to inadequate packing. At the receipt stage, crates must be inspected for damage, opened carefully, and insulators verified against specifications and packing lists, followed by inspection and resealing. For storage, insulators should preferably remain in original crates, stored on raised platforms in clean, dry areas free from water, oil contamination, and pests, with crates properly sealed to prevent rodent or termite entry. If unpacked, insulators must be hung on racks or protected with temporary coverings. During transportation, insulators must not be carried loosely or subjected to mechanical stress, and protective packaging must be ensured. On-site handling includes precautions such as not placing insulators directly on the ground, avoiding mechanical impacts, and ensuring proper inspection before installation. Detailed guidelines are also provided for installation and stringing, including avoiding bending or torsional stresses, proper lifting from

metal fittings only, correct assembly of hardware, and ensuring that insulators are not subjected to improper loads during conductor stringing. Damaged insulators are to be rejected at any stage.

MSETCL:

MSETCL primarily emphasizes robust packing and safe handling during transit and storage. Porcelain disc and long rod insulators are required to be packed in strong seasoned wooden crates with controlled weight limits to facilitate handling, while polymer insulators must be individually packed in water-resistant poly sleeves or PVC/cardboard casings to prevent ingress of moisture and rodents, followed by crate packing. Adequate cushioning, padding, and spacers are mandatory to prevent damage during transit and handling. Corona/grading rings and associated hardware are to be packed along with insulators or in separate crates. All packing cases must be properly sealed, clearly marked with essential details (manufacturer, rating, quantity, etc.), and designed to withstand rough handling conditions. The material received in such packing is generally stored in major stores without unpacking, indicating reliance on original packing integrity for storage protection.

8.2 Model Guidelines for Storage & Handling Procedures for Insulators

The model guidelines, which can be adopted by the Utilities, for safe & reliable storage & handling of various Insulators, are detailed under:

- a) **Packing and forwarding requirements:** Packing of insulators is required to be robust and suitable to withstand rough handling during transit, storage, and field handling, with all utilities specifying the use of strong seasoned wooden crates for porcelain insulators and protective packaging such as PVC tubes, poly sleeves, or sealed casings for polymer insulators to prevent ingress of moisture, rodents, and mechanical damage. Adequate cushioning, padding, spacers, and dunnage must be provided to avoid deformation or breakage, and packing cases must be clearly marked with all relevant details such as manufacturer, quantity, rating, and destination to ensure proper identification and traceability. Weight limitations of crates are also prescribed to facilitate safe manual handling.
- b) **Inspection at receipt stage:** Upon receipt at stores or site, insulator crates are required to be inspected for any signs of physical damage, and crates must be opened carefully ensuring that tools do not come in contact with the insulators. Nails and sharp projections are to be removed or flattened to prevent damage. Verification of type, quantity, and specifications against purchase orders and packing lists is mandatory, followed by sample or full inspection as per inspection checklists. After inspection, insulators are to be repacked and resealed in their original crates to maintain protection until use.
- c) **Storage conditions and arrangements:** Insulators are required to be stored preferably in their original packing under covered areas near closed stores, on raised platforms (minimum 300 mm above ground or above high flood level) to prevent moisture ingress, contamination, and mechanical damage. The storage area should be free from standing water, oil contamination, and biological threats such as termites and rodents. Where covered storage is not available, open storage may be permitted with adequate sand cushioning to prevent chipping. Stacking

height is to be limited (generally 3–4 layers) depending on packing condition, and proper identification marking and segregation by type and rating is required.

- d) **Special storage requirements for Composite/ Polymer Insulators:** Polymer insulators require additional precautions due to their silicone rubber housing, which is susceptible to damage. These are to be stored in original manufacturer packing and unpacked only at the time of installation. Protection against rodents and birds is essential, and where packing is not available, storage arrangements must be enclosed with wire mesh and covered with polythene sheets. Improper storage can lead to wear, tear, or surface damage affecting performance.
- e) **Handling during transportation:** During transportation from store to site, insulators are to be transported preferably in original crates with lids intact. If removed from crates, temporary protective packaging must be provided. Insulators must not be transported loosely, tied together, or secured with chains/ ropes that may cause mechanical damage. No other materials are to be placed over insulators during transit. Upon arrival, inspection must again be carried out, and damaged units must be identified and rejected.
- f) **On-site handling and pre-installation precautions:** At site, crates must be opened carefully and insulators must be protected with temporary covering after removal. Insulators should not be placed directly on the ground and must be kept on protective sheets to avoid contamination or mechanical damage. They must not be exposed to conditions where they can be stepped on, driven over, or impacted by other equipment. All units must be checked for physical damage, correct orientation, compatibility of fittings, and completeness of accessories before installation.
- g) **Installation and mechanical handling practices:** During installation, lifting arrangements must be attached only to metal end fittings and not to the sheds or housing of composite insulators. Care must be taken to avoid bending or torsional loads on long rod insulators. Insulators should not come in contact with ground or equipment during lifting and erection. Proper tightening of bolts, insertion of pins, and correct assembly of fittings, including corona rings and arcing horns, must be ensured. Personnel must avoid stepping or placing loads on insulators during work.
- h) **Precautions during conductor stringing:** During stringing operations, insulators must not be subjected to bending, twisting, or rotational stresses. Proper swivel fittings should be used, and conductor handling should avoid loops and twists. Insulator strings must be free to swing and align naturally, and no attempt should be made to correct conductor alignment by rotating insulators. All stringing equipment must be kept clear of insulators, and proper tension control methods should be used to prevent overstressing.
- i) **Condition monitoring and stock management:** Periodic condition monitoring is required, including visual inspection for physical damage (generally at regular intervals such as quarterly) and insulation measurement (for porcelain disc insulators on yearly basis). Additionally, first-in-first-out (FIFO) principles are to be followed for stock utilization, and dismantled insulators from replacement works are to be stored separately as per prescribed procedures.



- j) **Handling of damaged or defective insulators:** In case of damaged packing or observed defects, detailed inspection of individual insulators is required, and any unit with damage to housing, end fittings, or seals must be rejected and removed from service. Supplier responsibility for damage due to inadequate packing is also emphasized, ensuring accountability for quality during transit and handling.

9. Operation & Maintenance Practices for Insulators

Proper operation and maintenance (O&M) of transmission line insulators are essential to prevent electrical flashovers, minimize power outages, and extend asset life. Regular maintenance removes pollutants, detects degradation, and ensures safety, preventing the leakage current that causes catastrophic failures or significant energy losses in high-voltage systems. They help in preventing flashovers & outages, preventing electrical leakage, ensuring structural integrity, improving reliability & safety, extending asset lifetime, and upgrading technologies.

In this regard, the Operation & Maintenance Practices being followed by Member-Utilities for various Insulators have been considered, and based on the same, a few general suggestions have been listed for appropriate adoption.

9.1 Utility-specific Operation & Maintenance Practices for Insulators

Operation and maintenance practices being followed by various Utilities are as under:

a) **PGCIL:**

PGCIL follows an approach wherein the condition of insulators is periodically monitored during routine ground patrolling using high-zoom cameras to detect defects such as pollution, breakage, or physical damage, followed by suitable corrective actions. Punctured Insulator Detection (PID) is carried out for porcelain insulators on a case-to-case basis to identify defective units. For composite long rod insulators, thermo-vision (infrared) scanning is undertaken at intervals ranging from annually to once every five years depending upon factors such as age of insulators, failure history, and criticality of the line, thereby enabling condition-based maintenance and timely replacement of defective insulators.

b) **MSETCL:**

MSETCL adopts a combination of preventive and condition-based maintenance practices. Regular hot-line washing is carried out on EHV lines passing through industrial and fog-prone areas to reduce trippings due to pollution, with dedicated hot-line washing equipment deployed across zones. During outages, cold-line washing using water and chemical agents such as caustic soda is undertaken for cleaning insulator surfaces. Hotline maintenance using Puncture Insulator Detection (PID) devices is carried out regularly to detect defects such as leakage, puncture, contamination, and tracking. Advanced inspection techniques such as Remote Airborne Inspection & Scanning System (RAISS) using drones are employed for close monitoring of insulators, hardware, and conductors, enabling early identification of defects. Additionally, thermo-vision scanning is used to detect hot spots in transmission lines and associated equipment as part of preventive maintenance.

c) **MPPTCL:**

MPPTCL follows a comprehensive O&M regime involving routine and periodic patrolling, preventive maintenance, and fault rectification practices. Ground patrolling is carried out monthly, while detailed tower-top patrolling is conducted twice annually (pre-monsoon and post-monsoon), supplemented by drone-based inspections in select cases. Insulator flashovers and defects are identified during patrolling, and defective units are detected using PID and replaced through hot-line or cold-line maintenance. Insulators in polluted areas are periodically washed or

replaced. Fault location in case of breakdown is carried out using off-line fault locators to enable quick restoration. Preventive maintenance also includes maintaining proper tower earthing (monitoring tower footing resistance), clearing vegetation to maintain electrical clearances, and addressing environmental factors such as pollution and corrosion. Additional practices include cleaning of bird excreta, removal of nests, installation of bird guards/ monkey guards, and maintaining adequate clearances. Emphasis is also placed on rapid response during outages, including fault analysis, mobilization of resources, and restoration using emergency restoration systems (ERS).

9.2 General Suggestions on Operation & Maintenance Practices for Insulators

The general observations w.r.t. O&M practices being followed for Insulators, which may be appropriately factored in, are detailed under:

- a) **Inspection and patrolling practices:** Emphasis to be placed on routine inspection through ground patrolling, periodic detailed inspection (pre- and post-monsoon), and use of advanced tools such as drones and high-zoom cameras to detect physical damage, contamination, and hardware defects.
- b) **Diagnostic and condition monitoring techniques:** Condition monitoring techniques such as PID for porcelain insulators and thermo-vision/IR scanning for composite insulators may be used widely for detecting internal and surface defects, and for effecting timely corrective action.
- c) **Use of advanced technologies:** Use of drones (RAISS), thermal imaging, and other modern inspection & monitoring tools, aimed at improving detection accuracy and reducing manual effort, may be employed in critical stretches, and where found necessary.
- d) **Fault identification and restoration practices:** Structured approaches to be followed for fault identification using tools such as off-line fault locators and ensure rapid mobilization of resources for restoration, including use of emergency restoration systems (ERS) where required.
- e) **Preventive maintenance and auxiliary measures:** Additional practices such as maintaining tower earthing, vegetation management, anti-corrosion measures, and installation of bird/animal guards are to be undertaken to indirectly improve insulator performance and reduce external causes of failure.
- f) **Pollution mitigation practices:** Washing of insulators (hot-line and cold-line) is a common practice across utilities, particularly in polluted and coastal areas, indicating that pollution remains a major operational challenge requiring continuous intervention.
- g) **Maintenance intensity and operational challenges:** The need for frequent washing, periodic scanning, and continuous monitoring indicates that insulator systems require high maintenance effort, particularly in harsh environments, leading to increased O&M costs and logistical challenges. This aspect needs to be given due attention in selecting & deploying different types of Insulators.
- h) ***It is also emphasized that when faulty/ failed Insulators are replaced, they shall be replaced only with Insulators of similar or better quality/ performance. Under no circumstances, Insulators with lower quality/ performance shall be employed to replace that (the failed or otherwise) with better performance.***

10. Decisions & Observations of the Committee

10.1 Reporting of Insulator Failures

As insulators are important building blocks of transmission infrastructure, statistics w.r.t their failures need to be captured in sufficient detail to enable data-driven and evidence-based decision making. However, it is observed that there exists no proper format for reporting insulator failure events, in which all required failure details are captured. Accordingly, a uniform format for reporting insulator failures has been proposed to ensure uniformity, clarity, and completeness of information across utilities and regions. By doing so, a comprehensive database of insulator failures covering various details like failure location, type of insulator, year of commissioning, no. of years in service, mode of failure, prevailing environmental conditions, relevant snapshots of the failed insulator, etc., necessary for carrying out effective root cause analysis for each of the Insulator failure incident can be put in place & maintained.

This in turn helps in identifying recurring issues, manufacturing defects, or design inadequacies, and aids in improving quality control, maintenance planning, and selection of appropriate insulators for specific operating conditions. Additionally, consistent reporting enhances coordination among utilities, manufacturers, and regulatory bodies, leading to improved reliability and safety of the transmission system.

It is recommended that all utilities shall prescribe the format given at **Annexure-IX** for reporting Insulator failure incidents in their respective networks by their Field Offices to Head-Quarters, and establish & maintain a centralized database of insulator failures with them. They shall use this database to carry out the following:

- Pattern recognition across manufacturers, batches, and geographies
- Early warning system for batch-level defects
- Evidence-based specification development and manufacturer qualification/disqualification
- Benchmarking of insulator failure rates across utilities for performance-based regulation

The stipulated Reporting Format captures several important attributes of Insulator failures as given under:

- Type of Insulator Failure (Mechanical/ Electrical)
- Mode of Failure (Flash-Over, Flash-Under, Tracking & Erosion, Bird-Biting, De-capping, etc.)
- Pollution Severity as per CPRI Pollution Map-2023
- No. of In-Service Years
- Batch Traceability
- Specific details w.r.t. failed Insulator

Based on the databases maintained as above by concerned utilities, the consolidated details on Insulator failure incidents shall be furnished on quarterly basis or as and when sought by concerned RPCs, RLDCs, and NLDC.

Further, the Utilities shall also maintain proper records of (i) Replacement of Porcelain Insulators, (ii) Replacement of Polymer Insulators, (iii) Replacement of RTV Coated Porcelain Insulators, and (iv) Re-application of RTV Coatings on the already RTV coated Porcelain Insulators for taking informed decisions.

The Utilities are also requested to main records of supply/ power loss on account of line outages arising from insulator failures to ascertain the extent of contribution of the latter in the former.

(Time-line for implementation: latest by June, 2026)

10.2 Issues w.r.t. Porcelain Insulators and RTV Coatings and Composite Insulators

While the pros and cons of Porcelain and RTV Coatings and Composite Insulators have already been brought out in earlier Chapters, specific issues w.r.t. the same which require due attention in their selection & usage are detailed under:

- a) In order to correctly assess the failure rate of any specific type of Insulator, the no. of failures of the same in a given time period, say a year, alone does not give true picture, and is not sufficient; instead the complete base of that type of insulator from the same batch from same manufacturer in which those failures have taken place, is required. All such combinations, when properly considered together, enable one to arrive at the correct failure rate qualitatively and quantitatively, which information can be used for further decision making.

These failure rates may also be used for reviewing benchmark rates for insulators periodically, so that quality is not compromised to meet price constraints.

- b) While Porcelain Insulators have robust dielectric properties, and established performance record (long service life), and have been traditionally employed, specific issues of concern are their weight, being prone to vandalism, additional O&M requirements on account of frequent washing, and reduced performance levels in polluted and coastal areas.
- c) W.r.t. RTV coatings, they offer a proven, maintenance-free solution for high and very high pollution environments, and they are presently employed on Porcelain Insulators in substations in India. Given their good flashover performance, elimination of washing requirements, and comparatively long service life when properly applied, their use may be extended to that on transmission lines also by properly assessing their application for Insulators on transmission lines. In doing so, the issues w.r.t. RTV coated Porcelain Insulators such as weight, brittleness, and the period for which such coatings will be effective may be given due attention.
- d) While Composite/ Polymer Insulators are lighter in weight, require less maintenance, possess excellent performance in pollution environments, and vandal-resistant, specific issues of concern are the gap between their observed life-time and claimed life-time, and additional O&M requirements on account of periodic thermal imaging (IR scanning).
- e) To derive the same level of performance, Porcelain Insulators with RTV coatings may be compared with Composite Insulators. Further, since Porcelain Insulators with RTV Coatings are on the same platform as Composite Insulators [as per IEC PT 63432 (expected India adoption - JAN 2027) Composite and RTV Coated Insulators fall under the same category of HTM (Hydrophobicity Transfer Materials) Insulators], it is not appropriate to prescribe one in

preference to the other for any specific application, and both need to compete against each other on their own merits & strengths.

- f) Even though the technology for Composite/ Polymer Insulators is relatively new compared to that of Porcelain Insulators, improvements being undertaken to perfect the former (so that the claimed life time is actually achievable) by effecting appropriate quality changes in raw material, and manufacturing processes shall be quickly converged (so as to reach the claimed maturity levels) by ensuring the same are based on solid scientific findings, and not on trial and error basis.
- g) Infra-red scanning has been employed as primary O&M measure for Composite Insulators for effective identification of hotspots. Though it is widely adopted across global utilities and is supported by established international standards, practical difficulties in carrying out the same and the costs associated with the same as given under may be given proper attention:
- It is required to be carried out during specific time windows, i.e., early morning and late evening hours, when solar radiation is minimal, in order to obtain accurate thermal readings. This may pose safety risks to personnel, particularly in difficult terrains such as forested and hilly areas.
 - As the hotspot temperature in composite insulator in initial phases is relatively low, i.e., 0.5 to 2 degree centigrade in general and the same is to be captured from 40-60m away from insulator string, precise movement of crosshair (camera target point on the insulator surface) through the surface of insulator is required, which may sometimes difficult due to terrain/ environmental conditions.
 - Loading in transmission line also plays a crucial role in identification of hotspot. A lightly loaded line may have low intensity hotspot temperature which may not be detected through thermo-vision camera during hot weather conditions.
 - Thermo-vision scanning of insulators through drone may not be effective at present due to difficulty in thoroughly scanning the insulators.
 - Considering the extensive deployment of Composite insulators across the network, and their continued large-scale adoption, the O&M costs associated with the same need to be properly factored in.
 - The thermo-vision scanning market in India is in nascent stage under the service-based model and prices are not stable. However, with time and scale, cost of per insulator scanning may come down, but due to huge number of scanning, overall cost may increase.

In view of above, it is suggested that industry shall make efforts to improve IR Scanning techniques so that they become more effective & flexible to address the above practical concerns, or alternatively may come with other flexible & cost-effective solutions. Some plausible solutions which may be explored by the transmission utilities in this regard are leakage current detector, corona detector, and PID scanning.

- h) It is noted in this regard that when the technologies w.r.t various types of Insulators are perfected to eliminate gaps between claimed lifetime and actual lifetime, O&M burden cost and total life cycle costs are expected to come down.

10.3 Factors Influencing Insulator Selection

a) Consideration for Total Life Cycle Cost

While insulator selection is largely influenced by voltage level, environmental conditions, end-application, etc., there is a need to factor in the total life cycle cost of that type of Insulator. This is due to the fact that since the expected life of transmission system is 35 years, the insulators are also expected to ideally serve for the same no. of years. However, it has been noted that the observed life of the insulators is often less than the claimed life requiring replacements. It is noted that depending on the type of insulator employed and the prevailing operating conditions, the O&M expenses for each type of insulator would be different. Therefore, it is appropriate that while selecting a specific insulator, due consideration may also be given its total lifecycle cost covering its initial cost, maintenance cost, replacement (s) cost, outage costs, etc.

b) Consideration for Area-specific Features (Polluted/ Coastal/ Desert/ etc.)

- The transmission line generally traverses through many areas having different wind zones, pollution levels (based on ESDD and NSDD), terrain categories, atmospheric conditions etc. As these parameters play a vital role in selecting the type of insulators, these may be appropriately incorporated by the utilities at the tender stage itself.
- Further as a transmission line stretches over many km, passing through different terrains with different environment conditions, different insulators may be prescribed for normal stretches and polluted & coastal stretches. The insulator (s) selected should be such as to give expected performance levels for the most stringent conditions that will be encountered over the complete stretch.

c) Requirements for Manufacturers participating in Insulation Tenders:

- Necessary stipulations to ensure manufacturers with proven credentials only participate shall be included in the tenders. These, inter alia, may include specifying minimum no. of years (say 5 years) of proven field performance for the tendered EHV Insulators in tropical/ monsoon climates. Manufacturer after adopting the recommendations of this report having specified documented pre-mature failures, applicable to insulator manufacturing & material (say >2% failure rate within 5 years) may be disqualified for a definite period (say 1 to 2 years) as decided by the Utility.
- Batch Traceability: Each insulator to have unique QR code/RFID tag linking to manufacturing batch, test certificates, raw material sources, and commissioning date for lifecycle tracking. Both OEMs and EPC/ Developers shall take steps to ensure traceability w.r.t. which SL no of Insulator is going to which Site, Location, Tower for ensuring proper RCA in case of any failure.
- Extended performance warranty for (~ 5- 10 years) may be sought with annual condition assessment provision. It should appropriately factor in premature failures arising on account of issuing relating to the type of Insulator concerned.

(Time-line for implementation: latest by December, 2026)

10.4 Condition-Based Monitoring Framework

In order to ensure health of the Insulators installed, condition based monitoring framework shall be put in place by all Utilities. This is especially important for transmission lines in critical corridors, adverse environmental conditions (coastal and pollution dominated stretches). As the internal stresses developed within the Insulators keep accumulating, and are observed to be manifesting in external failures generally in monsoon season, this condition based framework shall incorporate the pre-monsoon survey and post-monsoon follow-up as given under:

- **Pre-Monsoon (Apr–May):** Thermo-vision scanning, drone-based UV corona camera inspection of all composite insulator strings on 400kV and 765kV lines.
- **Post-Monsoon (Oct–Nov):** Follow-up inspection of lines with prior insulator failures. Leakage current monitoring on identified hotspot lines.
- Cleaning of Insulators at regular intervals (as per Utility SOP's / recommendation from OEM's) in pollution and coastal stretches

It may be mentioned that the above are over and above the other normal O&M measures generally prescribed by the transmission utilities for ensuring the health of the Insulators.

It is also emphasized that when faulty/ failed Insulators are replaced, they shall be replaced only with Insulators of similar or better quality/ performance. Under no circumstances, Insulators with lower quality/ performance shall be employed to replace that (the failed or the otherwise) with better performance.

(Time-line for implementation: latest by December, 2026)

10.5 Improving Technical Specification of various Insulators

- a) General Philosophy for effecting changes in Technical Specification of Insulators should be based on the following:
 - a) **Understanding systemic failure patterns and ageing behaviour:** A large proportion of failures occur during monsoon months due to environmental stress acting on already degraded components. These findings indicate that failures are not random but are driven by inherent material, manufacturing, and ageing mechanisms, and therefore require systemic corrective measures rather than isolated interventions.
 - b) **Specification revision based on root cause analysis:** Improvements in technical specifications, should aim at not just in yielding marginal improvements, but in addressing the primary failure modes of the insulator concerned. Further, as already brought out, any revision of specifications should be based on detailed forensic root cause analysis of failures under Indian operating conditions, ensuring that changes are evidence based and targeted at eliminating root causes rather than symptoms.

Further, any additional type, acceptance, and manufacturing tests proposed to be prescribed should be directly linked to specific failure mechanisms observed in field data, as prescribing tests without such linkage may result in inappropriate calibration of pass/fail criteria, leading to ineffective quality control.

- c) **Holistic system-level improvement approach:** Improving insulator performance requires a comprehensive and integrated strategy encompassing proper technology selection, failure-driven specification development, standardized practices, and lifecycle-based decision-making. Incremental or isolated improvements in individual parameters are insufficient; instead, a systemic approach addressing design, procurement, operation, and maintenance aspects is essential to achieve sustained reliability and performance enhancement of the grid.
- b) Since technical specification for insulators define the essential design, material, electrical, mechanical, and environmental parameters required for safe and reliable power transmission, and ensure that the insulator can support conductor loads, prevent leakage currents, provide electrical isolation, and withstand operational voltages and environmental degradation, they need to capture & include all that is required, if not already done, to vouch for the technologies being used are matured enough so that the claimed performance translates into the expected field performance. It is also emphasized the said improvements cannot be on the basis of trial and error, but shall be based on solid scientific findings that such (proposed) additions will lead to significant improvements, and are aimed at eliminating the observed gaps in their performance.

Based on the information provided and deliberations held, some of the key areas where improvements in technical specifications are typically required have been detailed in Chapter-5. The same may be followed by all transmission utilities.

Further, the same shall also be incorporated appropriately by the transmission utilities in their respective Manufacturer-specific Quality Assurance Plans.

(Time-line for implementation: latest by December, 2026)

10.6 Improvements specific to Composite/ Polymer Insulators

- a) It is imperative to adopt advanced insulator technologies during insulator selection to ensure enhanced reliability under prevailing service conditions. In addition, the insulator selection methodology shall explicitly account for the pollution severity along the transmission corridor, in conjunction with the specified Basic Insulation Level (BIL).
- b) It is noted that the use of multiple hardware vendors and string configurations in Indian transmission lines has resulted in a large number of hardware variants for the same insulator rating. These differences in hardware geometry, corona ring dimensions, and conductor arrangements are leading to variations in electric-field distribution, mechanical loading, and corona performance, requiring separate validation through drawings and electric field modelling.

Accordingly, wider adoption of standardized hardware across utilities has been suggested to achieve better interchangeability, simplified engineering practices, and improved reliability of composite insulator systems in service.

- c) **Pollution & Moisture** is one of the main causes for Tracking along core/ housing interface and shed splitting observed predominantly in monsoon season. Contamination from fertiliser dust and pesticide deposits combined with monsoon wetting creates a conductive surface layer which is triggering leakage current and dry-band arcing.

The following improvements have been suggested to address such failures in future:

- HTV silicone ($\text{Si} \geq 32\%$) recovers hydrophobicity class HC1–HC2 within hours after pollution deposit removal — a capability absent in ceramic/porcelain.
 - FRP Rod - Water Diffusion Test acceptance criterion to be tightened to ≤ 0.1 mA and Water Absorption $\leq 0.05\%$.
 - Silicone - Water Absorption $\leq 0.25\%$ — ensures housing does not absorb moisture during prolonged monsoon wet conditions.
- d) It is noted that Electric Field Stress & Hardware-Insulator Incompatibility has led to shed damage concentrated near high electric field zones due to incorrectly sized grading ring on the insulator end fitting, or absent corona ring on-line hardware, causing localized corona-induced erosion.

The following improvements have been suggested to address such failure in future:

- Grading ring on insulator end fitting mandatory at ≥ 220 kV (HV end minimum); both HV end and tower end at ≥ 400 kV — controls triple-point E-field to ≤ 0.35 kV/mm as per CIGRE TB 284 / IEC 61109 Ed.3; housing surface ≤ 0.42 kV/mm
- Corona ring of the hardware (yoke plates, suspension/tension clamps) should be co-designed and EFM validated with insulator grading ring to eliminate hardware-origin corona directed at first shed; hardware edges should be grounded smooth.
- Post-installation UV corona camera inspection before energization; drone-based UV survey at periodical intervals (say, for every 3 years in service) to detect and correct corona activity before shed erosion progresses.

The general suggestions given w.r.t. Corona rings/ grading rings/ arcing horns in Chapter-7 shall be followed by all Utilities.

- e) During monsoon months, Lightning & External Overvoltage is observed to be the cause of failure concentration of Composite Insulators. The following improvements have been suggested to arrest the failures due to lightning incidences in future:
- Arc-quenching ring assemblies to be specified at ≥ 400 kV — diverts power arc away from polymer housing surface; plain arcing horns are strictly prohibited on composite strings as they concentrate arc energy on the silicone housing causing irreversible carbonization (CIGRE TB 365, 2008)
 - Line Surge Arresters (LSA) at towers with footing resistance $> 10 \Omega$ and in identified lightning-prone monsoon corridors
 - Higher ATH content (40–60 phr) in HTV compound improves arc resistance and slows carbonization propagation at shed surface;

(Time-line for implementation: latest by December, 2026)

10.6 Improvements specific to Porcelain Disc Insulators

- a) It is imperative to adopt advanced insulator technologies during insulator selection to ensure enhanced reliability under prevailing service conditions. In addition, the insulator selection methodology shall explicitly account for the pollution severity along the transmission corridor, in conjunction with the specified Basic Insulation Level (BIL).
- b) Ways and means of avoiding porcelain insulator failures:
 - *High strength ceramic body:* A high strength ceramic body enables the insulator to withstand severe environmental exposure, thermal cycling, and mechanical stress, thereby significantly reducing the risk of shattering, puncture, and crack formation.
 - *Factory applied RTV coated insulators:* Factory applied RTV silicone coating provides sustained hydrophobicity, improving performance in contaminated environments. Controlled application ensures uniform coating thickness, consistent quality, and minimal material wastage.
 - Use of Special Profile Insulators including Semiconducting glazed insulators.
- c) ESDD & NSDD levels and Shed Profile to be considered for designing insulators specification.
- d) Steel grade to be specified with low rusting characteristics. Additional Zinc rich coating to be considered for metal parts for high pollution zone in order to reduce the rust formation.
- e) Cement grade to be explicitly specified in technical specifications.
- f) All disc insulators ≥ 120 kN and all lines ≥ 220 kV shall have minimum 35% alumina content.
- g) For altitude above 1000 m, insulators shall have minimum 35% alumina content, irrespective of voltage class.
- h) It is suggested that combination testing (Insulator with Hardware) including Di-electric test / RIV & Corona test / Power Arc test may be made mandatory for string for every project if standard design not followed and either of the design/vendor changes.
- i) Steep wave front test / Thermal Mechanical performance test for every lot may also be made mandatory, wherever required, as per the lot size defined in IEC 60383/IS equivalent.

(Time-line for implementation: latest by December, 2026)

10.7 Storage, Application, Installation & Handling of various Insulators

It has been observed that incorrect storage, handling or installation practices can damage the silicone housing surface, misalign grading rings, or introduce mechanical stress at the rod-fitting may led to failure. Accordingly, it is suggested that Utilities prescribe for mandatory use a Comprehensive Storage, Handling & Installation Guide covering transport limits (vertical storage, minimum coiling radius), site storage requirements (UV protective cover, no ground contact), installation sequence, etc.

The general guidelines given in this regard in Chapter-8 shall be followed by all transmission utilities.

(Time-line for implementation: latest by December, 2026)

10.8 Way-forward

Going forward, it is pertinent to adopt a holistic and standardised approach for improving the reliability of Insulators used across EHV transmission systems to reduce/avert failure. In this regard, the utilities should prioritise improving the technical specifications covering design improvements and certain additional type tests, Acceptance tests and manufacturing tests. In case of Composite Insulators, focus should also be given to hardware–insulator interface design, ensuring strict compliance with validated electric field limits and proven design practices as electric field distribution across core, sheath and on complete Composite/Polymer Long Rod insulator is one of the prominent parameters for cause of erosion across Core sheath/ Shed. Standardisation of hardware configurations across utilities must be accelerated to minimise design variability, enhance interchangeability, and reduce the need for repeated validations.

Simultaneously, greater emphasis should be placed on pollution mitigation strategies, including optimized material properties (HTV silicone, FRP rod performance) and selective adoption of special profile porcelain insulators & RTV coating in severe pollution zones. Utilities should institutionalize a condition-based monitoring framework, leveraging modern tools such as drone-based UV corona inspection, thermos-vision scanning, and leakage current monitoring to enable early detection and preventive maintenance.

In reference to system perspective, lightning performance improvement measures, including proper shielding design, installation of line surge arresters, and adoption of arc-quenching devices, should be systematically implemented in high-risk corridors. Equally important is the enforcement of robust quality assurance mechanisms, including third-party inspections, stringent vendor qualification, batch traceability, and long-term performance guarantees.

Industry should develop & adopt newer technology like Insulator Fault Detector to predict and identify the fault location faster.

Finally, the establishment of a centralized insulator failure database will be critical to enable data-driven decision-making, early identification of systemic issues, and continuous refinement of specifications. Through coordinated action across design, procurement, installation, and maintenance domains, the transmission sector can significantly enhance the long-term performance, reliability, and resilience of insulator systems in diverse Indian operating conditions.





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GRID CONTROLLER OF INDIA LIMITED
(A Government of India Enterprise)

CIN : U40105DL2009GOI188682

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संदर्भ: NLDC/SO/2025/

दिनांक: 06th Oct 2025

To,

Member (GO &D),
CEA, Sewa Bhawan,
R.K. Puram,
New Delhi

Subject: Frequent incidents of HVAC Transmission Line Outages on account of Insulator Failures

Sir,

It has been observed that there are frequent tripping incidents in the HVAC transmission network attributable to insulator failures. This has been a cause of concern as such incidents have occurred on critical HVAC transmission corridors such as the West-South inter regional link, infed to Mumbai Metropolitan Region system. These failures have resulted in prolonged outages of transmission lines resulting in, reduced power transfer capability, and compromised grid security. RLDCs have been actively raising the trippings on account of insulator failures in RPC forum. A list of such outages is enclosed for reference as Annexe-1.

CEA has already laid down comprehensive regulatory provisions relating to construction standards, maintenance, and safety of transmission assets. However, the recent spurt of insulator failures indicate gaps in field-level implementation and monitoring by transmission licensees. The incident indicate the issues with compliance of CEA technical standards viz-a viz CEA Grid Standards 2010, CEA Technical Standards for Construction, 2022 and CEA Measures Relating to Safety and Electric Supply Regulations, 2023. A comprehensive Root Cause Analysis is required to find the reasons of these insulator failures. The remedial measures need to be implemented to avoid such incidents in future. This may necessitate close coordination with affected transmission licensees.

Therefore, it is kindly requested to constitute a committee to analyse these incidents of insulator failure with members from CEA, RPC, RLDCs, CTUIL and relevant transmission licensees. The Committee report may include the remedial measures to be implemented by transmission licensees to avoid such incidents in future.

Thanking You,

Yours sincerely,



S.Usha
(ED-NLDC)

Encl.: List of transmission outages due to insulator failures

Copy for kind information:

1. Chairperson, CEA
2. CMD, Grid-India
3. Member-Secretary, RPCs
4. Heads of RLDCs
5. Chief (Engineering), CERC

Outage Details of 765 kV WARORA(PG) - WARANGAL D/C Since Jan 2025										
Sl. No	Name	Outage Type	Owners	Outage Date	Quatge Time	Revival Date	Revival Time	Reason		
1	765KV-WARORA-PG-WARANGAL-1	FORCED	ATIL-Adani,WKTL	31-03-2025	14:41	31-03-2025	18:35	At Warangal End, Fault phase- Y&eN Phase, Fault Currents &eN 10.67kA, Fault Location - 23.5km. At warora end, 332 km, 3.54 kA.		
2	765KV-WARORA-PG-WARANGAL-1	FORCED	ATIL-Adani,WKTL	18-04-2025	19:22	18-04-2025	21:07	Tripped on R-E fault. Warangal end: R Phase to Ground fault. 2.217 kA, 212.9 km Zone-1 WARORA END: 78.6KM, 7.242KA R-E.		
3	765KV-WARORA-PG-WARANGAL-2	FORCED	ATIL-Adani,WKTL	18-04-2025	18:42	18-04-2025	19:55	Tripped on Rph-E fault. Warora end: Rph-E, 9.541kA, 63.48km,		
4	765KV-WARORA-PG-WARANGAL-2	FORCED	ATIL-Adani,WKTL	23-05-2025	19:37	24-05-2025	23:55	warora end- M1: 200.3km 3.27kA Rph-E M2: 192.8km 3.6kA Rph-E		
5	765KV-WARORA-PG-WARANGAL-1	FORCED	ATIL-Adani,WKTL	10-06-2025	00:11	10-06-2025	02:11	Tripped on R-E fault. Warangal end: 240.2km, R-E, 3.63kA,		
6	765KV-WARORA-PG-WARANGAL-2	FORCED	ATIL-Adani,WKTL	16-08-2025	07:16	16-08-2025	22:24	Tripped due to Y-N Fault Warangal end Indications: Location- 101.9km Fault Current- 5.282 kA.		
7	765KV-WARORA-PG-WARANGAL-2	FORCED	ATIL-Adani,WKTL	20-08-2025	18:24	21-08-2025	16:57	Line Tripped on Persisting R-G Fault. Fault Details at Warora End: M1: FD-235.52km, FC-3.23kA . Fault Details at Warangal End: M1: FD-91.6km , FC-5.5kA.		
8	765KV-WARORA-PG-WARANGAL-1	FORCED	ATIL-Adani,WKTL	20-08-2025	18:20	21-08-2025	16:57	Line Tripped on Persisting R-G Fault. Fault Details at Warora End: M1: FD-248.6km, FC-3.8kA . Fault Details at Warangal End: M1: FD-88.4km, FC-5.8kA.		
9	765KV-WARORA-PG-WARANGAL-1	FORCED	ATIL-Adani,WKTL	20-08-2025	18:20	23-08-2025	00:13	Line Tripped on Persisting R-G Fault. Fault Details at Warora End: M1: FD-248.6km, FC-3.8 kA . Fault Details at Warangal End: M1: FD-88.4km , FC-5.8kA. Line belongs to M/s Adani		
10	765KV-WARORA-PG-WARANGAL-2	FORCED	ATIL-Adani,WKTL	14-09-2025	03:44	18-09-2025	23:14	Line tripped on Z-1 B phase-e fault Warangal New end- 70.36 km, 6.67 kA, Warora end- 272.9 km, 2.811 kA		
11	765KV-WARORA-PG-WARANGAL-1	FORCED	ATIL-Adani,WKTL	16-09-2025	16:11	Still out	Still out	Tripped on B-E fault. Warangal - 294.4 km, 2.03 kA; Warora - 35.23 km, 13.42 kA		

Details of Transmission Elements Affected due to Insulator failure in Eastern Region since Jan 2025							
S.No.	Element	Owner	Nature	Reason	Outage Date & Time	Revival Date & Time	Outage(Hrs)
1	765KV-NEW RANCHI-MEDINIPUR-1	PGCIL	Planned	Defective CLR polymer Insulator replacement work.	23-01-2025 09:26	23-01-2025 17:38	8
2	765KV-NEW RANCHI-MEDINIPUR-2	PGCIL	Planned	REPLACEMENT OF DEFECTIVE INSULATOR	24-01-2025 09:08	24-01-2025 17:34	8
3	765KV-MEDINIPUR-NEW JEERAT-2	PGCIL	Planned	Replacement of defective insulator	29-01-2025 09:27	29-01-2025 16:23	6
4	765KV-MEDINIPUR-NEW JEERAT-2	PGCIL	Planned	Replacement of defective insulator	29-01-2025 09:27	29-01-2025 16:23	6
5	765KV-NEW RANCHI-MEDINIPUR-1	PGCIL	Planned	Replacement of damaged CLR insulator	13-02-2025 08:04	13-02-2025 18:44	10
6	765 KV MEDINIPUR-NEW JEERAT-2	PGCIL	Protection Tripping	Medinipur: R-Y, Ir: 5.626 kA, Iy: 5.629 kA, 130.5 Km	14-02-2025 15:20	14-02-2025 18:50	3
7	765 KV MEDINIPUR-NEW JEERAT-2	PGCIL	Protection Tripping	Medinipur: B-N, 4.7 kA, 72.8 km	20-02-2025 10:38	20-02-2025 12:09	1
8	765KV-MEDINIPUR-NEW JEERAT-2	PGCIL	Planned	Replacement of defective insulator caused due to lightening	28-02-2025 08:31	28-02-2025 18:38	10
9	765KV-MEDINIPUR-NEW JEERAT-2	PGCIL	Planned	Replacement of defective insulator caused due to lightening	28-02-2025 08:31	28-02-2025 18:38	10
10	765KV-NEW RANCHI-MEDINIPUR-2	PGCIL	EMERGENCY Shutdown	Replacement of broken insulator strings	09-04-2025 04:00	09-04-2025 10:32	6
11	400KV-NEW JEERAT-SUBHASGRAM(PG)-2	PGCIL	Protection Tripping	Subhasgram end: R-N fault, Z1 , 1.8 KM, 17.8 KA, New Jeerat end: RN fault , 90 KM , 3.62 KA	26-04-2025 21:57	27-04-2025 13:38	15
12	400KV-NEW JEERAT-SUBHASGRAM(PG)-1	PGCIL	Protection Tripping	Subhasgram end : R-N, Z1 , 13.54 KM , 12.99 KA, New Jeerat end : RN fault, 89.1 KM , 3.6 KA	26-04-2025 22:02	28-04-2025 02:07	28
13	765KV-MEDINIPUR-NEW JEERAT-2	PGCIL	EMERGENCY Shutdown	Replacement of broken CLR insulator	05-05-2025 04:20	05-05-2025 12:17	7
14	765KV-NEW RANCHI-MEDINIPUR-1	PGCIL	EMERGENCY Shutdown	To attend Replacement of 1 no damage CLR insulator at tower no-384 caused due to lightning.	10-05-2025 05:55	10-05-2025 10:03	4
15	765KV-MEDINIPUR-NEW JEERAT-1	PGCIL	EMERGENCY Shutdown	Replacement of damage CLR insulator at tower no-117 caused due to lightning	13-05-2025 05:21	13-05-2025 11:24	6
16	765KV-MEDINIPUR-NEW JEERAT-2	PGCIL	EMERGENCY Shutdown	Replacement of 1 no damage CLR insulator at tower no-004, caused due to lightning.	22-05-2025 04:46	22-05-2025 11:18	6
17	765KV-NEW RANCHI-MEDINIPUR-2	PGCIL	EMERGENCY Shutdown	Emergency s/d to attend damaged Middle phase 1 no Polymer Insulator at Lo no.194.	24-05-2025 03:51	24-05-2025 10:35	6
18	765KV-MEDINIPUR-NEW JEERAT-1	PGCIL	EMERGENCY Shutdown	Replacement of 1 no damage CLR insulator at tower no-242 caused due to lightning	25-05-2025 05:14	25-05-2025 09:19	4
19	400KV-NEW JEERAT-SUBHASGRAM(PG)-2	PGCIL	Protection Tripping	Subhasgram: R-Ph, Z-I, 23.1km,10.44kA. New Jeerat: R-Ph, Z-I, 80km, 3.916kA	25-05-2025 12:51	02-06-2025 10:26	189
20	400KV-NEW JEERAT-SUBHASGRAM(PG)-1	PGCIL	Protection Tripping	Tripped from Subhasgram end	26-05-2025 10:51	26-05-2025 10:58	0
21	400KV-NEW JEERAT-SUBHASGRAM(PG)-1	PGCIL	Protection Tripping	Y ,N , New jeerat - 44.2 km , 6.553 kA , Subhasgram, 49.3 km , 5.3 kA	28-05-2025 02:31	06-06-2025 12:45	226
22	765KV-NEW RANCHI-MEDINIPUR-2	PGCIL	EMERGENCY Shutdown	Replacement of broken Insulator.	03-06-2025 05:54	03-06-2025 12:05	6
23	765 KV NEW RANCHI-MEDINIPUR-1	PGCIL	Protection Tripping	N Ranchi : B-N, B - 4.97 kA, 160.27 km; Medinipur: Z1, B-N, 125km, 3.5kA	04-06-2025 16:59	04-06-2025 18:35	1
24	765 KV NEW RANCHI-MEDINIPUR-1	PGCIL	Protection Tripping	N Ranchi : B-N, B - 4.97 kA, 160.27 km;	04-06-2025 16:59	04-06-2025 18:35	1
25	765KV-MEDINIPUR-NEW JEERAT-2	PGCIL	EMERGENCY Shutdown	Replacement of 1 no damage CLR insulator at tower no-81 caused due to lightning	13-06-2025 05:24	13-06-2025 12:03	6
26	765KV-NEW RANCHI-MEDINIPUR-2	PGCIL	EMERGENCY Shutdown	For replacement of broken insulator at tower no-338 suspension tower	27-06-2025 05:03	27-06-2025 10:27	5
27	765KV-NEW RANCHI-MEDINIPUR-1	PGCIL	EMERGENCY Shutdown	Emergency shutdown for replacement of Damage CLR insulator at tower no-377	28-06-2025 04:46	28-06-2025 11:15	6
28	400KV-NEW JEERAT-SUBHASGRAM(PG)-1	PGCIL	Protection Tripping	R/I at New Jeerat : B ,N, F Current : 1b 8.774 kA, Dist 25.90 km, B-N, F Current 4.072 kA, F Dist 69.3 km.	29-06-2025 03:03	29-06-2025 15:56	12
29	400KV-NEW JEERAT-SUBHASGRAM(PG)-2	PGCIL	Planned Shutdown	replacement of identified insulators	30-06-2025 05:03	30-06-2025 19:58	14
30	765KV NEW RANCHI-MEDINIPUR-2	PGCIL	Protection Tripping	Medinipur: Y-Ph, 104.7km,3.732kA, Z-I New Ranchi:160.6km,3.58kA, Y-Ph, Z-I	30-06-2025 07:06	30-06-2025 07:44	0
31	765KV NEW RANCHI-MEDINIPUR-2	PGCIL	Protection Tripping	New Ranchi:160.6km,3.58kA, Y-Ph, Z-I	30-06-2025 07:06	30-06-2025 07:44	0
32	765KV NEW RANCHI-MEDINIPUR-2	PGCIL	Protection Tripping	New Ranchi: Y-Ph, 3.6kA,160.8km	30-06-2025 21:30	03-07-2025 04:24	54
33	765KV-NEW RANCHI-MEDINIPUR-2	PGCIL	EMERGENCY Shutdown	Insulator decapped at loc. 201	03-07-2025 11:02	04-07-2025 01:34	14
34	765KV-NEW RANCHI-MEDINIPUR-1	PGCIL	EMERGENCY Shutdown	Punctured CLR insulator has been detected at Loc No-29 (Middle Phase), Loc No-57 (Bottom Phase) and Loc No-43 (Middle phase), Loc no- 142 (Bottom phase), LOC 201 Top & Middle, Location 57 is a Railway Crossing Tower	05-07-2025 10:38	05-07-2025 17:57	7
35	765KV-NEW RANCHI-MEDINIPUR-2	PGCIL	EMERGENCY Shutdown	Damaged insulator replacement.	09-07-2025 04:39	09-07-2025 11:56	7
36	765KV-NEW RANCHI-MEDINIPUR-2	PGCIL	EMERGENCY Shutdown	Damaged insulator replacement.	10-07-2025 04:44	10-07-2025 11:36	6
37	765KV-MEDINIPUR-NEW JEERAT-1	PGCIL	EMERGENCY Shutdown	Insulator replacement work.	12-07-2025 04:59	12-07-2025 11:15	6
38	765KV-MEDINIPUR-NEW JEERAT-1	PGCIL	EMERGENCY Shutdown	Insulator replacement work.	13-07-2025 05:05	13-07-2025 13:38	8

Details of Transmission Elements Affected due to Insulator failure in Western Region since Jan 2025						
Sl. No	Name	Outage Type	Owners	Outage Date & Time	Revival Date & Time	Reason
1	400KV-BINA-SHUJALPUR-2	EMERGENCY	POWERGRID-WR2 (PGCIL)	03-Jan-25 12:24	03-Jan-25 18:57	For replacement of flashover insulators at 447 & 496 Locations
2	400KV-JABALPUR-REWA-2	EMERGENCY	POWERGRID-WR2 (PGCIL)	04-Jan-25 09:57	04-Jan-25 19:23	ESD to attend the insulator flashover issue
3	400KV-BHOPAL-MP-Damoh-1	PLANNED	POWERGRID-WR2 (PGCIL)	07-Jan-25 12:53	07-Jan-25 16:57	ESD to attend insulator flashover
4	400KV-BABLESHWAR-PADGHE-1	EMERGENCY	Maharashtra	09-Jan-25 00:00	09-Jan-25 04:07	ESD to attend flashover disc insulator
5	400KV-KALA-KUDUS-2	EMERGENCY	POWERGRID-WR2 (PGCIL)	10-Jan-25 12:14	10-Jan-25 20:18	Insulator damaged at Tower No. 128
6	400KV-NAGDA-SHUJALPUR-1	EMERGENCY	POWERGRID-WR2 (PGCIL)	13-Jan-25 16:16	13-Jan-25 20:48	ESD for replacement of flashover insulators at location No 552 & 563.
7	400KV-INDORE-MP-INDORE-2	EMERGENCY	POWERGRID-WR2 (PGCIL)	13-Jan-25 11:54	13-Jan-25 17:05	ESD For Replacement of insulator due to Dcapping at loc 100
8	400KV-BHADRAWATI-PARLI-1	EMERGENCY	POWERGRID-WR1 (PGCIL)	15-Jan-25 09:06	15-Jan-25 19:37	A/R Non Auto / A/R OFF For replacement of insulator string at Location No. 172
9	400KV-DHARIWAL-PARLI-1	EMERGENCY	POWERGRID-WR1 (PGCIL)	15-Jan-25 08:18	15-Jan-25 20:26	ESD For replacement of insulator string at Location No. 172
10	400KV-KANSARI-KANKROLI-1	EMERGENCY	POWERGRID-WR2 (PGCIL)	05-Feb-25 18:33	05-Feb-25 22:57	ESD - insulator replacement work at loc no 88 to rectify sparking in insulator
11	765KV-VADODARA-DHULE-1	PLANNED	BDTCL	03-Mar-25 08:52	03-Mar-25 20:03	Shutdown required to rectify shutdown defect (Insulator Replacement).
12	765KV-VADODARA-DHULE-1	PLANNED	BDTCL	04-Mar-25 17:22	05-Mar-25 18:42	Shutdown required to rectify shutdown defect (Insulator Replacement).
13	400KV-KOLHAPUR-MS-Kolhapur GIS-1	EMERGENCY	POWERGRID-WR1 (PGCIL)	06-Mar-25 06:02	06-Mar-25 17:16	A/R Non Auto / ESD on Insulator replacement due to flash over of insulator
14	400KV-KOLHAPUR-MS-Kolhapur GIS-2	EMERGENCY	POWERGRID-WR1 (PGCIL)	06-Mar-25 05:58	06-Mar-25 18:25	ESD on Insulator replacement due to flash over of insulator
15	400KV-KARJAT-LONIKHAND-II-1	PLANNED	Maharashtra	06-Mar-25 20:14	07-Mar-25 02:42	Insulator String Replacement/ Cold washing, DT testing
16	400KV-AURANGABAD-BOISAR-1	EMERGENCY	POWERGRID-WR1 (PGCIL),POWERGRID-WR2	08-Mar-25 12:47	08-Mar-25 19:44	A/R Non Auto / for insulator replacement work at tower no 604.
17	400KV-AURANGABAD-BOISAR-2	EMERGENCY	POWERGRID-WR1 (PGCIL),POWERGRID-WR2	08-Mar-25 12:21	08-Mar-25 19:52	for insulator replacement work at tower no 604.
18	765KV-Solapur-Raichur-2	EMERGENCY	RSTCL	14-Mar-25 10:19	14-Mar-25 13:38	ESD for Damaged Insulator replacement work at Tower number : 64 (Location number :9/23) in - R Phase
19	400KV-CHHEGAON-RAJGARH-1	EMERGENCY	Madhya Pradesh,POWERGRID-WR2	22-Mar-25 09:54	22-Mar-25 14:50	ESD for for attending insulator replacement work at loc no 562
20	765KV-BINA-INDORE-1	EMERGENCY	POWERGRID-WR2 (PGCIL)	10-Apr-25 12:56	10-Apr-25 18:55	ESD to attend replacement of flashover insulator
21	765KV-RAIPUR-PS -JHARSUGUDA-1	EMERGENCY	OGPTL	13-Apr-25 07:18	13-Apr-25 12:47	ESD to replace the faulty insulator at Tower no. 215
22	400KV-Raigarh-JHARSUGUDA-3	EMERGENCY	POWERGRID-WR1 (PGCIL)	19-Apr-25 06:41	19-Apr-25 11:19	To attend the de-capped CLR insulator string at Location 805 to avoid any unforeseen event .
23	400KV-BABLESHWAR-PADGHE-2	EMERGENCY	Maharashtra	20-Apr-25 17:44	21-Apr-25 00:47	Insulator cleaning between loc 847 to 854
24	765KV-Solapur-Raichur-2	EMERGENCY	RSTCL	20-Apr-25 14:16	20-Apr-25 18:56	ESD for replacement of the damaged insulator at Tower number 323
25	400KV-MAGARWADA-NAVSARI-2	EMERGENCY	POWERGRID-WR2 (PGCIL)	23-Apr-25 12:19	23-Apr-25 18:35	to attend the broken insulator ckt 1
26	400KV-MAGARWADA-NAVSARI-1	EMERGENCY	POWERGRID-WR2 (PGCIL)	23-Apr-25 12:13	23-Apr-25 18:05	To attend the broken insulator
27	400KV-BABLESHWAR-PADGHE-1	EMERGENCY	Maharashtra	11-May-25 19:54	11-May-25 22:48	ESD to replace the flash over insulator disc
28	400KV-BABLESHWAR-PADGHE-2	EMERGENCY	Maharashtra	15-May-25 21:11	16-May-25 08:42	ESD for Replacement of one burst Insulator string of DTN at location 98 Y phase observed in patrolling
29	400KV-BABLESHWAR-PADGHE-2	EMERGENCY	Maharashtra	15-May-25 21:11	16-May-25 08:48	ESD for Replacement of one burst Insulator string of DTN at location 98 Y phase observed in patrolling
30	765KV-Solapur-Raichur-2	EMERGENCY	RSTCL	17-May-25 10:58	17-May-25 14:57	ESD to attend damaged insulator at tower number-128
31	400KV-KHARGHAR-PUNE-PG-1	EMERGENCY	Maharashtra,WTPL-Adani	19-May-25 12:18	19-May-25 18:18	replacement of Y-Phase broken insulator at loc no 95(Matheran hill).
32	765KV-Wardha-AURANGABAD-3	EMERGENCY	POWERGRID-WR1 (PGCIL)	24-May-25 13:08	24-May-25 18:56	For Replacement of Broken Insulator (Polymer) at Samruddhin Highway crossing , Loc - 706
33	400KV-DHULE-MS-BABLESHWAR-1	EMERGENCY	Maharashtra	05-Jun-25 10:10	05-Jun-25 14:53	ESD to attend the flashover insulator at Loc no.388
34	400KV-BABLESHWAR-PADGHE-PG-1	EMERGENCY	DUMMY	06-Jun-25 03:19	06-Jun-25 12:43	Replacement disc Insulator strings at location 768 cut point Y Phase String
35	400KV-BABLESHWAR-PADGHE-1	EMERGENCY	Maharashtra	08-Jun-25 09:44	08-Jun-25 20:09	ESD for Flashovered Disc insulator string replacement by PLRI at loc 822 cutpoint & cut point D shackle bolt found loose At T.L no 741
36	400KV-PADGHE-BOISAR-1	EMERGENCY	POWERGRID-WR2 (PGCIL)	10-Jun-25 15:19	10-Jun-25 19:01	insulator was found damaged at Tower No. 737 accompanied by an abnormal sound and minor sparking.
37	400KV-DHARIWAL-PARLI-2	EMERGENCY	Dhariwal-STU (DIL),POWERGRID-WR1	12-Jun-25 08:56	12-Jun-25 17:00	Rectification of Insulator string of 400 KV Dhariwal Parli Ckt-2A is found broken at Loc No. 172.
38	400KV-BABLESHWAR-PADGHE-1	POST OCC	Maharashtra	14-Jun-25 09:22	14-Jun-25 19:50	1. To replace Insulator strings under scheme 2. To attain defects identified in line Patrolling. 3. To replace Faulty PID insulator string
39	400KV-BABLESHWAR-PADGHE-1	POST OCC	Maharashtra	15-Jun-25 08:58	15-Jun-25 21:05	1. To replace Insulator strings under scheme 2. To attain defects identified in line Patrolling. 3. To replace Faulty PID insulator string
40	765KV-Pune-GIS-PADGHE-PG-1	EMERGENCY	CWRTL-Adani,POWERGRID-WR1 (PGCIL)	26-Jun-25 10:06	26-Jun-25 18:12	Emergency outage is required on 765kv Pune- Padghe Ckt-1 on dated 26.06.2025 from 07:00 hrs to 16:00 hrs for The insulator string of 400 KVÂ Bhadrawati DhariwalÂ Ckt-2 is broken at Loc No. 8.
41	400KV-BHADRAWATI-PARLI-1	EMERGENCY	POWERGRID-WR1 (PGCIL)	01-Jul-25 10:31	01-Jul-25 17:50	ESD for insulator replacement
42	400KV-KHARGHAR-PUNE-PG-1	EMERGENCY	Maharashtra,WTPL-Adani	02-Jul-25 05:57	02-Jul-25 08:21	ESD for insulator replacement
43	400KV-KARJAT-LONIKHAND-II-1	PLANNED	Maharashtra	10-Jul-25 11:59	10-Jul-25 17:42	Insulator String Replacement
44	400KV-NAVSARI-DGEN-2	EMERGENCY	DGEN	06-Aug-25 06:10	06-Aug-25 10:09	Insulator string Broken in Bottom Phase circuit of 400KV DGEN -Navsari Ckt-2 on Tower no-112 toward Navsari side
45	765KV-Pune-GIS-PADGHE-PG-1	EMERGENCY	CWRTL-Adani,POWERGRID-WR1 (PGCIL)	07-Aug-25 13:25	07-Aug-25 20:07	For insulator replacement work at Loc 600.NL- 586
46	765KV-AURANGABAD-PADGHE-PG-2	EMERGENCY	POWERGRID-WR1 (PGCIL)	07-Aug-25 12:49	07-Aug-25 20:15	For insulator replacement work at Loc 600.
47	400KV-Bhadrawati-RAMAGUNDAM-2	EMERGENCY	POWERGRID-SR,POWERGRID-WR1 (PGCIL)	14-Aug-25 09:18	14-Aug-25 19:12	Rectification of broken polymer insulator string at loc.no.463 with 400 Kv Bhadrawati Ramagundam Ckt 1
48	400KV-LONIKHAND-PUNE-PG-1	EMERGENCY	Maharashtra,WTPL-Adani	15-Aug-25 14:32	15-Aug-25 20:59	for replacement of discs type insulator strings with AF long rod insulator by LMSD Chakan.
49	765KV-BINA-JABALPUR-3	EMERGENCY	JTCL	26-Aug-25 16:12	26-Aug-25 21:45	damaged insulatorat tower no-472

Details of Transmission Elements Affected due to Insulator failure in Western Region since Jan 2025						
Sl. No	Name	Outage Type	Owners	Outage Date & Time	Revival Date & Time	Reason
50	765KV-TAMNAR-DHARAMJAYGARH-2	EMERGENCY	GTPL	03-Sep-25 12:03	03-Sep-25 17:15	during our regular patrolling of the 765KV TAMNAR-DHARAMJAYGARH-2 line, found damaged insulator at location no. loc.no AP25 & AP29
51	400KV-BHADRAWATI-PARLI-1	EMERGENCY	POWERGRID-WR1 (PGCIL)	11-Sep-25 16:00	11-Sep-25 20:30	A/R Non Auto / Non auto required for replacement of broken insulator on 400kv Dhariwal-Parli-2A/R in non auto for attending fault on 400kV Bhadrawathi Dhariwal
52	765KV-Wardha-AURANGABAD-4	EMERGENCY	POWERGRID-WR1 (PGCIL)	17-Sep-25 09:50	17-Sep-25 19:09	A/R Non Auto / ESD to replace the insulator at loc 706
53	400KV-BHADRAWATI-PARLI-1	PLANNED	POWERGRID-WR1 (PGCIL)	22-Sep-25 07:59	22-Sep-25 19:55	Insulator replacement work
54	400KV-DHARIWAL-PARLI-2	PLANNED	Dhariwal-STU (DIL), POWERGRID-WR1	23-Sep-25 08:05	23-Sep-25 20:26	Insulator replacement work
55	400KV-BHADRAWATI-PARLI-1	PLANNED	POWERGRID-WR1 (PGCIL)	24-Sep-25 07:44	24-Sep-25 22:41	Insulator replacement work
56	400KV-DHARIWAL-PARLI-2	PLANNED	Dhariwal-STU (DIL), POWERGRID-WR1	25-Sep-25 07:59	25-Sep-25 20:46	Insulator replacement work
57	400KV-Wardha-AURANGABAD-2	EMERGENCY	POWERGRID-WR1 (PGCIL)	26-Sep-25 21:47	Still out	For insulator replacement work in 400 Kv Wardha Aurangabad I ,
58	400KV-Wardha-AURANGABAD-1	FORCED	POWERGRID-WR1 (PGCIL)	26-Sep-25 16:30	27-Sep-25 17:15	Line tripped on Y-G fault. On patrolling , insulator decapping found at Loc. 468.
59	400KV-BHADRAWATI-PARLI-1	PLANNED	POWERGRID-WR1 (PGCIL)	26-Sep-25 07:58	26-Sep-25 20:54	Insulator replacement work
60	400KV-BHADRAWATI-PARLI-1	PLANNED	POWERGRID-WR1 (PGCIL)	28-Sep-25 07:38	28-Sep-25 18:50	Insulator replacement work



भारत सरकार/ Government of India
विद्युत मंत्रालय/ Ministry of Power
केन्द्रीय विद्युत प्राधिकरण/ Central Electricity Authority
विद्युत प्रणाली अभियांत्रिकी एवं प्रौद्योगिकी विकास प्रभाग
Power System Engineering & Technology Development Division

Date: 29.10.2025

Office Order

विषय: Constitution of Committee to address the frequent transmission line outages on account of Insulator failures -reg.

महोदया/ महोदय,

Of late frequent outages of transmission lines on account of insulator failures have been observed. Given its bearing & significance, the matter merits a comprehensive root-cause analysis, and dealing with all pertinent issues holistically so that suitable measures can be put in place to arrest their failures.

2. Accordingly, a Committee, comprising the following members, is hereby constituted:

1.	Member (Power Systems), CEA	Chairman
2.	Chief Engineer (PSE&TD), CEA	Member
3.	Representative from PGCIL	Member
4.	Representative from Grid India	Member
5.	Representative from MSETCL	Member
6.	Representative from GETCO	Member
7.	Representative from MPPTCL	Member
8.	Representative from M/s Deccan Enterprises	Member
9.	Representative from M/s Aditya Birla	Member
10.	Representative from M/s Modern Insulators	Member
11.	Director (PSE&TD), CEA	Convener

3. TOR of the Committee:

- The Committee shall examine the incidents of insulator failures in order to conduct a comprehensive root cause analysis to find out the reasons of insulator failures.
- The Committee shall recommend remedial measures to avert such failures in future.
- The Committee after due deliberations shall submit its report within two months of its constitution.

4. Committee may co-opt any additional member, if required.

This issues with the approval of Competent Authority

भवदीय / Regards,
Signed by Bhanwar Singh
Meena
Date: 29-10-2025 18:17:07
(भवर सिंह मीना /Bhanwar Singh Meena)
निदेशक/Director

To,

Chairman & Managing Director, Powergrid Corporation of India, Gurugram, Saudamini, Plot No. 2, Sector-29, Gurgaon- 122001 (Haryana),	cmd@powergrid.in
Chairman & Managing Director, Grid Controller of India, First Floor, B-9, Qutab institutional Area, katwaria Sarai, Delhi- 110016	cmd@grid-india.in
Managing Director, Maharashtra State Electricity Transmission Company Ltd., C-19, E-Block Prakashganga, Bandra-Kurla Complex Bandra(E), Mumbai 400051.	dirop@mahatransco.in md@mahatransco.in
Managing Director, Gujarat Energy Transmission Corporation Ltd. Sardar Patel Vidyut Bhawan, Race Course, Vadodara- 390007	md.getco@gebmail.com cetr.getco@gebmail.com
Chairman & Managing Director, Madhya Pradesh Power Transmission Co. Ltd. Block No.2, Shakti Bhawan, Rampur, Jabalpur (M.P.) – 482008.	md@mptransco.nic.in
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Chief Executive Officer, Aditya Birla Insulators 303-304, GUNJAN TOWER, Near: Alembic Petrol Pump, Alembic-Gorwa Road,Vadodara (Gujarat)India, Pin - 390023.	abi.domestic@adityabirla.com abi.export@adityabirla.com
Chief Executive Officer, Modern Insulators Limited Talheti, Village Karoli, Tehsil Abu Road, Dist- Sirohi, Rajasthan- 307510	milabu@moderninsulators.com dpkudas@moderninsulators.com

Copy To,

1. SA to Chairperson, CEA
2. SA to Member (PS), CEA
3. PA to Chief Engineer (PSE&TD), CEA



भारत सरकार/ Government of India
विद्युत मंत्रालय/ Ministry of Power
केन्द्रीय विद्युत प्राधिकरण/ Central Electricity Authority
विद्युत प्रणाली अभियांत्रिकी एवं प्रौद्योगिकी विकास प्रभाग
Power System Engineering & Technology Development Division

Date: 26.12.2025

सेवा में,

<As per Address List>

विषय: Minutes of the first meeting of the Committee to address the frequent transmission line outages on account of Insulator failures - reg.

महोदया/ महोदय,

The first meeting of the committee to address the frequent transmission line outages on account of Insulator failures was held under the Chairmanship of Member (Power System), CEA, on 19.12.2025 at 03:00 p.m. in Manthan Conference Hall, 2nd Floor, Sewa Bhawan, R.K. Puram, New Delhi, 110066, through hybrid mode.

The minutes of the meeting are enclosed herewith for kind reference and necessary action by all concerned please.

भवदीय / Regards,

Digitally signed by
Bhanwar Singh Meena

Date: 26-12-2025

12:26:50

(भवर् सिंह मीना/ Bhanwar Singh Meena)

निदेशक/Director

Copy to:

1. SA to Member (PS), CEA
2. PS to Chief Engineer (PSE&TD), CEA

Address List

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				E-mail
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3	MSETCL	Mr. Anil Bharsakle	Chief Engineer (Tr.O&M)	ceom@mahatransco.in
		Mr. Yogesh Chavan	Superintending Engineer(Tr.O&M)	se1om@mahatransco.in
4	GETCO	Mr. P.R.Vasava	Executive Engineer	eetrvii@gebmil.com ; eerandm@gebmil.com
5	MPPTCL	Sh. Vinay Kumar Parwar	Superintending Engineer	parwarjvk@gmail.com
6	Deccan Enterprises	Sh. Vikas Jalan	MD	
		Sh. D. Mukherjee	President	dmukherjee@deccan.in
		Sh. Vineeth Pachava	Manager Technology	
7	Aditya Birla Insulators	Sh. Chandan Banerjee	Regional Head South-East Asia & India (North)	chandan.banerjee@adityabirla.com
8	Modern Insulators Ltd.	Dr. Sudalai Shunmugam	Jt. Vice President	sudalaishunmugam@moderninsulators.com
		Sh. Ashish Tripathi	Manager-Design	ashishtripathi@moderninsulators.com
		Sh. N.V. Ramkumar	Sr. V.P. (Tech. & Dev.)	nvramkumar@moderninsulators.com

Power System Engineering & Technology Development Division

Central Electricity Authority

Minutes of the first meeting of the Committee to address the frequent transmission line outages on account of Insulator failures:

A meeting was held under the Chairmanship of Member (Power System), CEA, on 19.12.2025 at 03:00 p.m. in Manthan Conference Hall of CEA in hybrid mode to address the frequent transmission line outages on account of Insulator failures. The list of the participants is given at **Annexure-I**.

Member (Power System), CEA welcomed all the participants to the meeting, and informed that the Committee was constituted vide CEA letter dated 29.10.2025, pursuant to the communication received from NLDC letter dated 06.10.2025, highlighting repeated tripping of 400 kV and above transmission lines due to insulator failures. He stated that the Committee shall undertake a detailed examination of insulator failures across regions, assess the data, and recommend remedial measures to avert such failures in future. He then requested Chief Engineer (PSE&TD), CEA to take up the agenda.

2. Chief Engineer (PSE&TD), CEA welcomed all the participants, and informed that as highlighted in the Grid-India communication dated 06.10.2025 outages of transmission lines esp. in critical loaded corridors on account of frequent insulator failures have significant impact on grid reliability, and in several cases, failures were also observed in the newly commissioned transmission lines. He stressed upon the importance of systematic collection and analysis of failure data, including details such as year of commissioning, years of service, voltage level, type & make of insulator, batch details, environmental conditions, failure location, maintenance aspects, and remedial actions taken. He stated that the objective of the Committee is to identify immediate, short-term and long-term measures to address the issue, and to suggest improvements in the technical specifications of the Insulators (porcelain as well as composite) so as to make them robust for Indian operating conditions. He then requested NLDC, OEMs of insulators, and Transmission Utilities to give their presentations on the agenda items.
3. The representative of NLDC presented an analysis of transmission line outages attributed to insulator failures based on outage data received to them . It was informed that during the period January, 2025 to September, 2025, repeated trippings of 400 kV and above transmission lines were observed on several critical EHV corridors, particularly those forming part of inter-regional power transfer links. In a number of cases, such outages resulted in prolonged restoration times, thereby impacting grid security. Region-wise analysis indicated a higher incidence of such outages in the Western and Eastern Regions, with specific corridors witnessing repeated trippings. It was further noted that many of the reported failures occurred on newly commissioned transmission lines. The causes reported by utilities included lightning, flashover, physical damage, de-capping and other electrical phenomena, however, in many cases detailed failure descriptions were not available, limiting precise root cause identification. NLDC emphasized the need for consistent and detailed reporting of insulator failure incidents, systematic root cause analysis, creation of a centralized database of insulator failures, adoption of condition-based monitoring techniques, and enhanced coordination among utilities, OEMs and system operators.
4. The representative of M/s. Deccan Insulators gave their presentation (**Annexure-II**) based on analysis of composite insulator failures observed in EHV transmission lines and the corrective and preventive measures undertaken/ proposed. The salient points of the presentation are as follows:

- a) More than four lakh composite long rod (CLR) insulators have been supplied by M/s. Deccan Insulators for EHV transmission systems.
- b) Analysis of reported failures indicated that a majority of the failures were concentrated in a limited number of transmission lines, accounting for nearly 95% of the reported incidents.
- c) The affected lines exhibited common characteristics such as high pollution severity, frequent lightning activity, cyclonic environmental conditions and hardware compatibility issues.
- d) Root cause analysis indicated that failures were attributable to a combination of factors including marginal technical specifications followed earlier, manufacturing variability in certain earlier batches (notably around 2018), high electric field stress and severe environmental conditions.
- e) Immediate corrective and preventive actions included enhanced IR scanning of critical corridors, identification and removal of suspect insulators and focused monitoring of affected lines.
- f) Improvements were undertaken in raw material specifications, including strengthening of FRP rod properties, improvement in glass transition temperature of FRP rods.
- g) Additional screening and testing measures such as Dry Power Frequency Testing (DPFT) of FRP rods were introduced to detect latent defects.
- h) Project-specific Electric Field Modelling (EFM) was adopted to ensure compatibility between insulator and hardware configuration and to control electrical stress.
- i) Emphasis was placed on proper shed design, increased sheath thickness, hardware standardization and adherence to recommended handling, storage and installation practices.
- j) It was stated that with strengthened specifications and improved manufacturing controls, composite insulators can reliably achieve a long-term service life.

5. The representative of Power Grid Corporation of India Limited (PGCIL) gave presentation (**Annexure-III**) on failures observed in composite long rod (CLR) insulators, findings of root cause analysis and improvements incorporated in the revised technical specifications. The salient points of the presentation are as follows:

- a) Failures observed in CLR insulators were broadly categorized into electrical and mechanical failures.
- b) The root cause of insulator failure can be attributed to raw material quality, design, improper manufacturing process, improper handling / storage / installation.
- c) Electrical failures were characterized by discharge activity, tracking, burning, flash-under, loss of hydrophobicity and degradation of FRP rods, whereas purely mechanical failures were observed only in a limited number of cases.
- d) Laboratory examination of the failed and suspected insulators revealed non-uniform moulding of silicone rubber around the FRP rod, interfacial gaps between housing and rod, degradation of bonding and moisture ingress.
- e) Chalking of silicone rubber surface, separation between glass fibre and epoxy resin matrix and axial degradation of insulators were observed in several cases.
- f) In a majority of failures, damage was located approximately 1 to 1.5 feet from the high-voltage end fitting, indicating concentration of electrical stress in that region.
- g) Extensive testing of failed, in-service and new insulators indicated that even failed insulators were passing earlier standard tests, highlighting inadequacy of earlier testing requirements.
- h) Based on root cause analysis, the technical specification for composite long rod insulators has been revised to enhance material requirements, increase minimum rubber sheath thickness, strengthen water diffusion and water absorption limits and specify minimum glass transition temperature for FRP rods.

- i) Electric field modelling requirements have been strengthened by mandating project-specific EFM studies for the actual insulator and hardware combination.
 - j) Type and acceptance testing requirements have been enhanced by inclusion of additional diagnostic tests and tighter acceptance criteria. In Type test, recovery of Hydrophobicity test modified to include Corona exposure at 12KV continuously for 100 hours instead of few minutes required earlier for making the sample hydrophilic, Ozone Resistance test on housing & weather shed material as per IEC 61854 introduced and Water diffusion test followed by pull-off test introduced (as per CIGRE TB-919).
6. The representative of M/s Modern Insulators pointed out that any broad attribution of failures to a particular category of insulators should be supported by detailed and segregated data, and that conclusions regarding relative performance of porcelain and composite insulators should be drawn only after comprehensive analysis. He also emphasized that environmental factors such as pollution severity should be assessed using established methodologies in line with IEC guidelines, rather than generic pollution mapping. He further sought clarifications regarding the exact nature and location of observed failures, including whether failures were predominantly electrical or mechanical in nature, the proximity of failure points to high-voltage end fittings, and whether phenomena such as flashover, tracking, partial discharge or degradation of FRP rods were observed. It was suggested that details such as presence of puncture marks, extent of degradation, and evidence of brittle fracture or decay of FRP rods should be systematically captured to enable meaningful root cause analysis. He further emphasized the importance of understanding the role of design aspects such as grading ring configuration, hardware compatibility, electric field control and application-specific stresses. It was suggested that failure analysis should distinguish between design-related issues, manufacturing variability, and site-specific operational and environmental conditions. The need for deeper technical examination of failure mechanisms, rather than generic classification of insulator failures, was underscored to enable formulation of effective and durable corrective measures.
7. The representative of M/s Aditya Birla Insulators sought clarification regarding the effectiveness and limitations of IR scanning as a diagnostic tool, including its reliability, frequency of application and correlation with actual failure modes. It was suggested that quantitative linkage between observed hotspots and subsequent failures needs to be established. The need for improved traceability of insulators, including batch identification and correlation of field failures with manufacturing data, was also highlighted.
8. Chief Engineer (PSE&TD), CEA remarked that addressing insulator failures requires coordinated efforts by system operators, utilities and manufacturers. The inputs received during the meeting would be examined further and additional data would be sought to enable formulation of appropriate recommendations. He also stated that while critically analyzing the insulator failure events is important, for which suitable inputs from NLDC and transmission utilities are required, since the concerned utilities in whose networks insulator failure events occur generally report those events to concerned OEMs for root cause analysis, the underlying issues relating to Insulator failures (porcelain/ composite) may not be completely unknown to the OEMs including the Member-OEMs and the Member-Utilities of this Committee; and some corrective action might have already been taken or under consideration by them. As such, it is desirable that they provide suitable inputs & suggest appropriate improvement measures which can be incorporated in the Technical Specifications of the Insulators as well as in the Utilities O&M practices concerning Insulators' health.
He further stated that whether the insulator failure events pertain only to composite long-rod insulators only, or it extends to porcelain long-rod insulators as well needed to be seen. To ascertain

the same, NLDC and Transmission utilities should furnish the relevant information for the insulator failure events in the network under their jurisdiction.

He also stated that already a few design specific parameters based on pollution levels prevailing in the area of insulators usage is in pace. There may be a need to broaden this criteria to include additional influencing factors like climatic conditions (rainfall), terrain (topography), etc., on which suitable inputs may be shared by the members. Further, international practices w.r.t improving insulators design may also need to be considered.

9. It was noted that as all the sought details required to address the insulator failures have not been obtained, the following specific details have been requested to be furnished to CEA to address the issue holistically:
- a) For the year 2025 for the network under their jurisdiction, NLDC to furnish detailed insulator failure data including Name & voltage level of the line, Reason for insulator failure, Year of commissioning of Insulator, In-service years of the Insulators before failure, Type of Insulator (Porcelain/ Composite), Make of the Insulator, Prevailing climatic conditions, Remedial action taken, relevant pictures of the failed insulators, and maintenance practices of the concerned utility to ensure insulators' health so that identification of failure patterns across voltage levels (400 kV, 765 kV) and climatic zones can be done.
 - b) For the year 2025 for the network under their jurisdiction, PGCIL and Transmission Utilities of Gujarat, Maharashtra, and Madhya Pradesh to furnish detailed insulator failure data including Name & voltage level of the line, Reason for insulator failure, Year of commissioning of Insulator, In-service years of the Insulators before failure, Type of Insulator (Porcelain/ Composite), Make of the Insulator, Prevailing climatic conditions, Remedial action taken, relevant pictures of the failed insulators, and maintenance practices of the concerned utility to ensure insulators' health so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.

Further, PGCIL and Transmission Utilities of Gujarat, Maharashtra, and Madhya Pradesh also to provide details of the improvements made in the technical specifications of Porcelain long-rod type Insulators and Composite long-rod type Insulators, and furnish a copy of latest versions of both. Further, they shall also provide the details of the O&M measures being undertaken to ensure insulators' health in their respective networks.

- c) Member OEMs (Deccan, Aditya Birla, and Modern Insulators) to provide inputs on improving Insulator design and material characteristics (FRP rod, shed, sheath, fittings, etc.) by duly factoring international practices and the prevailing IS/IEC standards, and suggest measures in improving technical specifications of porcelain and composite long-rod type insulators being followed by the power utilities in India.

The meeting ended with vote of thanks to all the participants.

Annexure-I**List of Participants****CEA**

1. Sh. Vijay Kumar Singh, Member (Power System)
2. Sh. N.R.L.K. Prasad, Chief Engineer (PSE&TD)
3. Sh. Bhanwar Singh Meena, Director (PSE&TD)
4. Smt. Jyoti Singh, Deputy Director (PSE&TD)
5. Sh. Amrendra Pratap Singh, Assistant Director (PSE&TD)

Aditya Birla Insulator

1. Sh. Chandan Banergi, R.H.

MODERN INSULATOR

1. Dr. Sudalai Shanmugan S., JVP (T&D)
2. Sh. Vikas Kumar, Sr. Manager

GETCO

1. Sh. P. R. Vasava, Executive Engineer

DECCAN

1. Sh. Debabrata Mukherjee, President
2. Sh. S.K. Rao, Sr. Manager
3. Sh. Yogendra Singh, AGM-Sales

POWERGRID

1. Sh. Amit Kumar, Sr. DGM
2. Md. Anisur Rahman, DGM
3. Sh. Ashish Singh, Chief Manager



ELECTRIFYING FUTURE



CEA Meeting Presentation

19th Dec' 2025

Deccan - PGCIL Case Study



Supplied: 4 Lakhs +
Insulators

Failure in
PGCIL lines
Reported

- 5 Lines of PGCIL was contributing to 95% Failures
- All these lines were showing a pattern ... high Pollution, Lightening, Cyclones, Hardware compatibility issue
- RCA -> Marginal Spec, Manufacturing noise , 2018 batch issue , High Electric Stress, Environmental Conditions
- CAPA -> IR Scanning & Suspect Removal

Joint Testing's
Data Analytics

Preliminary RCA
Combination of Factors

PGCIL Audit
Specification Change
Additional Tests

New Spec Supply will start from
Feb'26

Understood the
Pattern

5 Lines – 95%
Failures

Most Lines with Failure had a pattern

Pollution

Lightning

Cyclones

High Photon Count

Hardware

3.5 mm Sheath

Electric Stresses

Marginal Specifications

Environmental Conditions

Noise Parameters (Plant -> Site)

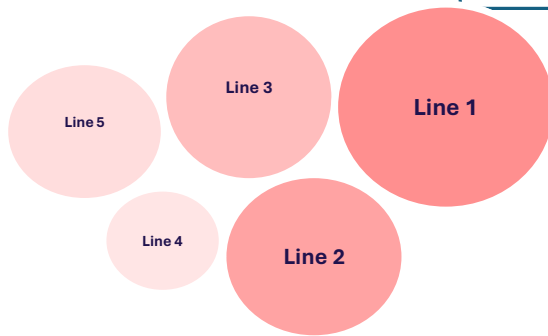
Improvements

Factory

Solutions:

- IR Scanning
- Remove suspect

Covers 95 %
of Issues



Reliability Improvement Actions after PGCIL issues reported

2022	2023	2024
FRP Rod Testing : Implemented Dry Power Frequency Testing (DPFT) on FRP rods	✓ In-house FRP Rod Manufacturing ✓ QMS Certification - QMS 9001-2015, EMS 14001-2015, OH&S 45001-2008 ✓ PGCIL Approval for FRP Manufacturing ✓ Water Diffusion Test - acceptance criteria from 1mA to 0.1mA ✓ Water absorption Test -Strengthened the acceptance criteria from 0.1% to 0.05% ✓ Tg Improvement - to 140 Deg C ✓ FRP Rod Testing at ERDA ✓ Introduction of Storage, Handling & Installation Guide ✓ ERDA Multi Stress Test (5000 Hours)	✓ EFM Validation by 3rd Party @ Integrated Software Solution (Canada) ✓ Built Data Analytics Team ✓ Leadership hiring from Industry Leaders like BHEL , GE, ABB , ALSTOM ✓ Testing of Imported Rubber in ERDA

Mostly 2018 (batch issue), very less between '18 to '22

From Failures -> **Learning** -> **Corrective Actions**



Understanding TL Complexity

Insulator is a complex product :
Not a commodity item

India is a subcontinent : every
line is different. China has line &
Zone-specific design.

Varied Climatic Condition

Application Complexity : too
many hardware's



Deep dive & Analysis

_Deccan's Analysis of PGCIL
Failures

Line / Region Specific Analysis :
Case Study Khavda

Study of China Spec and IEC
Requirements

PGCIL Technical Spec Change



Actions & Recommendations

Failure Mode Analysis :
CAPA recommendations

Raw Material as differentiators : FRP
Rod & Rubber

Design a Future Proof Insulator

Use Deccan's **Line Intel** for
understanding application

Fix the root to avoid the failure : the Technical Spec, The Design, The Application

China Spec Analysis

State Grid of China Specifications

Table 8 Technical parameters of 750 kV Composite Insulators

Specified mechanical load (kN)	120	210	300	420	550
Nominal structural height (mm)	7150/7350				
Nominal creepage distance (mm)	23500/24150				

Table 9 Technical parameters of 1000 kV Composite Insulators

Specified mechanical load (kN)	210	300	420	550	840	1000
Nominal structural height (mm)	9000/9750					
Nominal creepage distance (mm)	32000					

Table 10 Minimum sheath thickness

Voltage level (kV)	Minimum sheath thickness (mm)
110 and below	3.0
220	3.5
330	4.0
500	4.5
750	5.0
1000	6.0

Q / GDW 13253.1 — 2019

ICS 29.240

Q/GDW

State Grid Corporation of China Enterprise Standard

Q / GDW 13253.1 — 2019

Replaces Q/GDW 13253.1 — 2014

Purchasing standard of long rod composite insulators for

10kV~1000kV AC systems

Part 1: General technical specification

China used to face same failures 15~20 years back & Changed their Spec

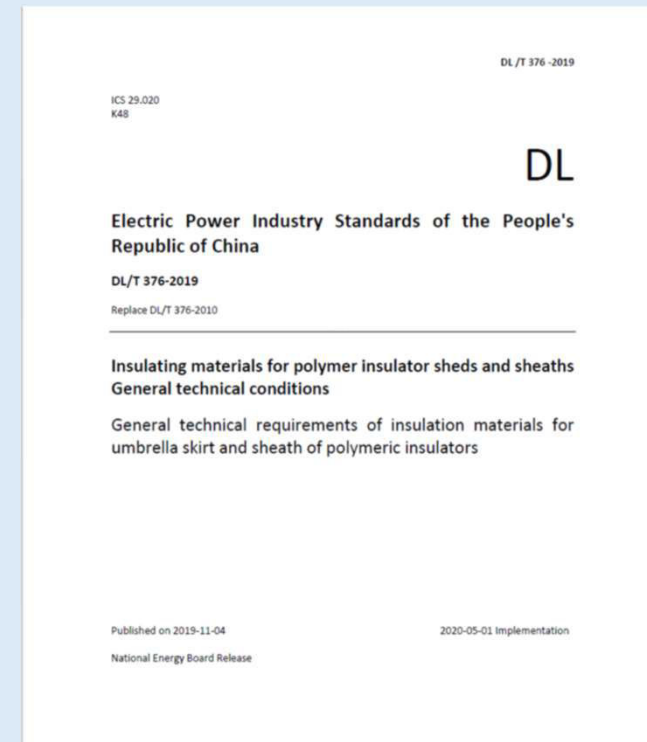
Testing for **FRP Rod** from China's Standards:

Parameters	Test Description
Steep Front Impulse Withstand Voltage Test	This test is performed on the bare rods.
Lightning Impulse Withstand Voltage Test	Performed on 5 samples of length 10±0.5mm. Sample is attached with electrodes on both ends and the sample is kept under a transformer's oil to prevent flashover. The sample should not show any breakdown or flashover at 100kV.
Thermal Induction Test	Performed on 3 samples of length 50±0.5mm. The samples are kept in an oven at 150°C for for 4 hours. After sample is cooled to room temperature, observe any oily exudate on the end face of core samples. Coat both ends with 1% ethanol solution of red or violet methine dye, and observe whether there are cracks on the ends of the core samples.
Rocking Fatigue Test	A sample of length 2240mm is kept under an oscillating swing of frequency 0.65Hz. Amplitude lies in range -200 to 400mm range. After swinging it for 12*10 ⁶ times, check for rod sample cracks or whitening of surface.
Tolerance in Diameter	In diameter, +0.03mm and -0.02 if d≤30 mm ±0.03mm if d>30mm
Mechanical Properties	Tensile Strength - 1100MPa (min) Bending Strength - 900MPa (min) In-Plane Shear Strength - 35MPa (min)
Electrical Performance	<u>Leakage Current for Water Diffusion does not exceed 0.05mA.</u> AC Breakdown Strength should not be less than 30kV/cm. Volume Volume Resistivity should not be less than 1×10 ¹⁰ (Ω.m) at 140°C
Thermal Bending Strength	After Being exposed in 150±5°C for one-hour, Thermal Bending Strength within 5 minutes should lie in range of 280MPa to 350MPa
Inspection Rules	Rod samples from each Batch is taken for inspection. The overall size of one batch shall not exceed 1000m.
Difference in Water Diffusion	After Removing samples from 100±0.5 hours boiling, the sample should be kept in a container filled with tap water at ambient temperature for at least 15 minutes. Complete the voltage test within 3 hours.
Difference in Water Absorption	6 Samples of size 50±1mm is taken for test. The sample size variation with diameter increase is not mentioned.
Manufacturing Process	Made of Epoxy resin and unblocked glass fibre extrusion and solidification
Dye Penetration	The dye is an ethanol solution containing 1% red or violet methine dye. The Dye penetration time is not less than 15 minutes.
Dry Power Frequency Withstand Voltage Test	Standard Procedure but, the temperature rise should not be more than 5K



Testing for **Silicone Rubber** from China's Standards:

Parameters	China's Standards Recommendation
Flammability	FV-0 level
Surface resistivity	Not less than 10 Siemen
Dielectric loss tangent value	Not more than 6%
Hydrophobicity weakening and Recovery characteristic (CHEMICAL)	Weakening: After soaking for 96 hrs, it is generally HC3 -HC4 level and there's no more than 1 HCS level sample Recovery: after soaking, let stand for 48 hrs, generally it is HC2 -HC3 level and no more than 1 sample of HC4 level
Resistance to tracking and electrical corrosion	Resistance to tracking and electrical corrosion must not be less than TMA4.5
Wear resistance	Volume loss is not greater than 0.3cm ²
Bending strength	Not less than 5 MPa
Impact strength	Not less than 4 kJ/m ²
Hardness change test after Water Boiling	Change should no be greater than 10% after boiling for 42 hrs
Accelerated climate test	Should meet UV Requirement
Corrosion resistance	(Acid+salt+salt reagent) 25 degrees Celsius for 24 hrs, No shedding, wrinkles, blistering or discoloration to be observed
Volume resistivity	Not less than 10
Crystallisation temperature of Insulation resistance of polyolefin material	Not lower than 100 degrees Celsius
Dielectric Strength	Not less than 20 kV/mm
Rubber Batch Size	Around 500kg
Tensile Strength	Not less than 4MPa
Elongation (Dumbell)	Not less than 150%
Tear Strength	Not less than 10 kN/m
Hardness (Shore-A)	Not less than 50
Water Absorption	Not more than 0.3%
DC Volume resistivity	Not less than 10 ¹³ m
Dielectric Constant	Not greater than 5.5:



PGCIL Technical Spec Comparison

Criteria	PGCIL Rev-2 (Jan'22)	PGCIL Rev-4 (Oct'24)
Standard Applicability	Based on PGCIL-specific needs	Updated with stricter and broader criteria
Pollution Performance	Same as GEC	Additional coverage for bird excreta mitigation
FRP Rod (Core)	ECR, Boron-free, $T_g \geq 140^\circ\text{C}$	ECR, Boron-free, $T_g \geq 140^\circ\text{C}$
HTV Silicone Rubber Sheath	Min 3 mm (AC), Min 5 mm (HVDC)	Min 5 mm for all, Si content $\geq 32\%$
Grading Rings	Used up to 765kV, slot locking	Mandatory E-field modeling, tighter specs
Electric Field Design	Basic EFM guidance	6-point EFM validation required
Corona & RI Performance	Low RI design	Strict E-field limits defined
Material for End Fittings	Forged/Cast Steel, SGCI	Stricter coatings, same materials
Sealing (End Fittings)	Silicone sealed	Proof with NDT, improved bonding
Weather Shed Profile	Alternate sheds	Same, improved quality control
Tests	IEC 61109, 62217, 60587, 62730	Extended testing , EFM, accelerated aging
Workmanship	No cracks, flash-free	10-yr guarantee with penalties
Galvanizing	600-900 gm/m ²	Same, SS bolts mandatory in marine
Design Responsibility	Supplier to design corona rings	EFM-based design validation

Deccan complying to PGCIL TS

Deccan adopted all new Test requirements

Deccan Going Beyond PGCIL TS – Designing Future Proof Insulator

PGCIL New TS is in line with China and will eliminate failures

Insulator Failure Mode Analysis:

Contributors to Insulator Life, Line Performance

Chairman's Vision

“

Recent **learnings** and subsequent root cause analysis led us to the need to review entire value chain of **design, material, manufacturing, field** and we must go beyond the **specifications** to ensure reliable performance of 25 years or more.

”

Learnings from

Failures

Chinese
Specifications

RCA

Industry Experts

Touch Point Analysis



Factors contributes to Insulator Life

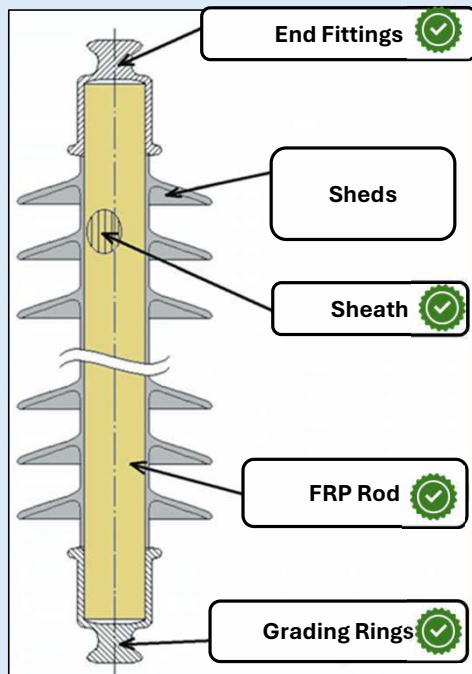
1. **Raw Materials** - > using best Rubber and Rod
2. **Manufacturing** - > additional stringent tests
3. **Transmission System** -> Corona, Electric Field, etc
4. **Insulator Design** -> Design new for long life



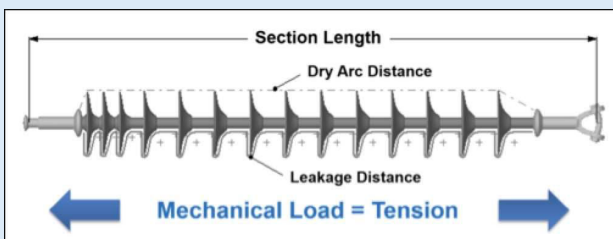
- Material Standardisation
- Stringent Tests
- **New Technical Spec**
- Electric field control thru' H/W
Standardization, GR , EFM
- **Design Future Proof insulator**

Future Proof Insulator: Insulator with 25 Years life

Design Review



Not Changed

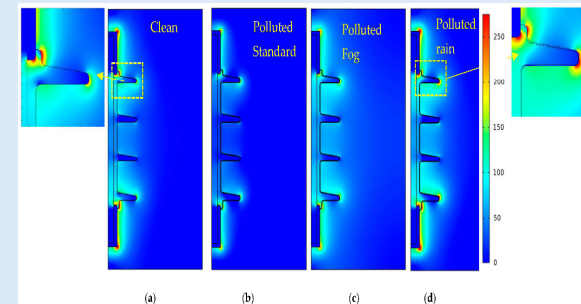
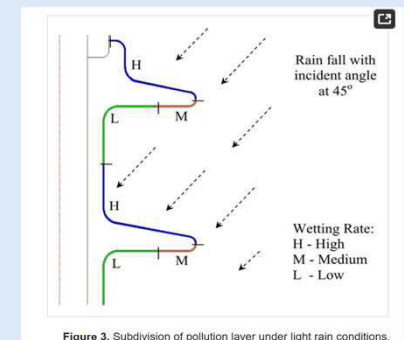


Improvements so far

- All end fittings have higher galvanisation coatings to meet coastal regions,
- 5mm sheath thickness, Rubber with < 0.25% water absorption -> New TS
- Own FRP Rod with high quality raw material and 140 TG.
- Project Specific EFM,
- Improved design for grading rings,



Sheds Design



Shed plays a important role in electric fields during extreme conditions.

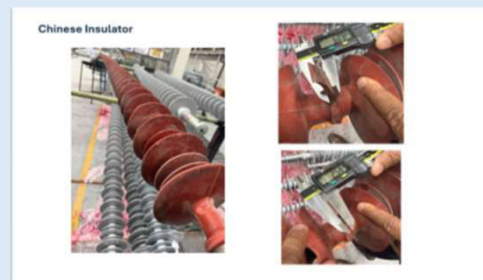
Source: <https://doi.org/10.3390/polym14030516>

Large Shed Profile Analysis w.r.t. to proven design



China's Standards

- For **1000 kV minimum**
 - Sheath Thickness : 6 mm
 - Large Shed base thickness : 7 mm (Sheath +1)
- Estimate For **765 kV**
 - Sheath Thickness : 5 mm
 - Large Shed base thickness : 6 mm (Sheath +1)



Actual
measurement



	Base Thickness	Tip Thickness
Large Shed	6.08	2.58

HVDC Insulator Design with 5mm Sheath

	Base Thickness	Tip Thickness
Large Shed	6.717	2.56

Recommendation:

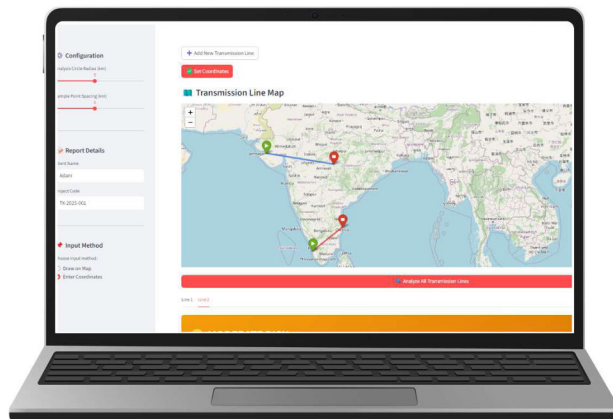
- Proven insulators have large Shed base = Sheath Thickness 5mm + 1 = 6 mm*

Deccan's first Digital Product : Line Intel

Environmental Analysis App for Transmission Lines

Deccan LineIntel

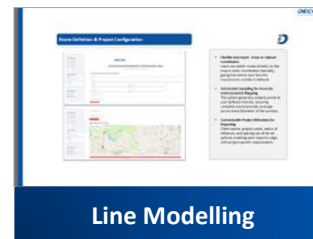
Smart Insights Across Every Kilometer of Your Transmission Line !



OBJECTIVES

- India is a sub-continent & every line is different
- Risk related to every line and terrain are to be studied / analyzed

KEY FEATURES OF LINEINTEL



Line Modelling



Risk Intelligence



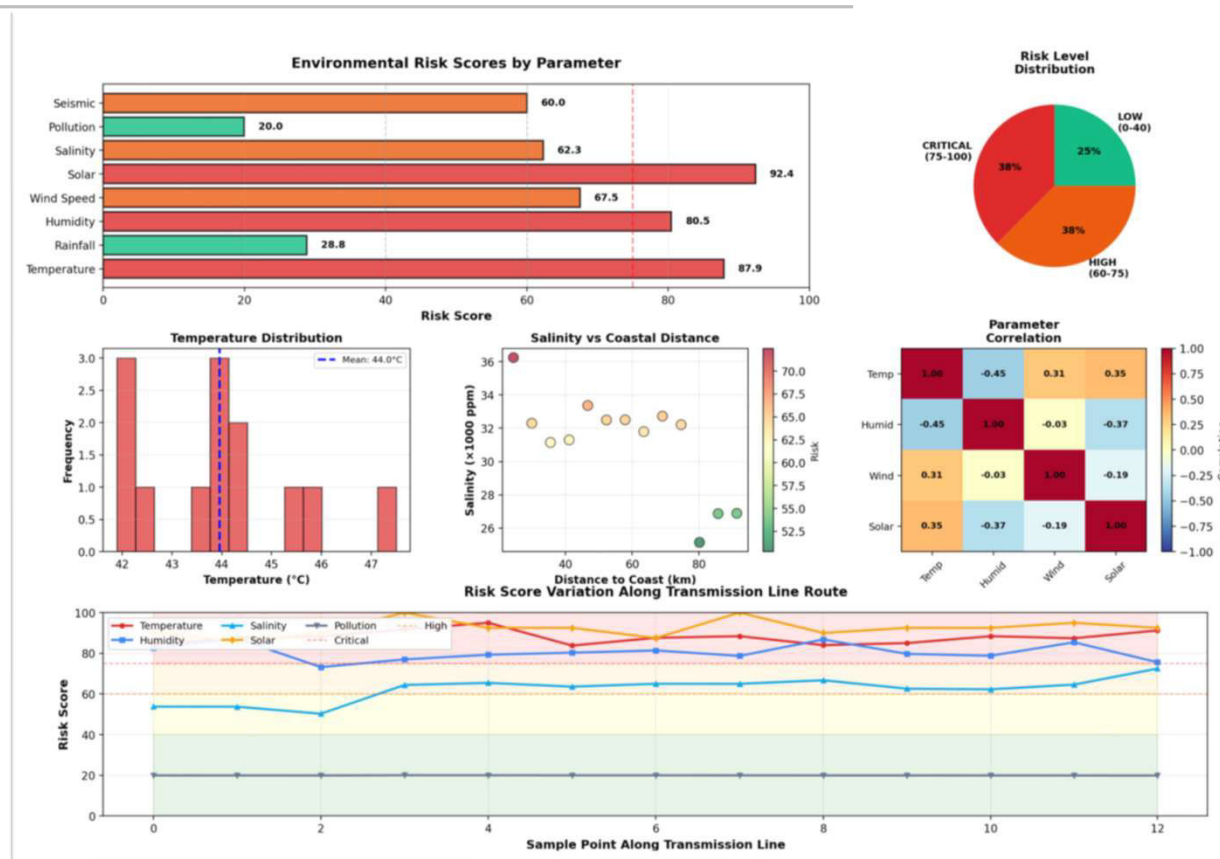
Geo Heatmaps



Report Suite

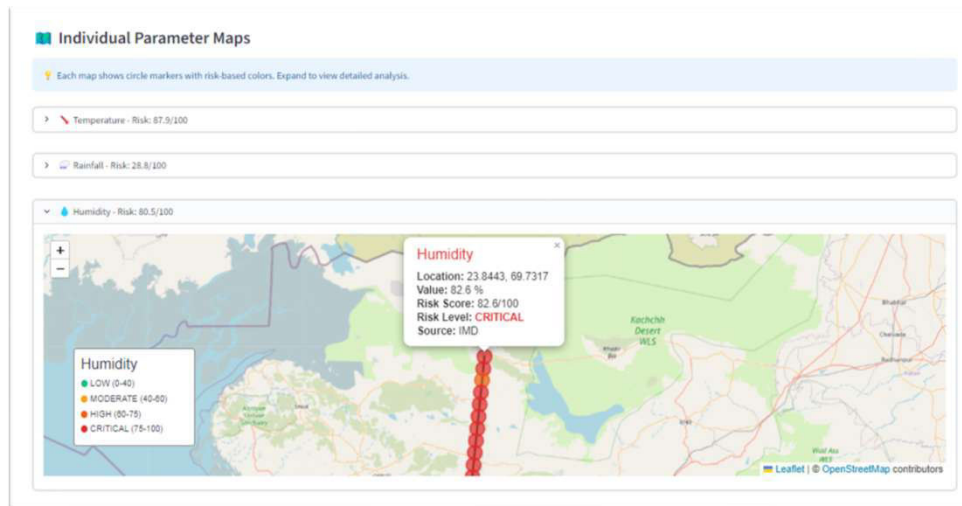


Risk Analysis Dashboard



- Understand Corridor Risk
- Identify Hotspots with Multi-Parameter Diagnostics
- Support Data-Backed Engineering Decisions

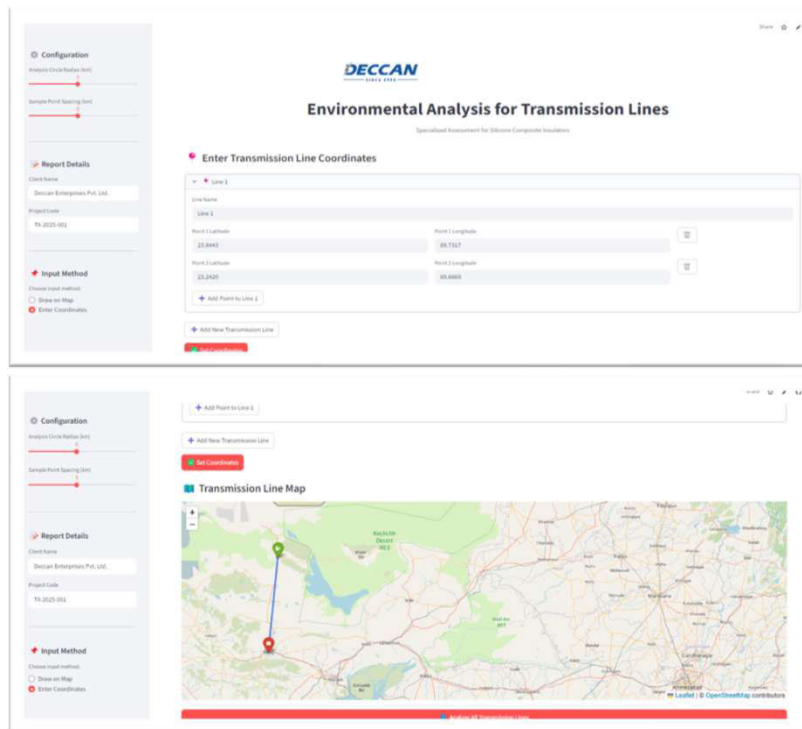
Detailed Parameter wise analysis



- Visualize Environmental Stress Along the Line**
 Interactive GIS maps show color-coded risk markers for every environmental parameter, making hotspot identification intuitive and immediate.
- Location-Specific Insights for Every Parameter**
 Each marker displays exact values (temperature, humidity, salinity, pollution, wind, etc.) along with risk scores and source attribution.
- Enhanced Precision with Geospatial Modelling**
 Distance-to-coast, pollution weighting, and coordinate-based variability create realistic environmental profiles for design and asset risk evaluation.



Route Definition & Project Configuration



Configuration

Analysis Circle Radius (km)

Sample Point Spacing (km)

Report Details

Client Name
Deccan Enterprises Pvt. Ltd.

Project Code
TX-2023-012

Input Method

Choose input method:

☐ Draw on Map

☒ Enter Coordinates

Enter Transmission Line Coordinates

Line 1

Point 1 Latitude	Point 1 Longitude	Point 2 Latitude	Point 2 Longitude
23.8443	80.7537	23.2426	80.8888

[Add Point to Line 1](#)

[Add New Transmission Line](#)

[Get Coordinates](#)

Transmission Line Map

- Flexible Line Input - Draw or Upload Coordinates**
 Users can sketch routes directly on the map or enter coordinates manually, giving full control over how the transmission corridor is defined.
- Automated Sampling for Accurate Environmental Mapping**
 The system generates analysis points at user-defined intervals, ensuring complete environmental coverage across every kilometer of the corridor.
- Customizable Project Metadata for Reporting**
 Client names, project codes, radius of influence, and spacing can all be set upfront, enabling each report to align with project-specific requirements.

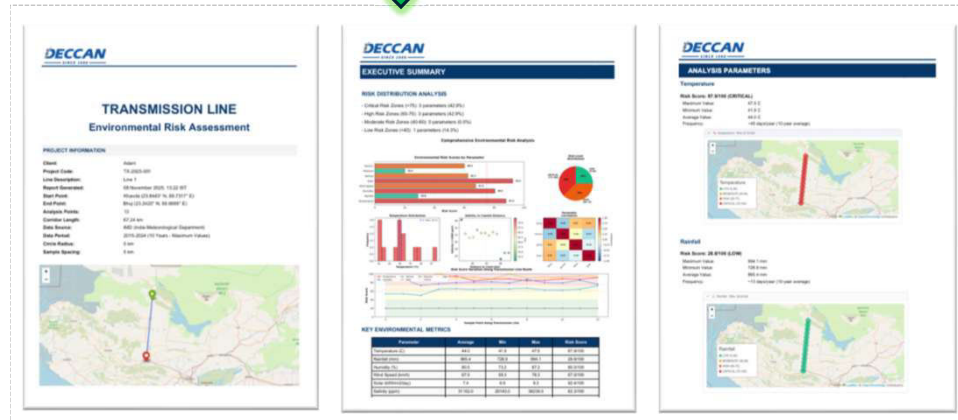
Insights Export & Technical Documentation



Detailed Analysis Data

ID	Lat	Long	Temp_max_risk	Temp_min_risk	Humidity_max_risk	Humidity_min_risk	Wind_max_risk	Wind_min_risk	Soil_max_risk	Soil_min_risk	Altitude_max_risk	Altitude_min_risk
1	23.8919	89.7357	42.2	45	84.2	79.2	23	13.267	82.9	208	82.5	83.8
2	23.7541	89.7253	43.9	45	87.8	78.2	9	24.3733	87.2	247	87.2	88.2
3	23.7439	89.7209	44.1	45	88.2	78.7	11	26.19	78.2	136	78.2	82.1
4	23.8937	89.7253	43.9	45	76.9	88.9	20	25.8967	77	249	77	88.9
5	23.8435	89.7253	47.5	45	95	88.6	11	32.82	79.3	142	79.3	72
6	23.8939	89.7367	43.9	45	83.5	88.2	9	32.8967	80.3	140	80.3	80.5
7	23.5432	89.6893	42.8	45	87.8	88.9	26	25.3833	82.4	135	82.4	78.3
8	23.4433	89.6893	44.2	45	88.4	78.1	17	25.5267	78.7	134	78.7	80
9	23.4439	89.6893	42	45	88	88.9	18	31.1833	86.9	139	86.9	79.2
10	23.3039	89.6893	42.5	45	88	88.9	17	30.9267	79.7	140	79.7	78.9

Download Reports



- Professional Multi-Page Engineering Reports**
 Automatically generated PDFs include summaries, key metrics, parameter analysis, and risk classifications based on IMD's 10-year maximums and geospatial models.
- Actionable Technical Recommendations** Reports
 dynamically produce maintenance and material recommendations-such as high-temperature insulators or anti-tracking coatings-based on actual risk levels.
- Exportable Data for Engineering Teams**
 CSV exports provide raw and processed environmental values for deeper analysis by design, reliability, and asset management teams.

Final Notes

PGCIL Issue's were mostly one batch (2018) related...IR scanning done to remove suspects , High Risk (3 lines) are protected, CAPA implemented

Since every line, zone, application (e.g. Solar) is different , **India should have zone specific line design....** China has

Further scope of TS Improvement :

- Specify Minimum **Shade Base of 6mm** for > 400kV
- Rubber **ATH size should be < 5 Micron**
- Longer Field performance for new sub-vendor

Handling & Storage of Insulators should be as per OEM's guidelines

PGCIL new TS adequately taking care of different failure modes - 5 mm Rubber, Testing beyond standards will eliminate failures.

Hardware compatibility (Project Specific EFM) , Shifting of Insulators from one line to other line to be avoided

A properly designed Silicone Composite insulator, using the RM, complying the EFM requirements , can give 30 Years life.

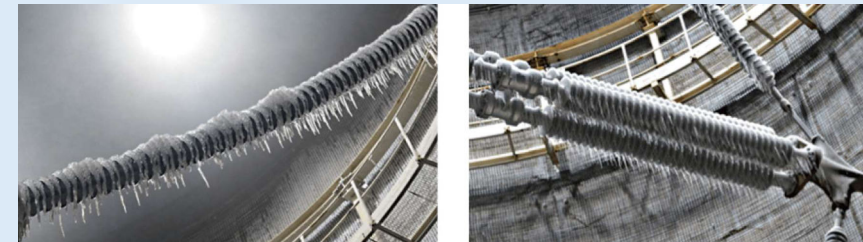
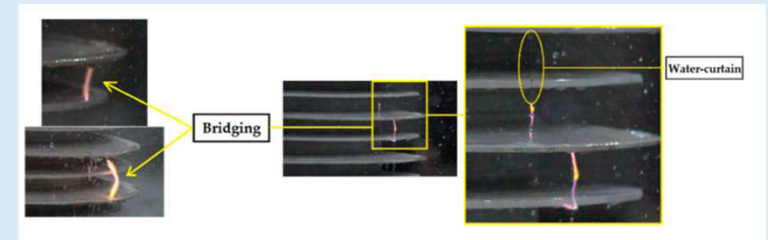
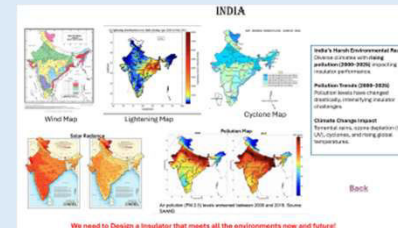
**“Wrong is wrong, even if everyone is doing it,
...Right is right, even if no one is doing it”**

Deccan will do the right thing, even with some short-term financial hit

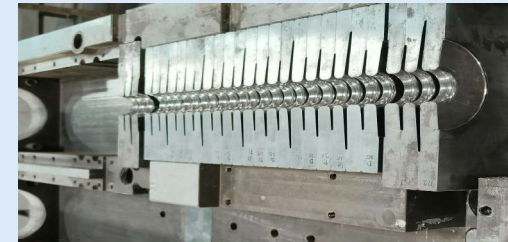
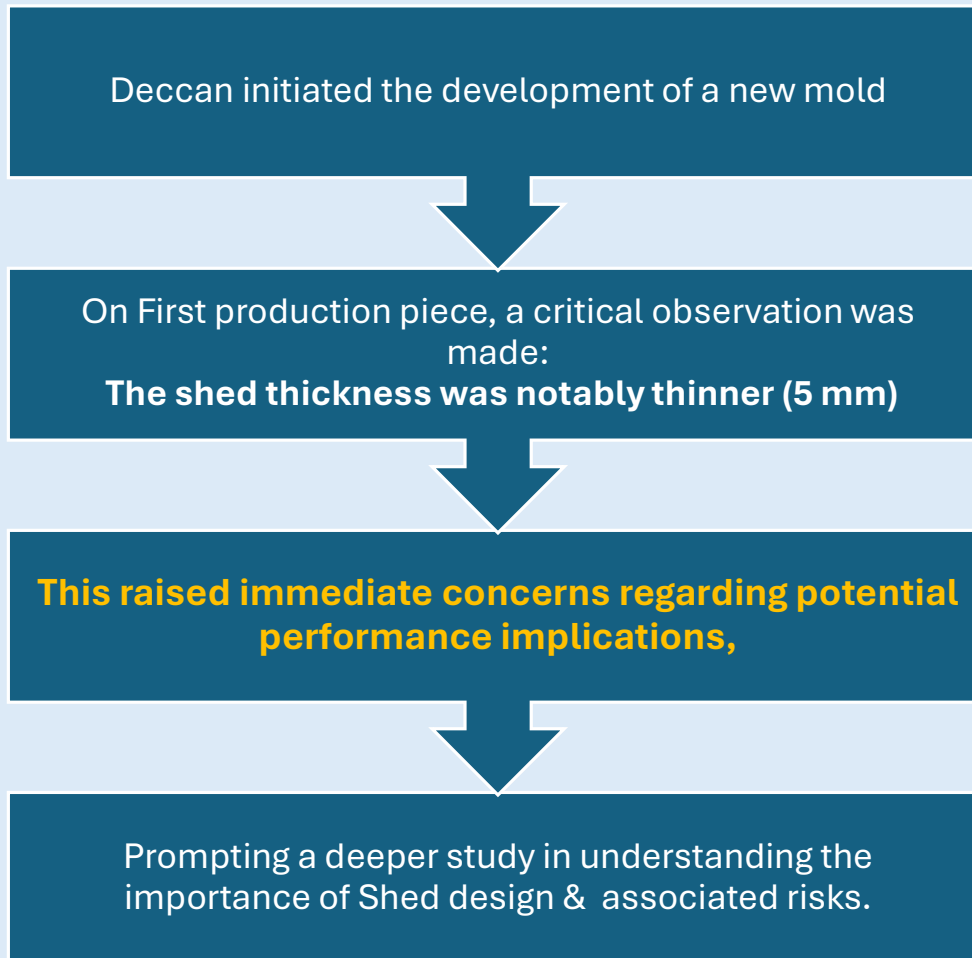
Thank you

Importance of Shed Design

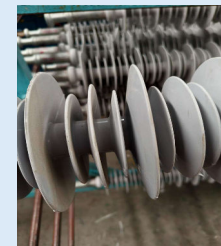
- **High Salinity & Sand (Khavda - Kutch):**
Thin **large root shed** wear out quickly under **sand abrasion** → sharp edges, high field stress.
- **Rain Bridging (Monsoon):**
Adequate **large root shed & tip thickness** prevents water film piercing and **flashover** along creepage.
- **Snow & Ice (Himalayan belts):**
Sufficient **large root shed thickness** ensures mechanical strength against ice load.
- **High Pollution Zones (Industrial/Marine):**
Thicker **large root shed** resist tracking, erosion, and dry-band arcing.
- **Water Washing**
Extra **large root shed & tip thickness** slows down erosion and preserves hydrophobicity.



Outcome of first trial on new TS



New Mould for 5mm thick Sheath



New Insulator

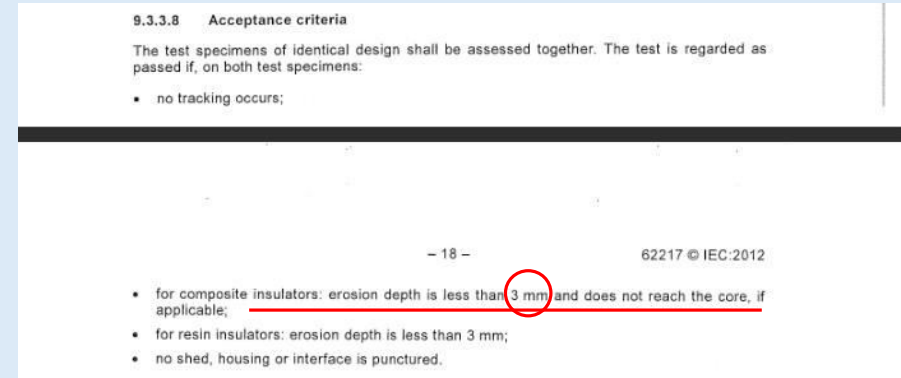
Observations:

1. Getting uniform 5mm Thickness
2. Smooth Shed Profile , No Shed Cut, Short Moulding
3. Meeting all machine parameters , Good Finish
4. Sheds “**not adequate**” ?
5. Importance of Large Shade base ? Recommendation/??

Importance of Shed Base Thickness

- **Tracking & Erosion Test:** A critical design limit stipulates that only 3 mm of erosion is acceptable. If shed thickness falls below 3 mm, measurement won't be accurately possible.

- ✓ Shed base 5 mm indicated 2 mm margin , after erosion

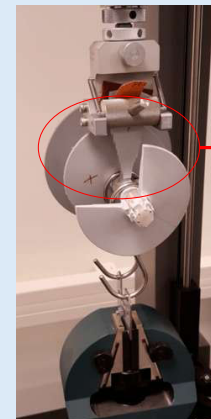


- **Mechanical Strength:** Thinner sheds inherently possess reduced mechanical durability, making them more susceptible to damage in India's harsh and varied climate conditions.

- ✓ Should be strong enough **for torrential rain** , climate change, **wind speed, snow fall, bird , pollution, sand abrasion**
- ✓ Should be strong enough for Transportation, handling, commissioning , installation,

- **Pull-Off Test:** Insufficient shed thickness can lead to premature tearing before the bonding strength can be accurately validated, compromising structural integrity.

- ✓ Should not get **teared during pull-off** / bonding test

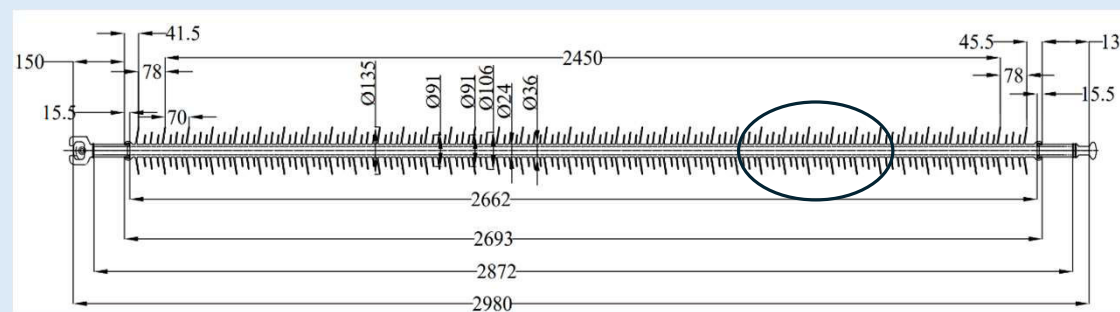
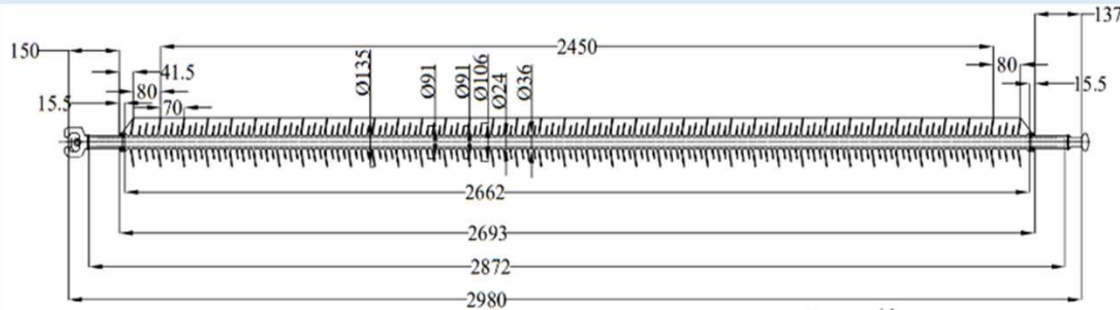


Right results of bonding will not be achieved as shed might get cut before impacting the bonding,

Technical drawing of a long, thin mechanical component, likely a shaft or pipe, showing various dimensions and a circled section. The dimensions are as follows:

- Overall length: 2585±1
- Section 1 (left): 138
- Section 2 (left): 53
- Section 3 (left): 55
- Section 4 (left): 0132
- Section 5 (left): 0132
- Section 6 (left): 021
- Section 7 (left): 032
- Section 8 (left): 096.5
- Section 9 (left): 2628±1
- Section 10 (left): 2669±2
- Section 11 (left): 2838±1
- Section 12 (left): 2947±2
- Section 13 (left): 2979±2

A circled section is located on the right side of the component, indicating a specific area of interest or a defect.

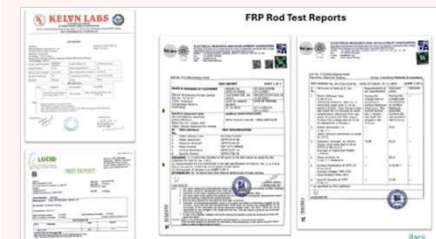


Different Sheds Pattern

Same
Shed
Pattern

- The **large shed profile** plays the most important role, since it protects others from rain / other climatic conditions.
- Maintaining the Dry Arcing Distance, designers change **Shed Profile to meet creepage**
- **Thicker the large Shed Base, better the mechanical strength, more erosion life**
- Thinner large Shed base helps in **reducing silicone rubber**
- Variation of **Large Shed base** will not impact in Design & Type test results
- Impact on long-term performance specially in harsh climatic conditions – not known

Controlled Inhouse Production



FRP Rod

Parameter	Earlier	Now
Hardness, Barcol	70-85	75-80
Specific Gravity	1.9-2.3	2.0-2.2
Glass Content	70-83%	80-83%
Dye Penetration	15min	20min
Water Diffusion (0.1% by weight of NaCl in de-ionised water, boiled for 100 hrs)	<=1mA	<=0.1mA
Water Absorption (20 Deg, 24 + hrs)	<1%	<0.05%
Thermal Bending Strength	>300 Mpa/ 150° C	>=320 Mpa/150° C
Flexural Strength	500 Mpa (min)	750 Mpa (min)
Glass Transient Temperature, Tg	120-125° C	Min 140° C

Additional Test : DPFT

Current Specifications :

Deccan Enterprises Pvt Ltd

Dated: 10-04-2024

Specification for FRP rod – Transmission Domestic

Sl.No	Parameters	sample	Ref. Std	Specification
1	Visual Appearance	100 %	Plant Standard	Free from cracks, dents
2	Dimensional Tolerance	1% of Batch	Plant Standard	Dia: ± 0.05 mm Length: ± 1 mm
3	Straightness	(min 10 Nos)	Plant Standard	1 mm/metre (max)
4	Hardness, Barcol	1/ Batch	ASTM D 2583	75 – 80 *
5	Specific Gravity, 23 $\pm$ 2 °C	1/ Batch	ASTM D 792	2.0 – 2.3 *
6	Glass content	1/ Batch	ASTM D 2584	80 % – 83% *
7	Dye penetration test	1/ Batch	IEC 62217	> 20 minutes *
8	Water Absorption at (20 $\pm$ 2 deg C, 24 hrs)	1/ Batch	ASTM D 570	<= 0.05 % *
9	Water diffusion test, (0.1% by weight of NaCl in de ionised water, boiled for 100 hrs,	1/ Batch	IEC 62217	<= 0.1 mA (To withstand 12 kV for one minute) *
10	Thermal Bending strength	1/ Batch	Plant Standard	>=350 Mpa/150 deg C *
11	Tensile strength	Once in 4 Months	ASTM D3916	760 Mpa (min)
12	Flexural strength	Once in 4 Months	ASTM D4476	750 Mpa (min) *
13	ECR Rod Stress corrosion / Brittle Fracture test(1 mol HNO ₃ , at 80% tensile stress)	Once in 4 Months	Plant Standard	> 96 hours shall withstand, No Cracks
14	Glass Transition temperature, Tg	Once in 4 Months	ASTM D 3418	140° C min *
15	Boron Content , B ₂ O ₃	Once in 4 Months		<=50 ppm
16	FRP Rod surface finish	min 5 Nos	Plant Standard	Rods should be grinded for good bonding, suitable for silicone composite insulators. Ground rods will be wiped to clean dust particles,before packing and dispatch.Ra Value – 3 to 5

* Changed Requirements

100% In-house Rods Manufacturing

Changed Silicone Rubber Vendor

DJ Silicone NE-T-2U

TECHNICAL PARAMETERS	TECHNICAL DATA	DEPL COMMENTS
Hardness, Shore-a, points	65-67	OK
Tensile Strength, Mpa, Die C	≥ 4.0	OK
Elongation at Break	≥ 200	OK
Tension Set, percent Die C	≤ 2	OK
Tear Strength, kN/m Die C	≥ 13	≥ 15 *
Volume Resistivity, Ohm-cm	$\geq 1.0 \times 10^{13}$	1.0×10^{14} *
Dielectric Loss Tangent, Tg	$\leq 3 \times 10^{-2}$	OK
Dielectric Strength, kV/mm	≥ 17.5	≥ 20 *
Tracking Resistance, Class	4.5	1A 4.5, Depth of Erosion ≤ 0.25 mm *
Density, g/cc	1.52-1.55	OK
Plasticity, temperature 100 Deg C	135-155	OK, Please specify lower range plasticity to match Viscosity 24-36 as we face problem during moulding
Vosco, ML (25 Deg C 1+4)	24-38	OK, Preferable 24-36
Tc 90 (165 Deg C x 7 minutes)		155 Deg C x 6 minutes values to be given *
Water Absorption, GB/T -1034-2008	$< 0.25\%$	**
Silicone Polymer Content	Min. 33 %	**
Flammability	Category Vo as per IEC 60695-11-10	**
Arc Resistance, IEC 61621	> 240 Sec	**

- Vendor Agreed to provide as per new specifications
- * Changes to old specification Introduced
- ** New Specifications

- * Changed requirement
- ** New / Additional Requirement
- All Test slabs are cured in compression at 155 Deg C for 10 Minutes.

Note: Material Composition for Making NET 2U as confirmed by your representative Mr. Gaurav on 29th August, 2024 :

1. DMC from DOW,MPM,SHINETSU, BLUESTOR
2. Fumed Silica from CABOT, WACKER
3. Treated ATH from CHINALCO
4. Other additives such as silicone oil and colour master batches and vulcanising agents from domestic manufacturers in China.
5. NO PPT SILICA SHALL BE USED.
6. All insulation in China meets "China Electric Power Academy of Sciences in the management of Insulator Industry".
7. Rubber will be suitable for manufacture of ULTRA HIGH VOLTAGE SILICONE COMPOSITE INSULATOR upto 765 kV AC/800 kV DC.

Stringent Guidelines on material to be used

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Design Analysis

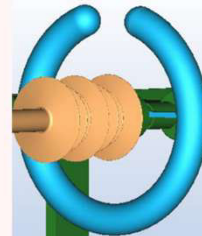
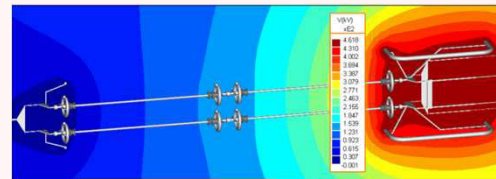
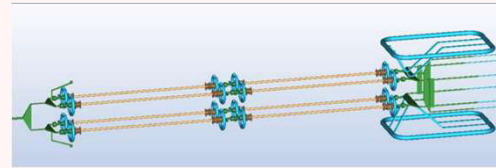
EFM:

Earlier:

- EFM was done on standard hardware

Now:

- Policy change : Design is to be cleared after EFM is passed using project specific hardware.
- Validation done of our Electric Field Modelling by Coulomb software provider, Integrated Engineering Software ,Canada.
- Grading Ring changes with higher margin in electrical field at critical areas to meet PGCIL requirements



DECCAN
SINCE 1966

INTEGRATED
ENGINEERING SOFTWARE

Comparison of results between Integrated Engineering Software & Deccan

Case-1: Original Model with Hardware

	Location	Suggested Values of E-Field* (kV/mm)	Maximum Magnitude of E-Field obtained (kV/mm) by Integrated Engineering Software	Maximum Magnitude of E-Field obtained (kV/mm) by Deccan	% Difference
1	Inside FRP	<3.0	0.233	0.229	1.72
2	Inside SiR		0.243	0.238	2.06
3	On 0.5mm above the surface of SiR sheath	<0.45	0.259	0.263	1.52
4	On the surface of Ball fitting	<2.1	0.396	0.399	0.75
5	On the surface of Socket fitting		0.648	0.661	1.97
6	On the surface of Grading ring (Ball Side)		1.087	1.073	1.29

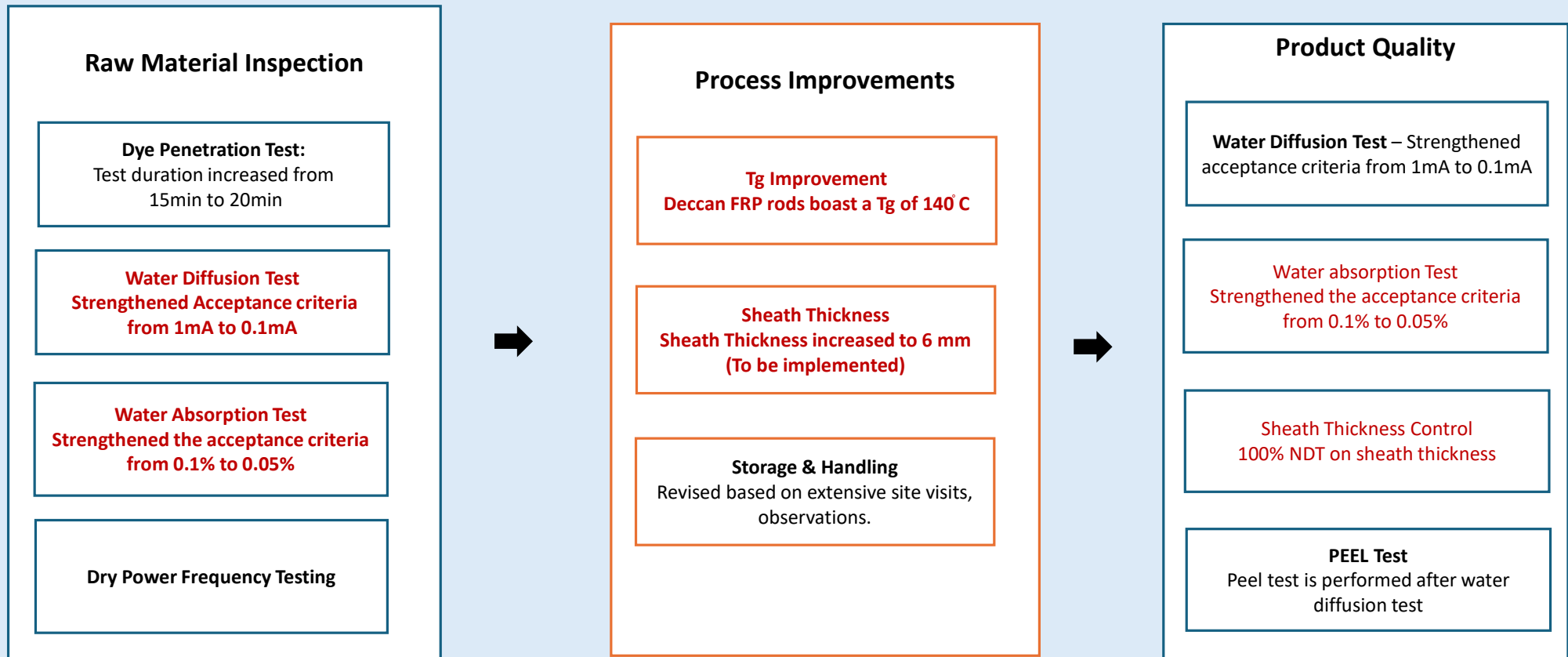
Case-2: Grading rings of one of the insulators is removed and no other changes are made to the model considered in Case-1

	Location	Suggested Values of E-Field* (kV/mm)	Maximum Magnitude of E-Field obtained (kV/mm) by Integrated Engineering Software	Maximum Magnitude of E-Field obtained (kV/mm) by Deccan	% Difference
1	Inside FRP	<3.0	0.416	0.415	0.24
2	Inside SiR		0.331	0.331	0.00
3	On 0.5mm above the surface of SiR sheath	<0.45	0.377	0.377	0.00
4	On the surface of Ball fitting	<2.1	0.789	0.789	0.00
5	On the surface of Socket fitting		0.819	0.819	0.00

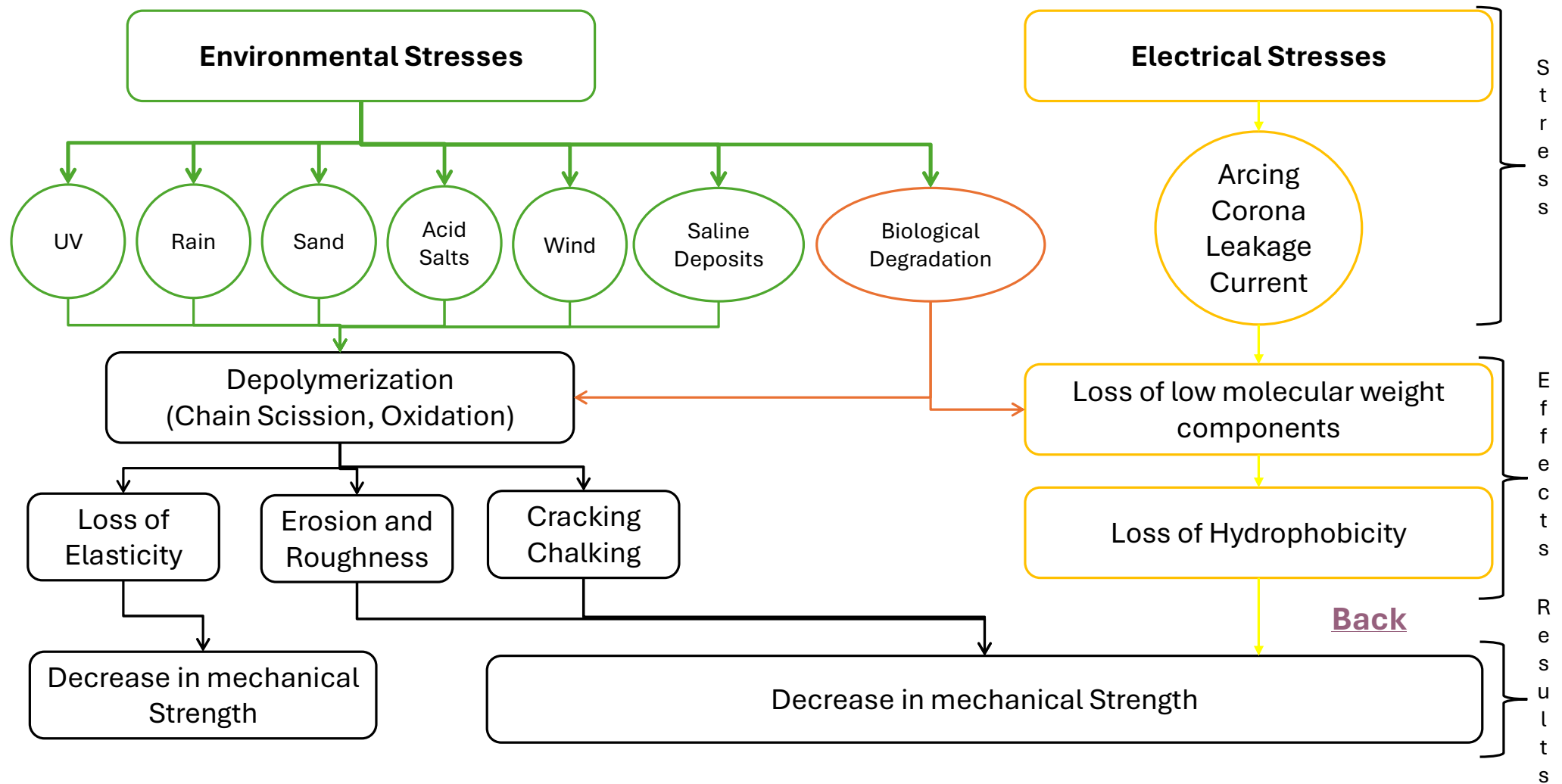
Variation within 2%
* Attributed to version difference

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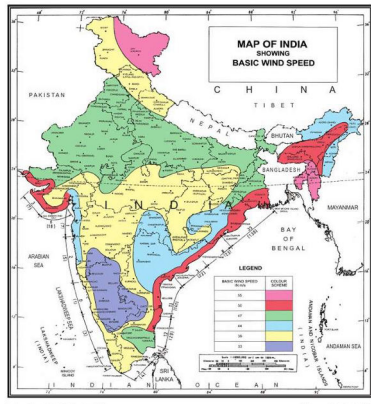
Stringent Tests to control Manufacturing Noise Parameters

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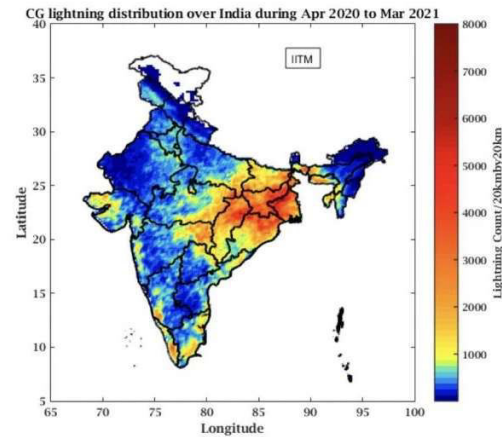
Stress on Insulators



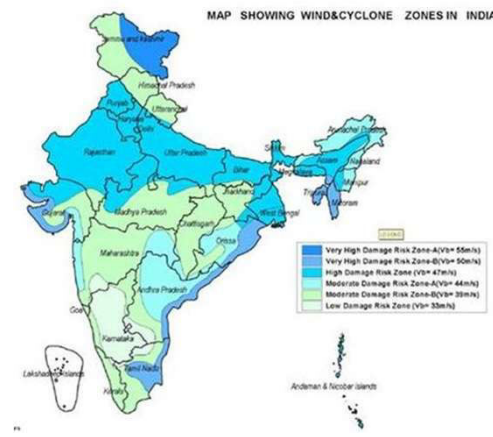
INDIA



Wind Map

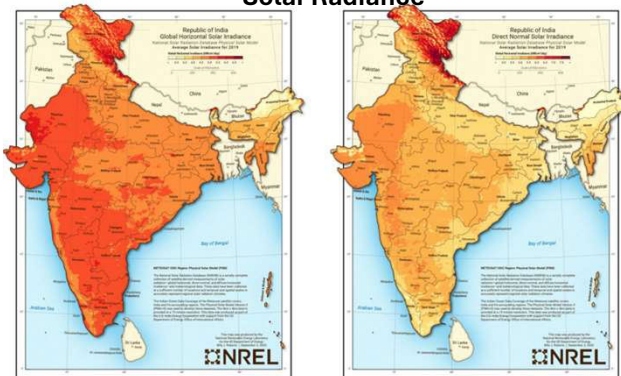


Lightening Map

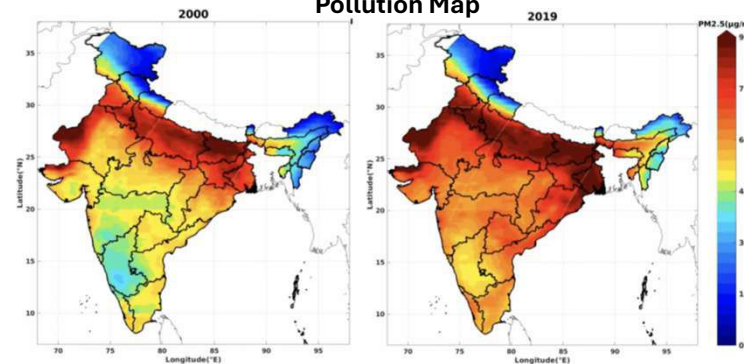


Cyclone Map

Solar Radiance



Pollution Map



Air pollution (PM 2.5) levels worsened between 2000 and 2019. Source: SAANS

India's Harsh Environmental Reality
Diverse climates with **rising pollution (2000–2025)** impacting insulator performance.

Pollution Trends (2000–2025)
Pollution levels have changed drastically, intensifying insulator challenges.

Climate Change Impact
Torrential rains, ozone depletion (high UV), cyclones, and rising global temperatures.

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We need to Design a Insulator that meets all the environments now and future!

Our Approach for Study



Khavda RE Park : Rann of Kutch, Gujarat



Data Acquisition: Site maps and relevant document



Environmental Analysis : Historical Data Analysis



Site Reconnaissance : Visit by Deccan Team

Case Study : Khavda Region



Zone 1

RE-Park: High dust, abrasion risk.



Zone 2

Creek: High Salt deposits.



Zone 3

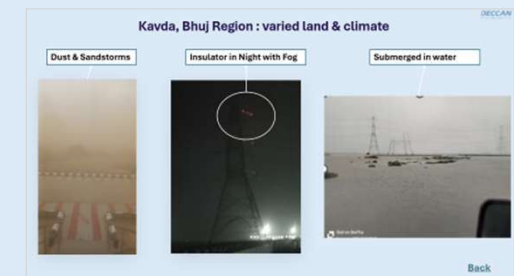
Bhuj Region: Salt deposits.



Year Wise Weather Data of the region

Year	Max Temp (°C)	Min Temp (°C)	Avg Temp (°C)	Max Wind Speed (km/h)	Min Wind Speed (km/h)	Avg Wind Speed (km/h)	Max Humidity (%)	Min Humidity (%)	Avg Humidity (%)	Max Rainfall (mm)	Min Rainfall (mm)	Avg Rainfall (mm)
2024	45	15	30	15	5	10	85	25	55	100	0	50
2023	45	15	30	15	5	10	85	25	55	100	0	50
2022	45	15	30	15	5	10	85	25	55	100	0	50
2021	45	15	30	15	5	10	85	25	55	100	0	50
2020	45	15	30	15	5	10	85	25	55	100	0	50

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Kavda, Bhuj Region : varied land & climate

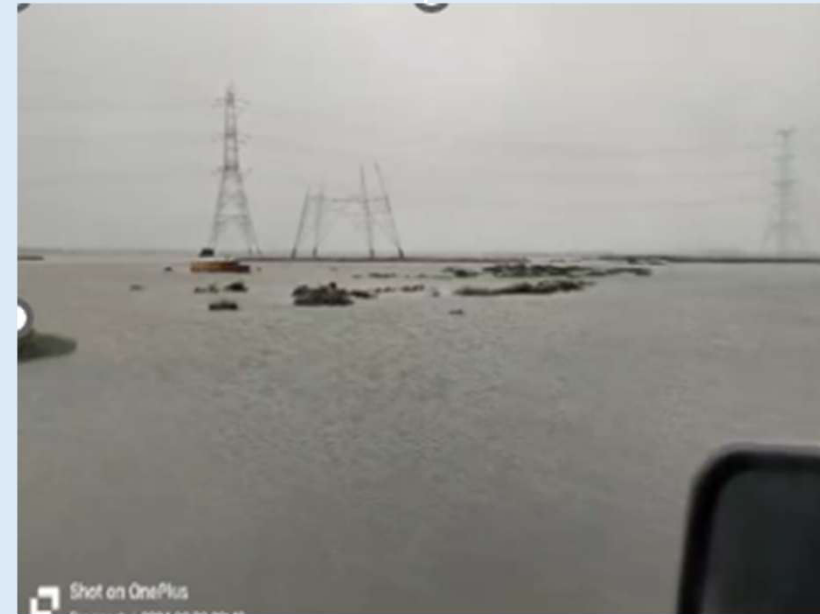
Dust & Sandstorms



Insulator in Night with Fog



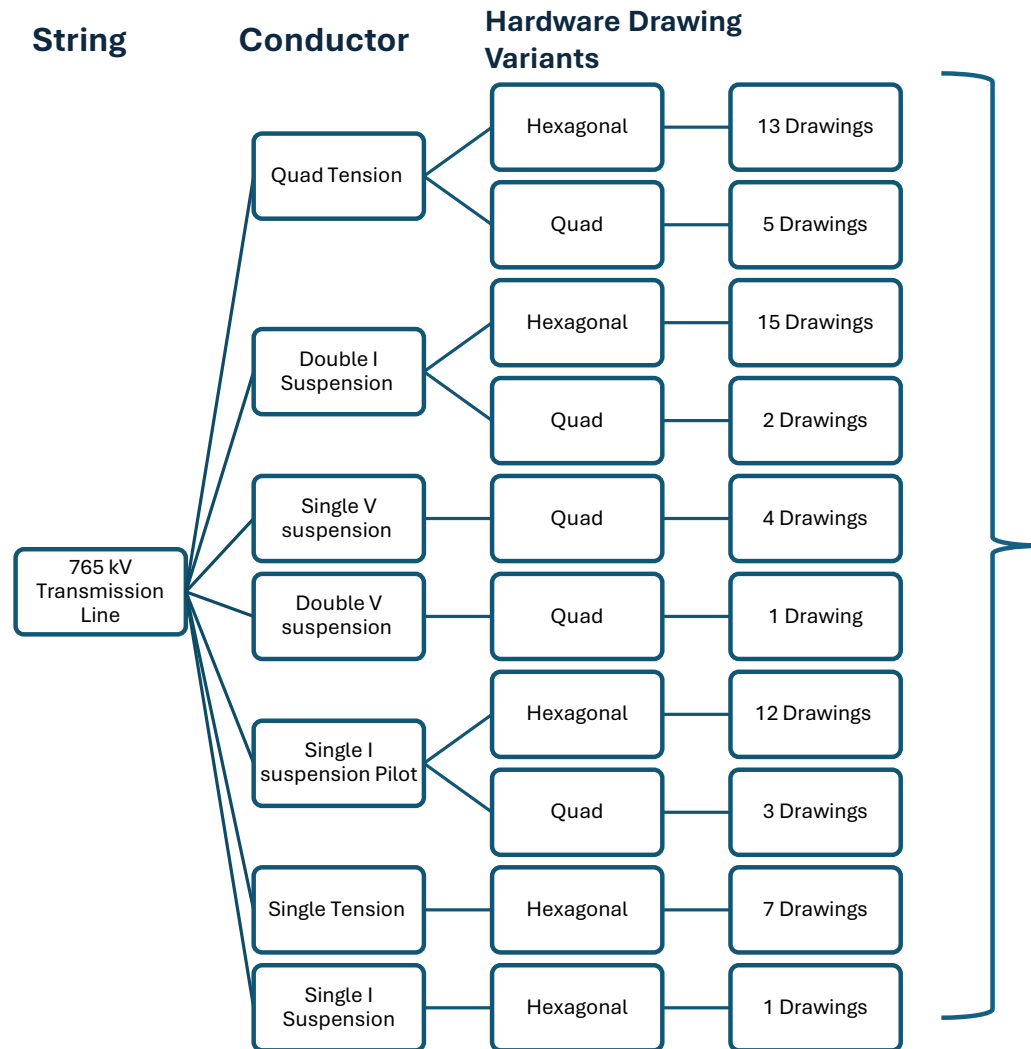
Submerged in water



These Lines needs extra precaution!!

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Overview of Hardware Variations for 765 kV Lines



For 765 kV Transmission Lines

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Hardware Vendors

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String Configurations

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Conductor Variants

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Hardware Drawings

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EFM Compatibility for each line is critical

Year Wise Weather Data of the region

2024

Climate information	Year to date	All Years	Daily Summary (Year to date)	Max	Average	Min
🔥 Hottest month	May	May	High temperature (°C)	42	34	23
❄️ Coldest month	January	January	Low temperature (°C)	30	23	10
💧 Wettest month	August	August	Precipitation (cm)	9.97	0.21	0
🌬️ Windiest month	August	June	Wind (km/h)	26.9	9.41	2.8

2023

Climate information	Year to date	All Years	Daily Summary (Year to date)	Max	Average	Min
🔥 Hottest month	May	May	High temperature (°C)	44	33	22
❄️ Coldest month	January	January	Low temperature (°C)	30	22	7
💧 Wettest month	July	August	Precipitation (cm)	17.77	0.14	0
🌬️ Windiest month	August	June	Wind (km/h)	63.9	15.07	3.2

2022

Climate information	Year to date	All Years	Daily Summary (Year to date)	Max	Average	Min
🔥 Hottest month	April	May	High temperature (°C)	44	33	19
❄️ Coldest month	January	January	Low temperature (°C)	30	21	8
💧 Wettest month	August	August	Precipitation (cm)	16.61	0.21	0
🌬️ Windiest month	May	June	Wind (km/h)	33.1	14.64	3

2021

Climate information	Year to date	All Years	Daily Summary (Year to date)	Max	Average	Min
🔥 Hottest month	May	May	High temperature (°C)	43	33	22
❄️ Coldest month	January	January	Low temperature (°C)	29	22	9
💧 Wettest month	September	August	Precipitation (cm)	4.43	0.11	0
🌬️ Windiest month	July	June	Wind (km/h)	34.8	15.27	3.5

2020

Climate information	Year to date	All Years	Daily Summary (Year to date)	Max	Average	Min
🔥 Hottest month	May	May	High temperature (°C)	44	33	21
❄️ Coldest month	January	January	Low temperature (°C)	30	22	8
💧 Wettest month	August	August	Precipitation (cm)	6.66	0.12	0
🌬️ Windiest month	May	June	Wind (km/h)	36.8	14.88	3.5

2019

Climate information	Year to date	All Years	Daily Summary (Year to date)	Max	Average	Min
🔥 Hottest month	May	May	High temperature (°C)	45	33	22
❄️ Coldest month	January	January	Low temperature (°C)	30	22	9
💧 Wettest month	August	August	Precipitation (cm)	8.16	0.13	0
🌬️ Windiest month	July	June	Wind (km/h)	37.1	15.76	3.1

2018

Climate information	Year to date	All Years	Daily Summary (Year to date)	Max	Average	Min
🔥 Hottest month	May	May	High temperature (°C)	45	35	24
❄️ Coldest month	December	January	Low temperature (°C)	29	22	9
💧 Wettest month	August	August	Precipitation (cm)	1.36	0.03	0
🌬️ Windiest month	June	June	Wind (km/h)	37.4	15.88	3.5

2017

Climate information	Year to date	All Years	Daily Summary (Year to date)	Max	Average	Min
🔥 Hottest month	May	May	High temperature (°C)	44	34	22
❄️ Coldest month	January	January	Low temperature (°C)	30	22	8
💧 Wettest month	July	August	Precipitation (cm)	6.22	0.12	0
🌬️ Windiest month	May	June	Wind (km/h)	31.2	16.08	3.7

2016

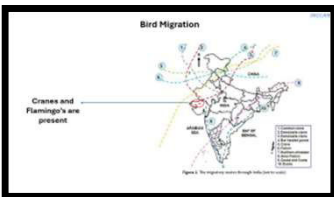
Climate information	Year to date	All Years	Daily Summary (Year to date)	Max	Average	Min
🔥 Hottest month	May	May	High temperature (°C)	46	34	24
❄️ Coldest month	January	January	Low temperature (°C)	30	22	10
💧 Wettest month	August	August	Precipitation (cm)	3.38	0.09	0
🌬️ Windiest month	May	June	Wind (km/h)	33.7	15.55	2.6

2015

Climate information	Year to date	All Years	Daily Summary (Year to date)	Max	Average	Min
🔥 Hottest month	May	May	High temperature (°C)	45	35	23
❄️ Coldest month	December	January	Low temperature (°C)	30	22	9
💧 Wettest month	August	August	Precipitation (cm)	23.3	0.15	0
🌬️ Windiest month	July	June	Wind (km/h)	51	15.91	3.5

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Environmental Factor Analysis



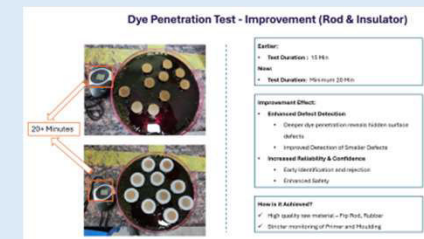
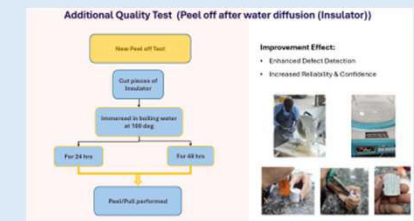
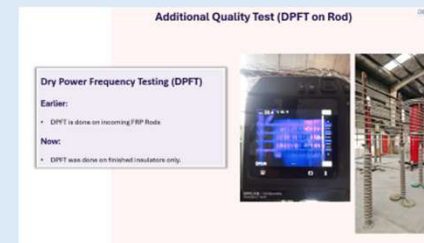
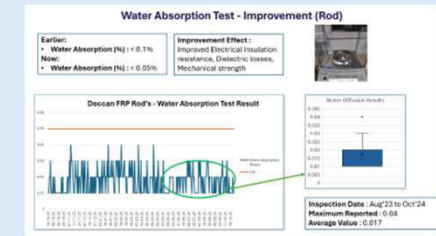
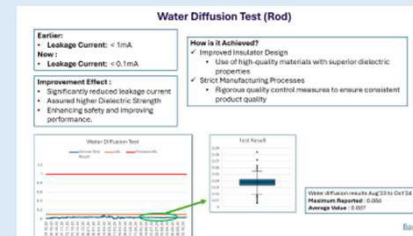
1. **Wind:** Although the region is cyclone-prone, historical data suggests a low risk of high wind speeds directly impacting this area.
2. **Humidity:** The region experiences around 40-50% humidity, a moderate level with no direct impact on performance.
3. **Rain:** This region has moderate precipitation.
4. **Cyclone:** Region is under high-risk zone for cyclone – But in last 10 years it had seen **3 major cyclone** , and speeds were dispersed by the time they reached Kutch.
5. **Salt Deposits:** Region is under coastal area and salt deposit could be high.
6. **Lightning:** The high incidence of lightning strikes in the region poses a risk to insulator integrity.
7. **High Solar Radiation:** The region's high solar radiation, in conjunction with any salt deposits, could accelerate insulator degradation. This combined effect requires careful consideration.
8. **Bird Activity:** The presence of large migratory birds, primarily cranes and flamingos, increases the risk of collision damage / Bird Drop to insulators.

Deccan: Going beyond TS

Tests beyond the standard

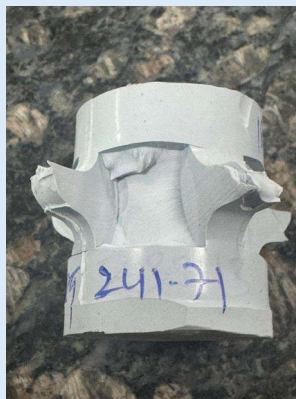
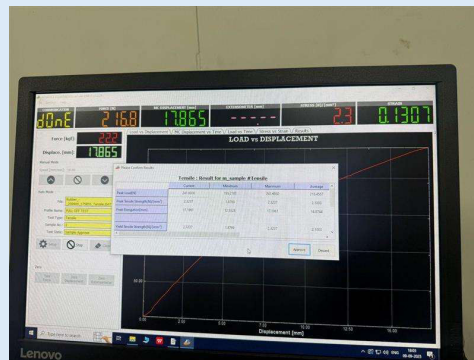
- ✓ **FRP Rod Testing : Implemented Dry Power Frequency Testing (DPFT) on FRP rods**
- ✓ **In-house FRP Rod Manufacturing**
- ✓ **PGCIL Approval for FRP Manufacturing**
- ✓ **Water Diffusion Test - acceptance criteria from 1 to 0.1mA**
- ✓ **Water absorption Test - acceptance criteria from 0.1% to 0.05%**
- ✓ **Tg Improvement - to 140 Deg C**
- ✓ **FRP Rod Testing at ERDA**
- ✓ **Introduction of Storage, Handling & Installation Guide**
- ✓ **ERDA Multi Stress Test (5000 Hours)**
- ✓ **Built Data Analytics Team**
- ✓ **Leadership hiring from Industry Leaders like BHEL , GE, ABB , ALSTOM**
- ✓ **Testing of Imported Rubber in ERDA**

Early Adaptor



Deccan : The Early Adaptor for PGCIL's new Tests

Pullout Test – To Check Bonding



Shear Test to check bonding



Data Analytics

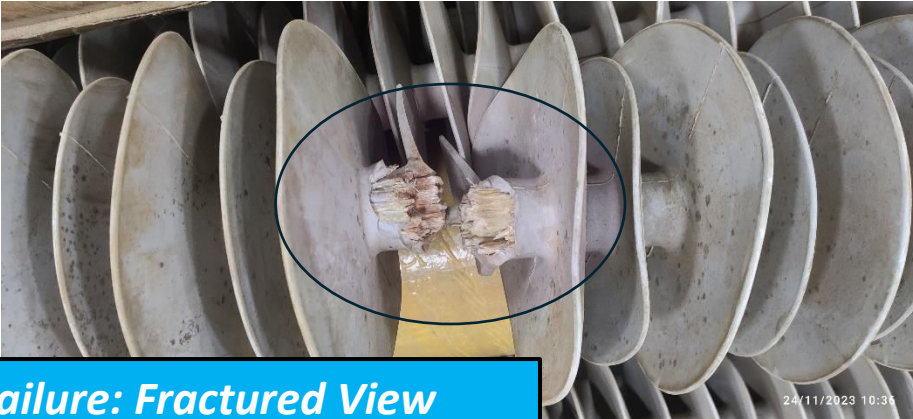
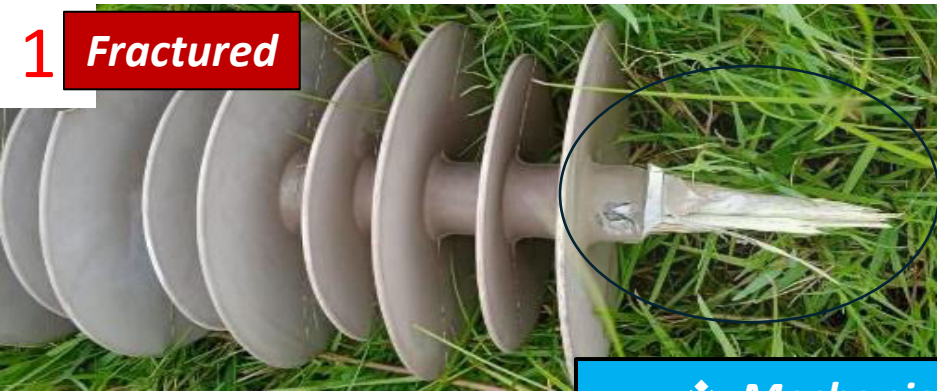


Process Improvement in CLR Insulator

**POWERGRID CORPORATION OF INDIA LTD.
CC, GURGAON, INDIA**

- **Failures observed in insulators during service.**
- **Latest POWERGRID Technical Specification for CLR Insulator (Rev-3, March'2024)**
- **Way forward.**

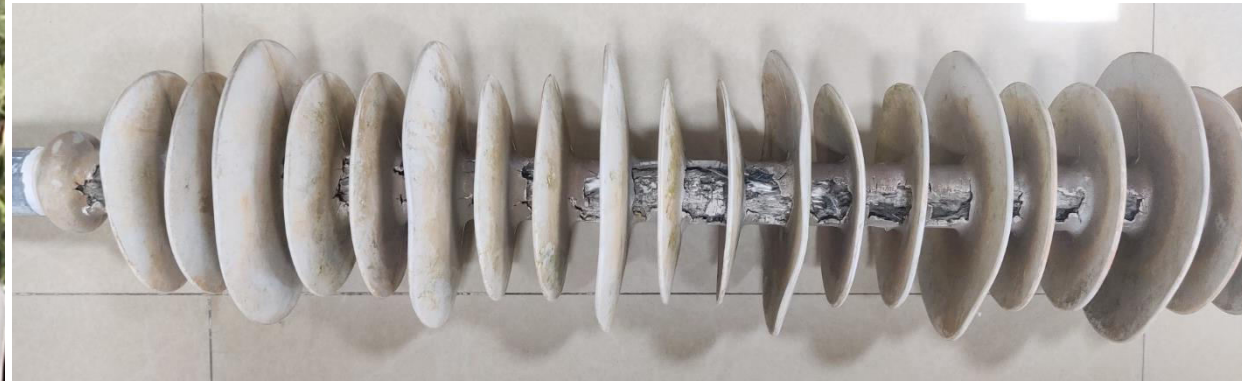
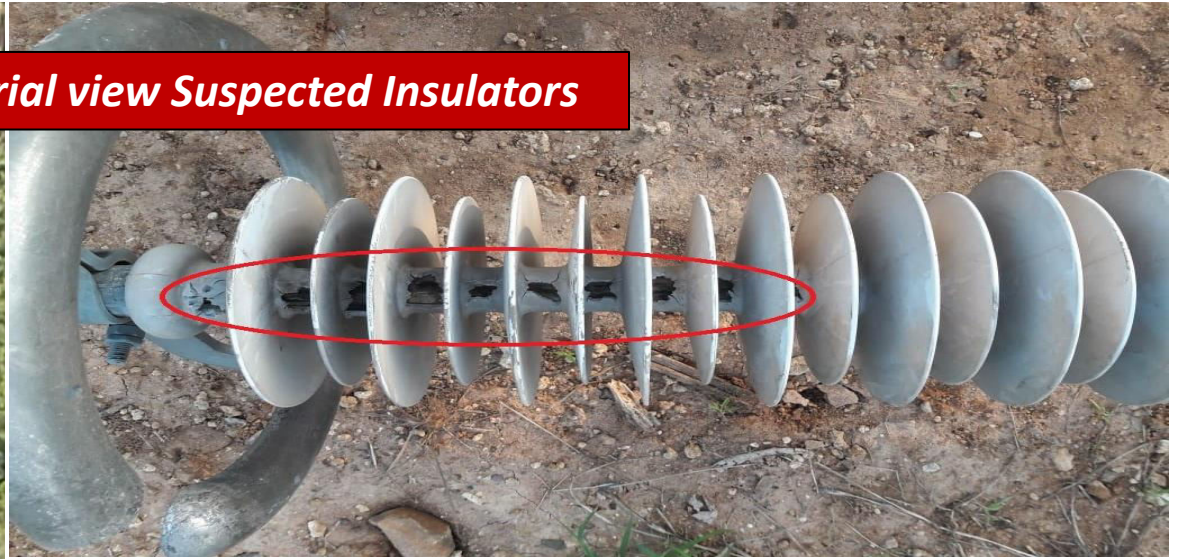
1 Fractured



❖ Mechanical Failure: Fractured View
❖ Minimal or No Electrical Activity observed



Pictorial view Suspected Insulators



- ❖ No Mechanical Failure
- ❖ Electrical Activity observed
Discharge/Tracking/Under Flash

3 Flash Over



Failed Insulator: Possibly Flash Over



Fracture Analysis

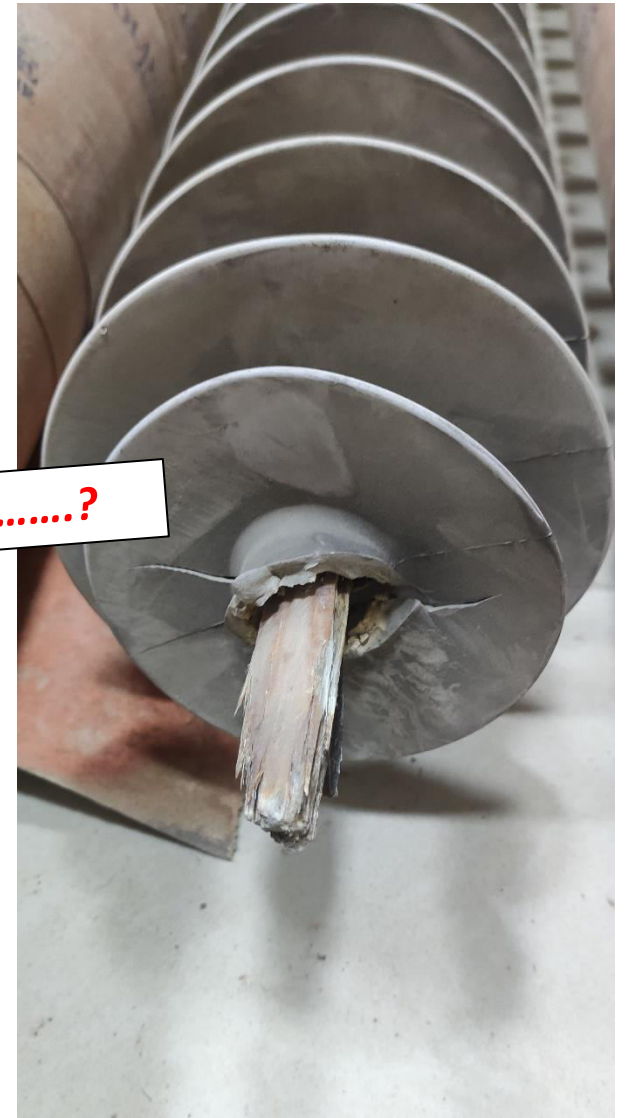
In some cases, fractured insulators FRP rod degraded severely and looked like decayed wood.

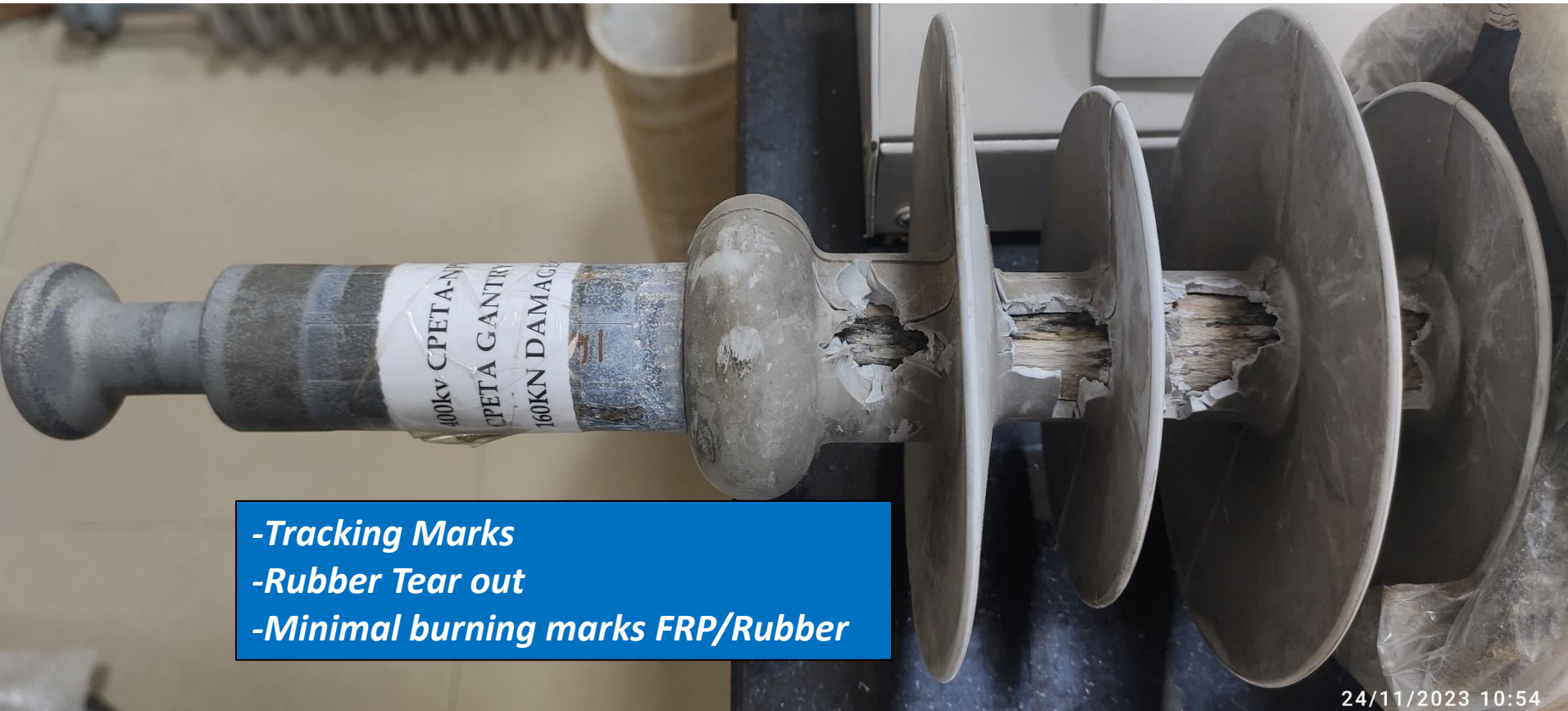


Tracking and Burning of FRP



Tracking Through FRP or Rubber or Interface or Surface.....?





- Tracking Marks
- Rubber Tear out
- Minimal burning marks FRP/Rubber

24/11/2023 10:54

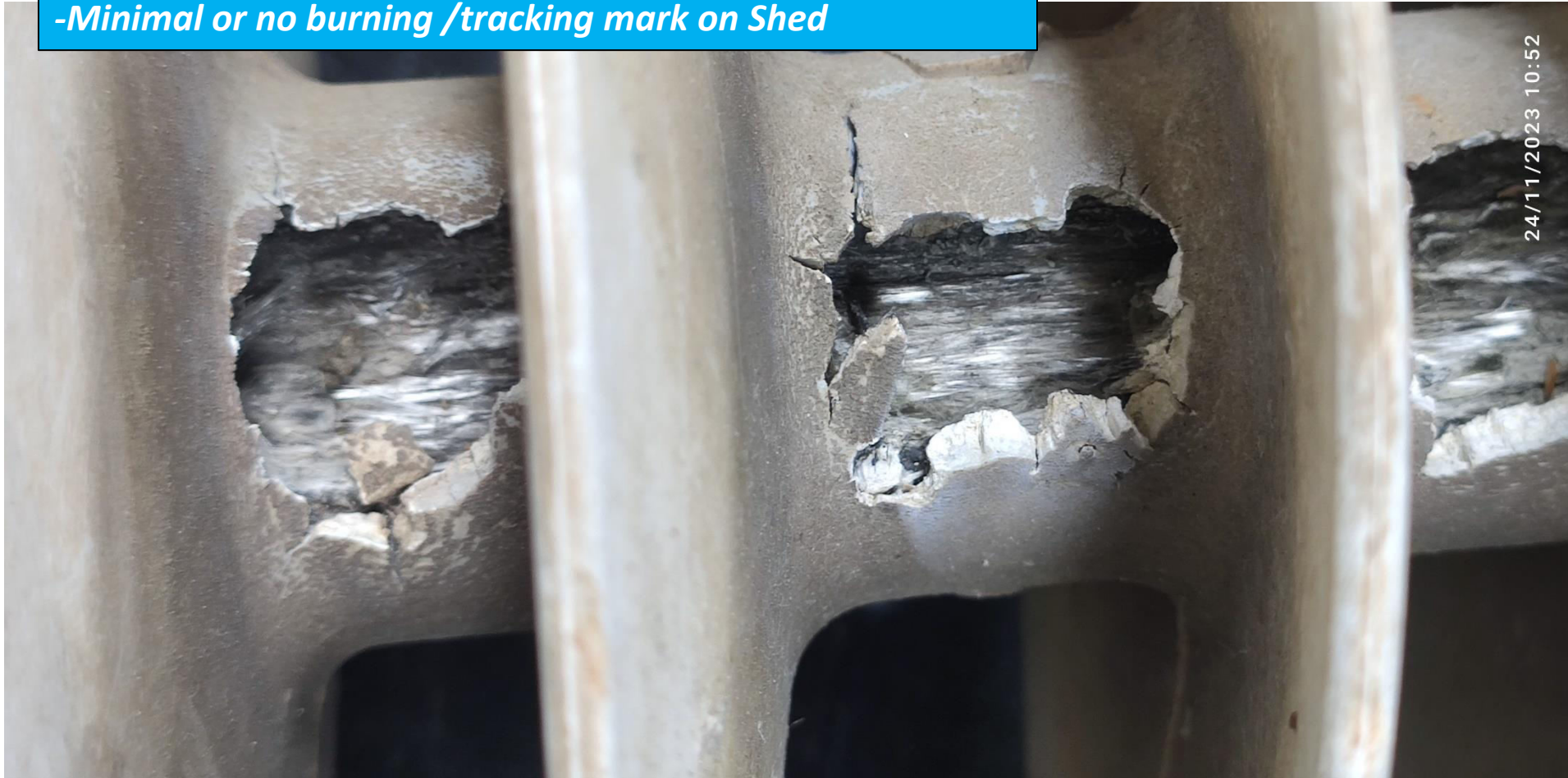
Tracking Through FRP or Rubber or Interface or Surface.....?

Observations of Insulators received at PARTeC

Annexure-III (Page 57 of 74)

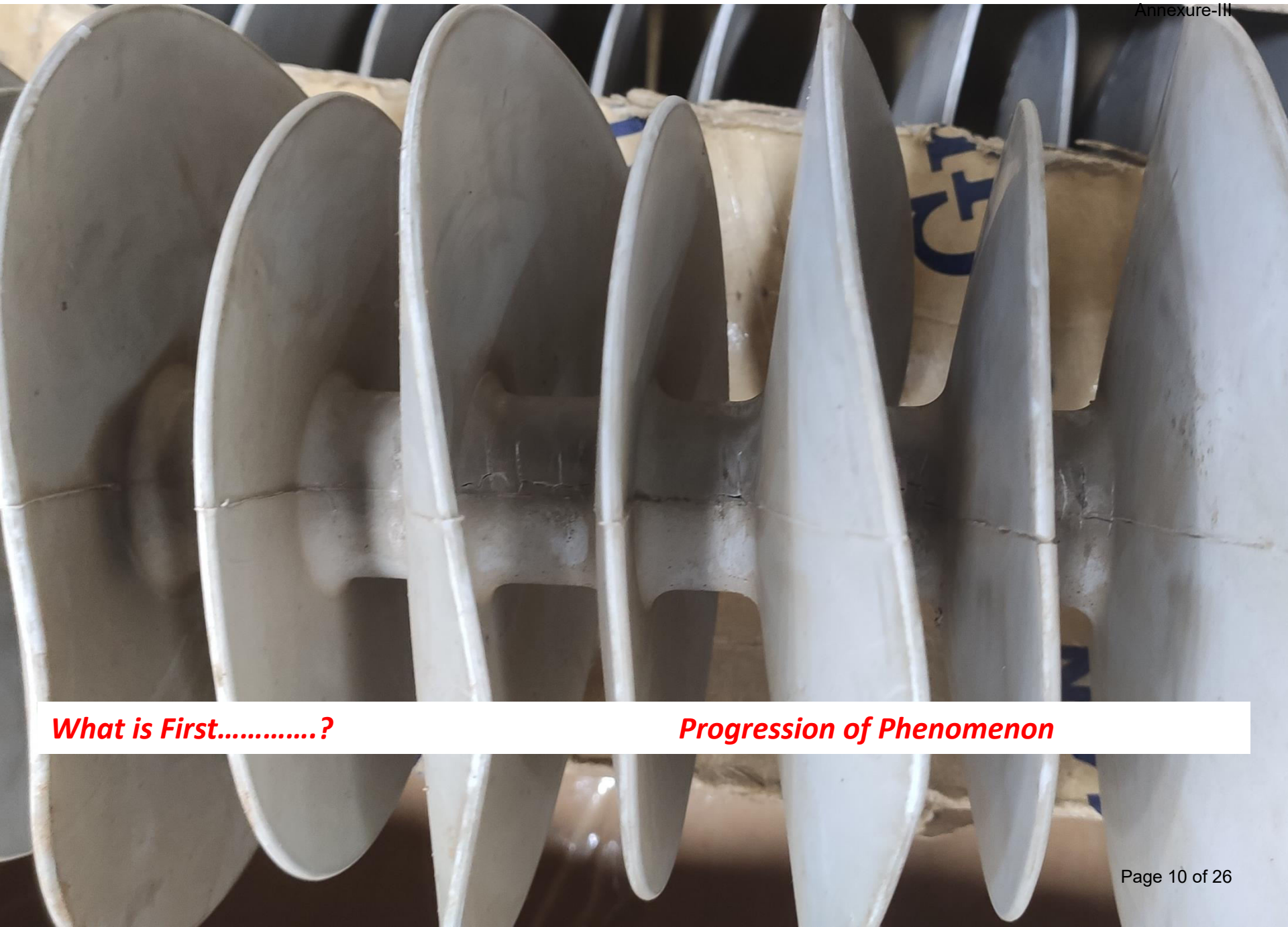
Annexure-III

- Burning of FRP*
- Burning of Sheath Rubber*
- Minimal or no burning /tracking mark on Shed*



24/11/2023 10:52

Tracking Through FRP or Rubber or Interface or Surface.....?



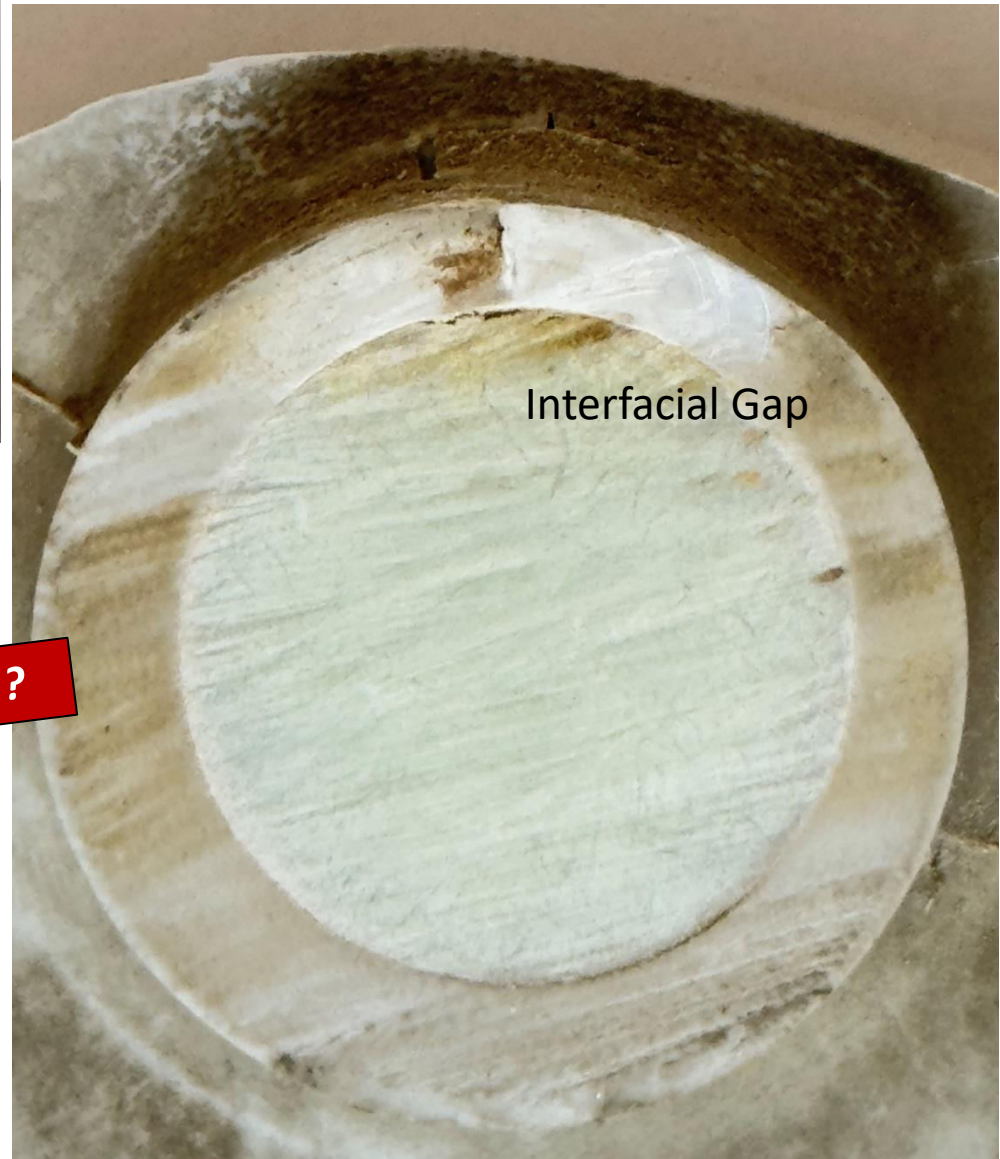
What is First.....?

Progression of Phenomenon



24/11/2023 10:43

Progression of Phenomenon: Crack opening

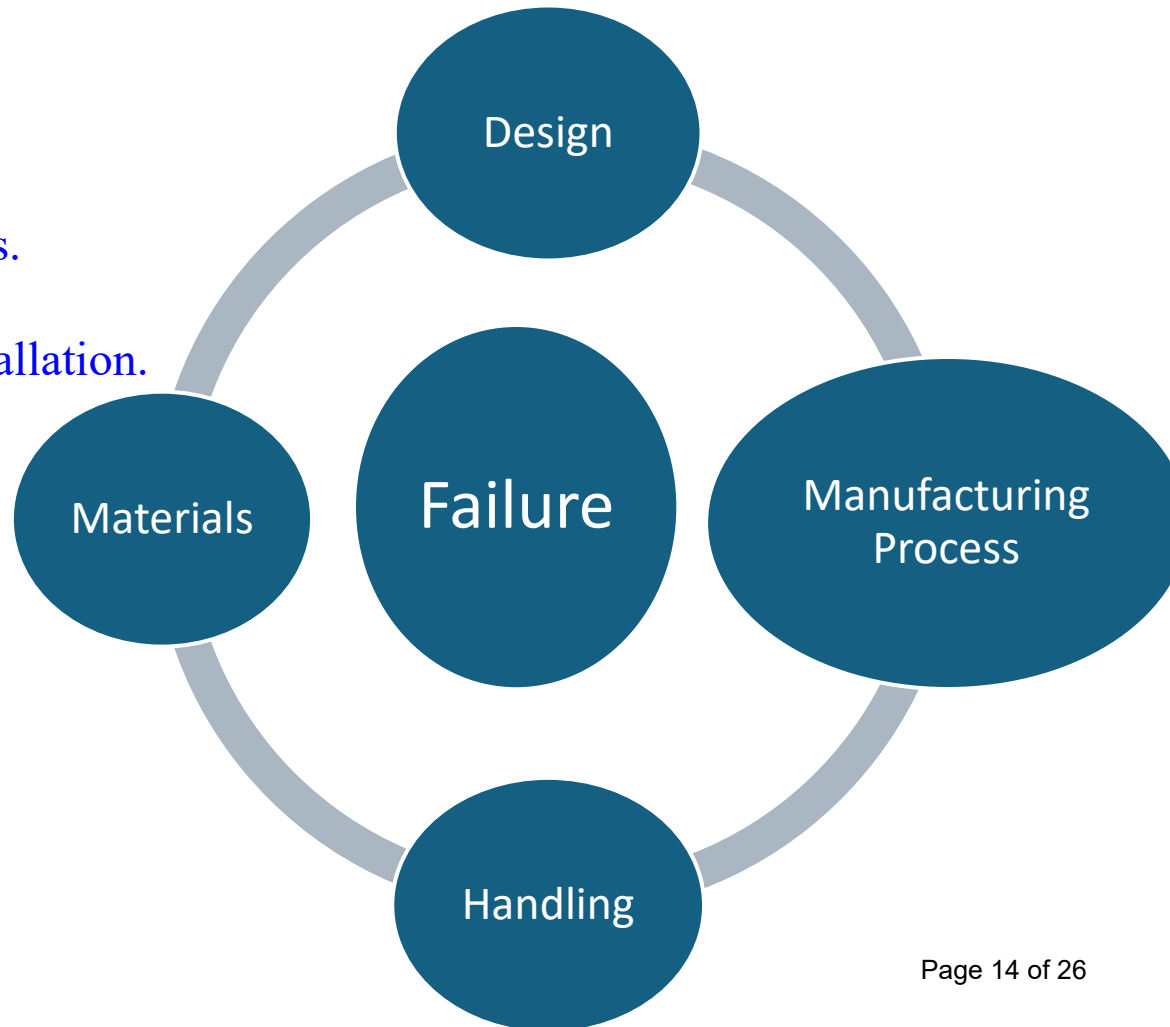


Beginning of Tracking/Leakage Current.....?



The possible reasons for insulator failure can be attributed to:

- Raw material quality.
- Design
- Improper Manufacturing process.
- Improper Handling/Storage/Installation.

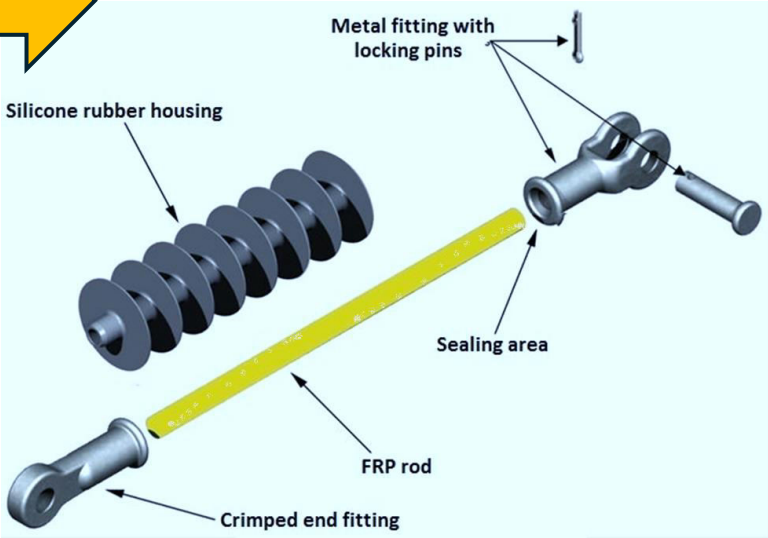
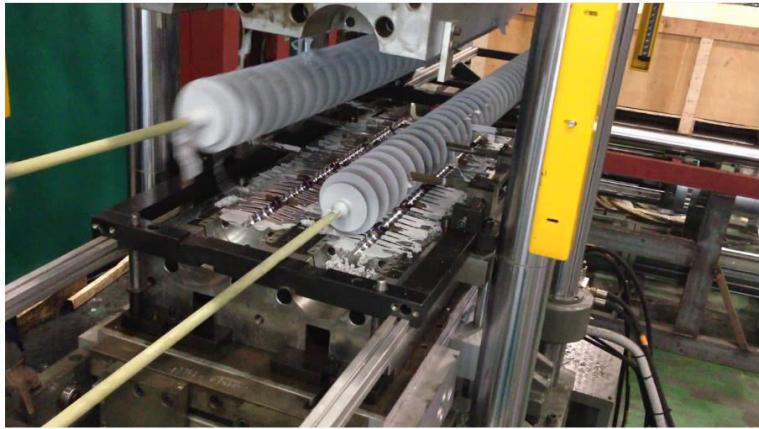


Composite Long Rod Insulator (CLR-i)

Composite is a material consisting of two or more distinct phases bonded together



Manufacturing Process



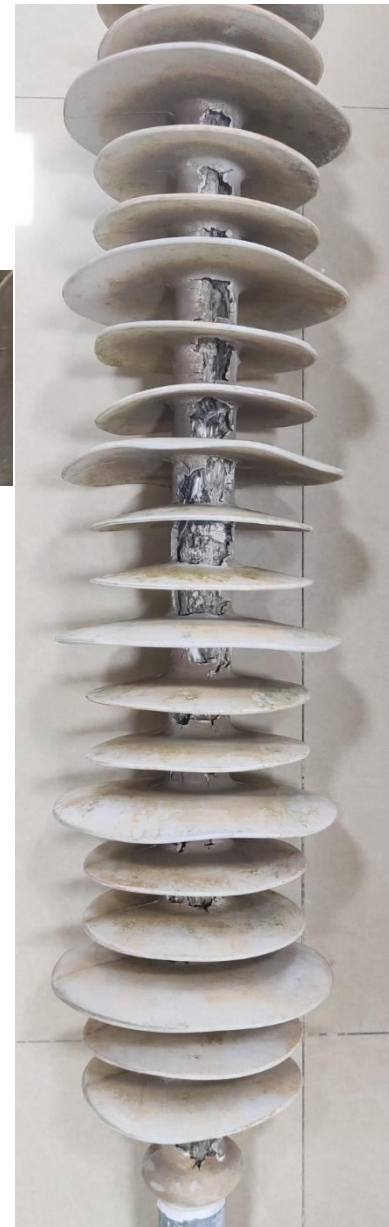
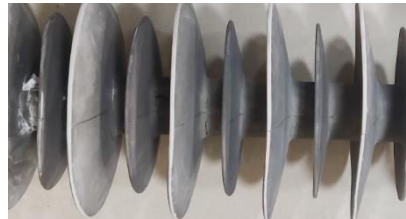
Observation from Photos and evaluation of Failed/Suspected CLRi received at PARTec

- In most of the cases abnormal overheating caused CLRi Damaged.
- In severely damaged insulators major cracks and peel off of silicon sheath occurred and FRP rod was visible.
- Cracks on sheds around the FRP rod may have led to moisture ingress during rainfall, foggy season or early mornings.
- Chalking (powder formation) was observed in some cases on the surface of silicon rubber.
- Degradation of the interface between housing and FRP rod.
- Degradation of CLRi in axial direction



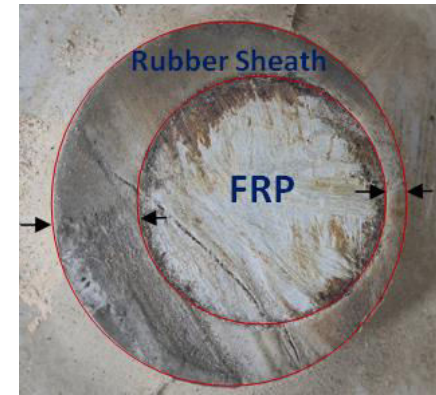
Observations:

- Most of the failed insulators have marks of electrical phenomenon/activities like discharge, tracking and burning on FRP rod.
- Chalking and separation between glass fiber and epoxy resin matrix on the surface.
- Flash-under type of failure.
- Loss of Hydrophobicity
- Most of the insulators failed at 1 to 1.5 feet from high voltage fitting.
- In few Cases, Flash over and darkening of CLRI shed observed.



Observations:

- Manufacturing defect in terms of non-uniform molding of silicon rubber around the FRP rod.
- In few cases brittle fracture of FRP rod was observed
- Very few insulators failed mechanically. These very few mechanically failed CLR insulators do not show signature of electrical activities/phenomenon. In such cases the location of fracture was different from most of the fracture failure initiated due to electrical activities/phenomenon.



• OBSERVATIONS

- Various Tests conducted on failed insulators, in-service insulators as well as on new insulators for Root Cause Analysis (RCA) of failure of insulators.
- It was observed that even the failed insulators were passing all the tests .
- Accordingly based on RCA, Technical Specification for Composite Long Rod (CLR) Insulators has been revised in October'2024 in consultation and detail deliberation with Insulator manufacturers for improvement in the performance of CLR insulators.
- Modifications are summarized under following categories:
 - i) Technical requirements of constituent materials viz. housing & weather shed material and FRP Rod
 - ii) EFM Study
 - iii) Type Test requirements
 - iv) Acceptance & Tests during manufacturing requirements
 - v) Failure Guarantee/Suspect Provisions.

Modifications in TS for CLR Insulator

- **Technical requirements of constituent materials viz. housing & weather shed material and FRP Rod**
 - Minimum Thickness of rubber sheath 5mm in place of 3mm specified earlier. To mitigate the effect of wear & tear and to improve the porosity of sheath.
 - Minimum silicon content for housing & weather sheds modified to 32% by weight from 30% specified earlier to mitigate the degradation of rubber based on TGA (Thermogravimetric analysis) findings.
 - Minimum dielectric strength(BDV) of silicon rubber compound is set as 20kV /mm.
 - Transition Temperature (Tg) for FRP rod (minimum 140° C) specified in the TS.

Modifications in TS for CLR Insulator

EFM Study:

- Requirements for EFM studies modified as per the provisions of IEEE 2015. EFM studies shall be submitted for the same combination of Insulator + Hardware which is to be used for the project.
- EFM Report shall contain all the details of Insulator string, Hardware Fittings, method & software used for analysis, Software inputs, assumptions, E-field images & graphs etc.
- 3D Modelling as per actual design/drawings of CLR insulators and H/W fittings.
- In-house validation of EFM study based on model/ inputs provided by manufacturer.

Modifications in TS for CLR Insulator

➤ EFM Study

Sr. No.	Parameter	Earlier Specification	Revised Specification
		Limits/Range-kV/cm	Limits/Range-kV/cm
1	Electric field on sheath surface of the insulator housing	4.5 (<i>0.5mm above the sheath surface</i>)	4.2 (<i>Along the Insulator Sheath</i>)
2	Electric field inside the housing and core	30	30
3	Surface E-field magnitudes on end-fittings & corona rings	21	18
4	Electric Field on End Fitting sealing point	--	3.5

Modifications in TS for CLR Insulator

➤ Type Test Requirements:

- Recovery of Hydrophobicity test modified to include Corona exposure at 12KV continuously for 100 hours instead of few minutes required earlier for making the sample hydrophilic.
- Ozone Resistance test on housing & weather shed material as per IEC 61854 introduced.
- Water diffusion test followed by pull-off test introduced (as per CIGRE TB-919). *Three Samples with rubber housing and one shed are to taken for water diffusion test as per IEC 62217, except that the current during the whole test shall not exceed 0.5mA (r.m.s) instead of 1mA. Thereafter, The Pull-off test shall be performed at 4 locations per shed (separated radially by 90°), for each of the 3 test samples taken from the insulator. The test is passed if the average stress is more than 1.5 N/mm² (for each sample).*

Modifications in TS for CLR Insulator

➤ Acceptance Test Requirements:

- Hardness Test on Housing & weather shed material included in acceptance test also.
- Water diffusion test followed by pull-off test introduced.

➤ Tests during manufacturing Requirements:

- SEM (Scanning Electron Microscopic) Analysis with EDS (Energy Dispersive Spectroscopy) on FRP rod cross-section, Surface analysis by optical spectrograph, FTIR Signature analysis introduced.

➤ Failure Guarantee Provisions:

- Apart from physical breaking/de-capping provision of suspect insulator also added.
- Rise in temperature of insulator housing & weather sheds by more than 5°C w.r.t ambient temperature shall be treated as failed insulator and to be replaced immediately.

WAY FORWARD

- **Automation in Silicon rubber compound making process.**
- **Automation in FRP Rod manufacturing, crimping, cleaning, pre-heating primiering, crack detection etc.**
- **Automation in injection moulding process (Self opening , closing, cleaning, interchange, ejection of final product etc.)**
- **Automation in routine testing.**
- **Integration of all the automated manufacturing process in one assembly line with No/minimal human interface.**

धन्यवाद



भारत सरकार/Government of India
विद्युत मंत्रालय/Ministry of Power
केन्द्रीय विद्युत प्राधिकरण/Central Electricity Authority
विद्युत प्रणाली अभियांत्रिकी एवं प्रौद्योगिकी विकास प्रभाग
Power System Engineering & Technology Development Division

Date: .03.2026

सेवा में,

<As per Address List>

विषय: Minutes of Second Meeting of the Committee to address the frequent transmission line outages on account of Insulator failures -reg.

महोदया/ महोदय,

The second meeting of the committee to address the frequent transmission line outages on account of Insulator failures was held under the Chairmanship of Member (Power System), CEA, on 12.02.2026 at 10:30 a.m. in Manthan Conference Hall of CEA, New Delhi through physical mode.

The minutes of the meeting are enclosed herewith for kind reference and necessary action by all concerned please.

भवदीय / Regards,
Digitally signed by
Kavita Jha
Date: 05-03-2026
14:53:09
(Kavita Jha)

निदेशक/ Director

Copy to:

1. SA to Member (PS), CEA
2. PS to Chief Engineer (PSE&TD), CEA

To

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		Sh. Ashish tripathi	Manager-Design	ashishtripathi@moderninsulators.com
		Sh. N.V.Ramkumar	Sr. V.P. (Tech. & Dev.)	nvramkumar@moderninsulators.com

Power System Engineering & Technology Development Division

Central Electricity Authority

Minutes of Second Meeting of the Committee to address the frequent transmission line outages on account of Insulator failures

The second Meeting of Committee to address the frequent transmission line outages on account of Insulator failures was held under the Chairmanship of Member (Power System), CEA, on 12.02.2026 at 10:30 a.m. in Manthan Conference Hall of CEA through physical mode. The list of participants is given at

Annexure-I. *It is noted that no representative from GETCO attended the meeting.*

1. In the opening remarks, Member (Power System), CEA welcomed all the participants and stated that the meeting has been convened in continuation of the first meeting held on 19.12.2025. He informed that pursuant to the deliberations in the first meeting, detailed failure statistics, technical specifications and Operation & Maintenance (O&M) practices have been received from certain utilities, and the same would be critically discussed in the meeting with a view to see what improvements can be suggested in the specifications of various types of Insulators. He then requested Chief Engineer (PSE&TD), CEA to take up the agenda.
2. Welcoming all the participants, CE (PSE&TD), CEA stated that in response to the deliberations held in the first meeting, valuable inputs had been received from all Member Utilities and Member OEMs. He stated that in order to suggest concrete and effective recommendations, detailed information including insulator failure data, technical specifications and QAPs had been sought. He further emphasized that insulator failure data supported by proper documentation, including photographs and root cause analysis, is necessary for arriving at evidence-based conclusions, particularly in view of the observed increase in insulator failures during monsoon months and multiple tripping incidents reported in certain regions during 2025. He stated that the Committee would examine the adequacy of existing type tests, acceptance tests and manufacturing tests especially in cases where failed insulators had passed all the prescribed tests, and would deliberate on the possible additional tests or improvements in technical specifications. The issues relating to storage and handling practices, O&M measures, and standardization of failure reporting format should also be given due attention. He then requested the participating members of transmission utilities and OEMs to present their findings and suggestions agenda-wise.
3. The representative of M/s MPPTCL presented detailed analysis of insulator failures from 2015 to 2025 along with analysis of failure trends during the year 2025 (**Annexure-II**). The salient points of the presentation are as follows:
 - a) The installed base in MPPTCL system comprises approximately 9.5 lakh Porcelain Disc Insulator Strings (PDIS) and approximately 1.2 lakh Silicone Rubber Composite Insulator Strings (SRCIS), indicating a ratio of approximately 8:1.
 - b) During the year 2025, failures reported were:
 - 86 Nos. of Porcelain strings
 - 69 Nos. of Composite strings

- c) On normalization with respect to installed base, the failure rate of composite insulators was observed to be significantly higher compared to porcelain insulators.
- d) Composite insulator failures from 2015–2025 were reported as 176 Nos., with nearly 39% of such failures occurring in 2025.
- e) Nature of faults in Composite Insulator:
- **Core:** Electrical failure of a core owing to splitting during line construction, initial and subsequent damage of core subjected to excessive bending load, typical fracture of a core by the stress corrosion (brittle fracture) mechanism.
 - **Housing:** Punctured silicon rubber shed, Chalking of shed material caused by leakage current activity, Chalking of shed material caused by ultraviolet radiation, Cracking of sheds, Erosion due to UV, weathering and electrical activity etc., Hydrolysis of epoxy housing material, Splitting of sheds owing to radial mechanical stress, Exposure of core owing to shed movement, Damages of Silicone rubber housings due to mis-handling, Shed damage caused by birds, rodents and termites, Mould (mold) Growths.
 - **Housing to core interface:** Internal breakdown and fracture of the housing caused by tracking up the core/housing interface, Puncture caused by tracking up the core/housing interface.
 - **End fitting:** End fitting damage from power arc.
 - **Corona/ Power Arc Protection:** Damage to seal and degraded shank surface without appropriate corona protection, Damage to seal and degraded shank surface due to improper tightening of corona protection Ring(s) / Arcing Horn(s).
- f) Possible cause of Composite Insulator failure are Improper design w.r.t. climatic conditions, Inferior Raw Material, Inferior Manufacturing Process, Inadequate Quality Control mechanism, Improper dispatching/transportation, Poor / Improper storage, Mal practices & handling during construction & maintenance, Direct/indirect lightening strokes.
- g) Failure rate was observed to be higher during monsoon months (June–August), indicating possible correlation with rainfall and lightning activity.
- h) Higher failure of incidence was observed in cultivated plain land areas.
- i) Analysis of string configuration indicated relatively higher failure tendency in tension strings after adjusting for proportion of such strings in the network.
- j) Preventive measures which may be considered to minimize failure incidents are:
- Highest possible “Fibre to Resin ratio” for FRP rods.
 - Increase Housing/Sheath thickness.
 - Adopt measures to divert Arc Path away from shed/housing.
 - Redesign of End-Fittings for mould anchoring mechanism.
 - Compression of End-Fitting half way before moulding & remaining after moulding to minimize possibility of FRP slippage movement.
 - Improve Quality Control Mechanism.
 - Awareness to handle Composite Insulators.

k) MPPTCL has informed that a committee has been constituted to analyse the insulator failures within its jurisdiction, and the committee's report is currently under consideration.

l) MPPTCL recommendation:

- Review of insulator rates.
- Standardization of material composition for manufacturing of insulators.
- Development of standard SOPs/guidelines for manufacturing and maintenance practices.

4. The representative of M/s MSETCL presented agenda-wise responses (**Annexure-III**). During the presentation, it was informed that a total of 241 insulator failures occurred in Year 2025 in their network due to various reasons, including lightning/thunderstorms, heavy faults during rain, dense fog conditions, pollution, insulator disc flashover, failure of insulator strings, manufacturing defects, de-capping, bird-related faults, ageing effects, and earth faults. The salient points of the presentation are summarized below:

a) MSETCL suggested inclusion of the following additional Additional Type Tests & Acceptance Tests:

- Ozone resistance test as per IEC 61854, Clause 7.6.4 to be included in Type test.
- Recovery of hydrophobicity test and Corona test as per relevant IEC/IS.
- Tests on FRP rod and silicon rubber compound
- Accelerated ageing test of 5000 Hrs as per relevant IEC/IS.

b) For porcelain long rod insulators, inclusion of following tests to be incorporated in the technical specification were suggested.

- Power Arc Test (IEC 61467)
- Thermal Mechanical Performance Test (IEC 60575)

c) For Composite Polymer long rod insulators, inclusion of following tests to be incorporated in the technical specification were suggested.

- Accelerated Ageing Test
- Sheath thickness test
- End Fitting moisture ingress test
- Enhancement of FRP rod 'Tg'

d) O&M Practices/ measures being specifically followed by MSETCL are as under:

- Hot-Line Washing
- Cold-Line Washing
- Hotline Maintenance / Puncture Insulator Detection (PID)
- Remote Airborne Inspection & Scanning System (RAISS) using drone
- Thermo-scanning
- Tower Footing Resistance Measurement
- Tower leakage Resistance Measurement

5. The representative of M/s PGCIL shared their inputs covering various tests like type tests, acceptance tests, manufacturing tests of Porcelain long rod insulators and Composite long rod insulators (**Annexure-IV**).

a) PGCIL also shared the requirement of Additional Type Tests & Acceptance Tests which are as under:

- Ozone resistance test as per IEC 61854, Clause 7.6.4 to be included in type test.
- Recovery of Hydrophobicity test & Corona test as per relevant IEC/IS.
- Tests on FRP rod and silicon rubber compound.
- Accelerated ageing test of 5000 hrs. as per relevant IS/ IEC.

He also informed that all these tests have been incorporated in PGCIL's latest Technical Specification.

b) For composite polymer long rod insulators, it has been suggested that the technical specification to be updated to incorporate provisions for the following tests:

- Accelerated Ageing Test,
- Sheath Thickness Test,
- End-Fitting Moisture Ingress Test, and
- Enhancement of FRP rod Tg.

6. The representative of M/s Epsilon Asia Group made a presentation highlighting global experience and asset management perspectives relating to insulator performance in transmission systems (**Annexure-V**). He emphasized the need for structured risk evaluation and long-term policy approach in addressing insulator failures.

During the presentation, concern was raised regarding insulator failures occurring within 5% to 33% of their expected service life. By way of illustration, he mentioned that in certain PGCIL transmission lines, some insulators have been in satisfactory operation for 25-30 years. However, in some of the lines, insulators were reportedly being replaced very frequently, sometimes within 5 years or less. He further emphasized that even if an insulator fails electrically, mechanical failure must be avoided. The salient points of the presentation are as follows:

- a) Detailed segregation of failures into infant mortality, mid-life failures and ageing-related failures is essential for drawing meaningful conclusions (based on bathtub curve analysis which is a graphical representation of a products failure rate over its lifespan).
- b) Insulator performance issues are not unique to India; several Transmission System Operators (TSOs) globally have adopted structured risk assessment, diagnostics and deployment optimization strategies.
- c) Insulator policy worldwide is increasingly guided by long-term asset management principles, and clear definition of "long-term performance" and "acceptable risk impact" is necessary for sound technical decision-making.
- d) Failure prevention and failure management must be treated with equal importance under a risk-based framework.

- e) Composite (HTM – Hydrophobic Transfer Material) insulators are widely deployed due to superior pollution performance; however, silicone-based materials have finite service life influenced by electrical stress, UV exposure, pollution severity, coastal/industrial environments and climate-related stress factors.
- f) Indian operating conditions are highly diverse and severe, including very high rainfall regions, arid zones, high-altitude terrains, extensive coastline, high UV index and therefore global assumptions on silicone ageing may not directly apply.
- g) Based on the data shared by the utilities, certain insulators are failing in early-life and mid-life stages, indicating need for realistic life expectancy assessment.
- h) Specification enhancements may provide incremental improvements; however, service life expectations must be rationalized considering environmental stress.
- i) End-of-life progression of silicone-based HTM insulators typically involves loss of hydrophobicity, progressive silicone degradation, housing damage and possible compromise of mechanical integrity.

He opined that the Committee may examine global experiences relating to selection of insulator material, geometry and type under harsh environmental conditions, rather than restricting deliberations to incremental modifications of existing specifications.

7. The representative of M/s Modern Insulators presented analysis of insulator failures which have occurred under the jurisdiction of GETCO, MPPTCL, PGCIL and MSETCL networks based on the failure details shared by them (**Annexure-VI**).

He stated that polymer, being an organic material, undergoes natural degradation over time and, therefore, its service life should not be directly compared with that of porcelain insulators. The following observations were made in the presentation:

- a) Month-wise failure distribution indicated higher incidence during high rainfall periods.
- b) Failure clustering was observed in certain voltage levels and corridors.
- c) With respect to service life, porcelain insulators were indicated to generally exhibit longer and more stable performance, often exceeding 20 years under Indian terrain conditions, whereas composite insulators may be more susceptible to premature ageing and material fatigue under combined environmental stresses.
- d) In terms of reliability behaviour, porcelain insulators were described as following a relatively stable “bathtub curve” pattern with a long useful life phase, while polymeric insulators may exhibit accelerated deterioration due to combined stresses.
- e) Regarding pollution performance, porcelain insulator failures were linked to site-specific pollution severity (USCD and local conditions), whereas polymeric insulators may be vulnerable to phenomena such as shed bridging.
- f) Phase-wise failure distribution indicated that porcelain insulator failures were observed more frequently in top/bottom phases in agricultural zones, whereas polymeric insulator failures were reported more generally in top and middle phases.
- g) In tension string applications, porcelain insulators were indicated to have comparatively better performance under high tensile loads, while polymeric insulators were noted to have relatively higher failure risk under sustained mechanical stress.
- h) Based on above mentioned observations, the representative of M/s Modern Insulators emphasized on the following recommendations:

- Pollution severity must be quantified as per IEC methodology.
- Detailed data regarding creepage distance and shed profile (standard/deep/steep) at the failed locations should be made available for proper analysis.
- The nature of failure (electrical or mechanical) must be clearly identified and documented.
- Profile efficiency, which has not received adequate attention, should be incorporated as a defined requirement in the relevant Indian Standards (IS).
- Environmental conditions should be duly considered during insulator design, and the specific suitability requirements for porcelain or polymer insulators based on site conditions should be explicitly specified in the tender documents.

It was suggested by representative of M/s Modern Insulators that joint site visits to selected failure locations may provide deeper insight into terrain-specific stress and failure mechanism.

8. NLDC furnished their inputs with respect to the Insulator Failure Analysis pertaining to transmission line outages caused due to insulator failures in the networks of IndiGrid/ Adani. A total of 68 incidents reported during 2025 were analyzed (**Annexure-VII**). The salient points of the same are summarized below:

- a) Out of total 68 reported incidents, 58 incidents (85%) pertained to 765 kV lines.
- b) Adani's network accounted for 50 incidents (73%) of the total incidents.
- c) The analysis indicated a strong seasonal trend, with 42 incidents (62%) of failures occurring during the monsoon period (June–September) and July–August emerging as the peak months having 27 incidents (41%).
- d) In terms of reason of failures, insulator puncture/tracking and broken insulators constituted a significant share (24%) of incidents, while cases of FRP rod brittle fracture were also observed. It was further noted that nearly 46% of incidents did not have clearly specified failure reasons, highlighting a gap in root cause documentation.
- e) High degree of correlation between monsoon season and composite insulator failures was observed for the reported incidents. Out of all the incidents, 62% of the total failures occurred during monsoon season only; however, actual climatic conditions were not reported at the time of failure.

9. M/s Deccan Enterprises furnished additional Tests, design improvements and quality assurance practices being implemented beyond existing utility specifications and IEC requirements (**Annexure-VIII**). The salient points of the same are as follows:

- a) Additional acceptance tests including
 - High voltage test on Composite insulators for Evaluation of Defects in FRP rods and Interfaces of composite insulators with IR camera
 - Water diffusion test on complete unit
 - Acid resistance test (with 1M HNO₃)
 - Shear test

- Peel test

b) Additional Routine Manufacturing Tests

- Peel test at room temperature
- Peel Test after 100 hours Boiling
- NDT-based minimum sheath thickness verification and sheath thickness uniformity

c) Design improvements implemented:

- Higher galvanization for coastal/polluted regions
- Sheath thickness: 5 mm (NDT ensured)
- Shed root ≥ 6 mm, Shed tip ≥ 2.5 mm³
- Silicone rubber water absorption $< 0.25\%$
- In-house FRP rods with $T_g \geq 140^\circ\text{C}$
- Project-specific Electric Field Management (EFM)

d) It was stated that stringent control over raw materials through proper inspection, careful selection, and additional factory testing prior to lot acceptance is critical to ensuring long-term insulator performance. Such measures would help ensure raw material quality and robustness well before insulator manufacturing begins.

10. The representative of M/s Aditya Birla Insulators shared a presentation covering comparative performance, lifecycle aspects and global practices relating to Porcelain and Composite long rod insulators (**Annexure-IX**). The salient points of the same are summarized as under:

- Insulators as per the type of material used are categorized as Organic (Silicon Rubber Insulator), Inorganic (Ceramic insulators) and Hybrid (RTV Coated Ceramic insulator).
- Insulators are subjected to thermal, environmental (UV, pollution, acid rain), physical (bird contact, sand storms) and mechanical stresses.
- Ceramic insulators in service are generally designed with creepage of 16 mm/kV and have demonstrated service life beyond 35 years in most cases, with gradual and predictable ageing characteristics.
- Composite Long Rod Insulators (CLRI), typically designed with 25–31 mm/kV creepage, ideally should provide improved flashover performance; however, based on shared data, service life has been observed to vary between 3–11 years, with a significant number of failures occurring within the first 3 years of operation, and ageing behaviour appearing less predictable.
- Diagnostic tools such as infrared (IR)/ thermal scanning have limitations and weak correlation with actual failure modes. Considering the large expansion of transmission network (>220 kV), periodic scanning across diverse terrain may be operationally challenging and economically burdensome.
- Traceability and failure analysis systems are well established for ceramic insulators, while similar systems for CLRI remain limited.

- g) Product traceability practices implemented by ABI, including 2D barcode-based tracking from pre-firing to post-firing stage, were shared as a measure to improve work-in-progress tracking, production control and elimination of manual entries.
 - h) From lifecycle cost perspective, although CLRI may offer lower initial and installation cost, shorter and uncertain service life may result in multiple replacements, increased outages, maintenance cost and reduced line availability. Ceramic insulators, despite higher upfront cost, may provide lower total cost of ownership (TCO) due to longer service life and stable performance.
 - i) A comparative economic illustration for a 400 kV, 100 km transmission line transferring 500 MW using 120 kN type insulators indicated significantly higher cumulative replacement cost in case of CLRI over ceramic insulators.
 - j) Additional societal impacts associated with repeated replacements, such as agricultural loss, safety risks to maintenance personnel, theft risk during shutdowns and overall grid inefficiencies, were also highlighted.
11. The Committee noted that environmental factors such as rainfall, lightning and pollution play a significant role in influencing insulator performance. It was further emphasized that the integrity of the interface between the FRP rod, housing and end fitting is critical to the long-term reliability of composite insulators, and that electric field stress concentration near the high-voltage end requires focused design attention.
12. After detailed deliberations, it was decided that the member-utilities would submit the following details:
- a) Improvements required in the Technical Specifications of Porcelain Disc Insulator, Porcelain Long-Rod Insulator and Composite Long-Rod Insulator may be furnished **along with justification**.
 - b) Additional Type Tests, Acceptance Tests, Manufacturing Tests that need to be prescribed for Porcelain Disc Insulator, Porcelain Long-Rod Insulator and Composite Long-Rod Insulator may be furnished **along with justification**.
 - c) Quality Assurance Plan (QAP) being followed by the Utility for Porcelain Disc Insulator, Porcelain Long-Rod Insulator and Composite Long-Rod Insulator.
 - d) Storage and Handling Procedures being followed by the Utility for Porcelain Disc Insulator, Porcelain Long-Rod Insulator and Composite Long-Rod Insulator. Relevant Guidelines on the same may also be shared.
 - e) Views/ Inputs on appropriateness of providing Corona ring, Grading ring, Arcing horns at Tower side/ Line side of the Insulator String at different Voltage levels (132/ 110 kV, 220/ 230 kV, 400 kV, 765 kV) may be furnished **along with justification**.
 - f) PGCIL is also requested to furnish Observations from their planned China Tour to ascertain efficacy of various aspects relating to use of Composite Long-Rod Insulators.
 - g) Considering the details of Insulator Failures of various Utilities made available, it is requested to furnish probable reasons for the observed different categories Insulator Failures, and ways & means of reducing them.
 - h) Additional Inputs, if any.

It was also decided that the OEMs would submit the following details:

- a) Pros and Cons of using various Types of Insulators in Indian Grid.

- b) Improvements required in the Technical Specifications of Porcelain Disc Insulator, Porcelain Long-Rod Insulator and Composite Long-Rod Insulator may be furnished **along with justification.**
 - c) Additional Type Tests, Acceptance Tests, Manufacturing Tests that need to be prescribed for Porcelain Disc Insulator, Porcelain Long-Rod Insulator and Composite Long-Rod Insulator may be furnished **along with justification.**
 - d) The list of External Factors which may have bearing in the operation of various types of Insulators, and ways & means of incorporating them in their design.
 - e) Views/ Inputs on appropriateness of providing Corona ring, Grading ring, Arcing horns at Tower side/ Line side of the Insulator String at different Voltage levels (132/ 110 kV, 220/ 230 kV, 400 kV, 765 kV) may be furnished **along with justification.**
 - f) Suggestions w.r.t. specific use of different types of Insulators (Porcelain / Polymer) on transmission lines which can be stipulated in the relevant Tenders may also be furnished.
 - g) Considering the details of Insulator Failures of various Utilities made available, it is requested to furnish probable reasons for the observed different categories Insulator Failures, and ways & means of reducing them.
 - h) Additional Inputs, if any.
13. Based on the deliberations of the Committee held so far, and after receipt of all above details, the Draft Report of the Committee would be prepared, and shared to all the Committee Members for comments. And the same would be discussed & finalized in the first half of April, 2026.

The meeting ended with vote of thanks to all the participants.

Annexure-I**List of Participants (12.02.2026)****CEA**

1. Sh. Vijay Kumar Singh, Member (Power System)
2. Sh. N.R.L.K. Prasad, Chief Engineer (PSE&TD)
3. Smt. Kavita Jha, Director (PSE&TD)
4. Smt. Jyoti Singh, Deputy Director (PSE&TD)
5. Sh. Amrendra Pratap Singh, Assistant Director (PSE&TD)

POWERGRID

1. Md. Anisur Rahman, Sr. DGM
2. Sh. Ashish Kumar Singh, Chief Manager

ABI

1. Sh. Chandan, R.H.

MSETCL

1. Sh. Yogesh Charan, Superintending Engineer

MPPTCL

1. Sh. Vinay Kumar Parwar, Superintending Engineer

DECCAN

1. Sh. Yogendara Singh, AGM-Sales
2. Mohommed Ali, Sr. Mnager
3. Sh. S.K. Rao, Sr. Manager Sales

EPSILON

1. Sh. Neelesh Arora, CEO Epsilon Asia

GRID INDIA

1. Sh. Aman Gautam, C. Manager
2. Sh. Suhas Damhare, CGM

MODERN INSULATOR LTD.

1. Sh. N.V. Ram Kumar, Sr. VP
2. Dr. Sudalai Shunmugam S., JVP



M. P. Power Transmission Company Ltd.

(Wholly owned by Govt. of Madhya Pradesh)

FREQUENT TRANSMISSION LINE OUTAGES ON ACCOUNT OF INSULATOR FAILURES

Analysis of Historical data of incidents of failure of Insulators

Year wise Insulator String Failure Analysis

Year	Porcelain				Polymer			
	132kV	220kV	400kV	Total	132kV	220kV	400kV	Total
2015	41	36	21	98	--	--	--	--
2016	66	70	14	150	1	--	--	1
2017	53	36	6	95	2	--	--	2
2018	50	39	7	96	3	--	--	3
2019	69	81	12	162	7	2	--	9
2020	72	53	5	130	2	--	--	2
2021	78	54	10	142	8	4	--	12
2022	82	45	6	133	15	4	--	19
2023	82	48	11	141	17	3	--	20
2024	84	63	5	152	31	8	--	39
2025	49	31	6	86	50	18	1	69
Total	726	556	103	1385	136	39	1	176

Composite Insulator Failure Rate is higher and is in increasing trend w.r.t. to Porcelain Insulator

Failure of Insulators from 2015 to 2025 Annexure-II

Year wise & Tower Type wise Insulator String Failure Analysis

Year	Porcelain							Polymer						
	132 kV	132 kV	220 kV	220 kV	400 kV	400 kV	Total	132 kV	132 kV	220 kV	220 kV	400 kV	400 kV	Total
	Susp.	Ten.	Susp.	Ten.	Susp.	Ten.		Susp.	Ten.	Susp.	Ten.	Susp.	Ten.	
2015	34	7	31	5	21	--	98	--	--	--	--	--	--	--
2016	50	16	66	4	12	2	150	1	--	--	--	--	--	1
2017	46	7	31	5	6	--	95	2	--	--	--	--	--	2
2018	31	19	38	1	7	--	96	1	2	--	--	--	--	3
2019	52	17	72	9	9	3	162	6	1	2	--	--	--	9
2020	50	22	45	8	5	--	130	2	--	--	--	--	--	2
2021	63	15	45	9	9	1	142	5	3	2	2	--	--	12
2022	50	32	38	7	6	--	133	12	3	3	1	--	--	19
2023	66	16	44	4	11	--	141	11	6	1	2	--	--	20
2024	61	23	60	3	5	--	152	18	13	6	2	--	--	39
2025	41	8	29	2	6	--	86	35	15	11	7	1	--	69
Total	544	182	499	57	97	6	1385	93	43	25	14	1	--	176

- Out of 176No. failed Polymer Insulators, Suspension Insulators is 119No. & Tension Insulators is 57No.
- In 132kV & 220kV Transmission line, suspension insulators contributes about 60% part and tension about 40% part of total Insulators.
- Weightage of failure of Tension Insulators works to be 142No. ($57/0.4$).
- Failure rate of tension insulators is higher.

Failure of Insulators from 2015 to 2025 Annexure-II

Month wise Insulator String Failure Analysis								
Month	Porcelain				Polymer			
	132kV	220kV	400kV	Total	132kV	220kV	400kV	Total
Jan	66	114	20	200	8	2	--	10
Feb	23	34	--	57	1	3	--	4
Mar	49	28	5	82	2	--	--	2
Apr	34	25	2	61	--	1	--	1
May	49	31	2	82	6	2	--	8
Jun	82	53	17	152	9	3	--	12
Jul	98	59	16	173	37	9	1	47
Aug	87	60	15	162	26	9	--	35
Sep	116	62	9	187	29	6	--	35
Oct	64	36	6	106	7	1	--	8
Nov	24	16	4	44	6	1	--	7
Dec	34	38	7	79	5	2	--	7
Total	726	556	103	1385	136	39	1	176

Failure of Insulators in 2025

Annexure-IV (Page 19 of 164)

Annexure-II

Month wise Insulator String Failure Analysis

Month	Porcelain				Polymer			
	132kV	220kV	400kV	Total	132kV	220kV	400kV	Total
Jan	9	3	--	12	4	1	--	5
Feb	3	4	--	7	--	--	--	--
Mar	2	--	1	3	--	--	--	--
Apr	1	1	--	2	--	--	--	--
May	6	6	--	12	1	--	--	1
Jun	4	5	1	10	3	2	--	5
Jul	1	4	--	5	15	5	1	21
Aug	9	5	3	17	6	3	--	9
Sep	14	3	1	18	19	5	--	24
Oct	--	--	--	--	1	1	--	2
Nov	--	--	--	--	--	1	--	1
Dec	--	--	--	--	1	--	--	1
Total	49	31	6	86	50	18	1	69

Insulator Failure Rate is higher during Rains.

Failure of Insulators from 2015 to 2025 Annexure-1

Annexure-IV (Page 20 of 164)

Terrain Categories wise Insulator String Failure Analysis								
Terrain Category	Porcelain				Polymer			
	132kV	220kV	400kV	Total	132kV	220kV	400kV	Total
Agriculture	457	374	84	915	103	34	1	138
Forest	65	42	3	110	7	1	--	8
Hill	99	67	11	177	15	1	--	16
Hill / Forest	2	10	--	12	1	--	--	1
Plain	103	63	5	171	10	3	--	13
Total	726	556	103	1385	136	39	1	176

Soil Strata wise Insulator String Failure Analysis								
Soil Strata	Porcelain				Polymer			
	132kV	220kV	400kV	Total	132kV	220kV	400kV	Total
Black Cotton	385	312	50	747	76	28	--	104
Hard Rock	61	41	--	102	14	2	--	16
Lal Murram	52	19	13	84	9	4	--	13
Normal	144	135	39	318	30	5	1	36
Stony Soil	84	49	1	134	7	--	--	7
Total	726	556	103	1385	136	39	1	176

Failure of Insulators in 2025

Annexure-IV (Page 21 of 164)

Annexure-II

Terrain Categories wise Insulator String Failure Analysis

Terrain Category	Porcelain				Polymer			
	132kV	220kV	400kV	Total	132kV	220kV	400kV	Total
Agriculture	36	27	5	68	38	17	1	56
Forest	7	4	--	11	3	1	--	4
Hill	1	--	1	2	6	--	--	6
Hill / Forest	--	--	--	--	--	--	--	--
Plain	5	--	--	5	3	--	--	3
Total	49	31	6	86	50	18	1	69

Soil Strata wise Insulator String Failure Analysis

Soil Strata	Porcelain				Polymer			
	132kV	220kV	400kV	Total	132kV	220kV	400kV	Total
Black Cotton	38	19	1	58	34	14	--	48
Hard Rock	3	2	--	5	2	--	--	2
Lal Murram	3	--	4	7	3	4	--	7
Normal	5	4	--	9	6	--	1	7
Stony Soil	--	6	1	7	5	--	--	5
Total	49	31	6	86	50	18	1	69

Insulator Failure Rate is higher in plane cultivated land.

Conclusion based on data analysis Annexure-II

- Porcelain Disc Insulator String (PDIS)- about 9.5 lakh.
- Silicone Rubber Composite Insulator String (SRCIS)- about 1.2 lakh
- Ratio of PDIS to SRCIS- **about 8(Eight):1(One)**.
- Failure of Insulators in year 2025:
 - ✓ Porcelain Disc Insulator strings- 86No.
 - ✓ Silicone Rubber Composite Insulators- 69No.
 - ✓ Ratio PDIS to SRCIS - **about 1.3:1**
- Failure rate of SRCIS in year 2025 is about **6 (Six) time** more than the failure of PDIS.
- Failure of SRCIS from year 2015 to 2025 – 176 No.
- Percentage failure of SRCIS in year 2025 – 39%

Manufacturer wise & Area wise Analysis of Silicone Rubber Composite Insulator Strings failure

Manufacturer wise Polymer Insulator Failure Analysis

Make	From year 2015 to 2025				In year 2025			
	132kV	220kV	400kV	Total	132kV	220kV	400kV	Total
ABI India	56	16	--	72	16	7	--	23
Deccan	5	5	--	10	5	3	--	8
Decosil	29	5	1	35	12	1	1	14
DEPL	3	--	--	3	2	--	--	2
GKXEPL	6	3	--	9	6	1	--	7
Phoenix India	15	1	--	16	2	--	--	2
SparkIL	10	--	--	10	1	--	--	1
SRI India	8	7	--	15	3	5	--	8
Not Visible	4	2	--	6	3	1	--	4
Total	136	39	1	176	50	18	1	69

Area wise Polymer Insulator Failure Analysis

Divisional HQ	From year 2015 to 2025				In year 2025			
	132kV	220kV	400kV	Total	132kV	220kV	400kV	Total
Barwaha	12	--	--	12	5	--	--	5
Indore	13	2	--	15	8	--	--	8
Ratlam	25	7	--	32	2	2	--	4
Ujjain	10	2	1	13	7	1	1	9
Bhopal	18	3	--	21	2	1	--	3
Bina	5	2	--	7	2	1	--	3
Itarsi	16	13	--	29	9	8	--	17
Seoni	3	--	--	3	1	--	--	1
Jabalpur	10	1	--	11	5	1	--	6
Satna	4	1	--	5	2	1	--	3
Damoh	16	6	--	22	5	3	--	8
Gwalior	4	2	--	6	2	--	--	2
Total	136	39	1	176	50	18	1	69

Area wise Polymer Insulator Failure Analysis

Annexure-IV (Page 26 of 164)

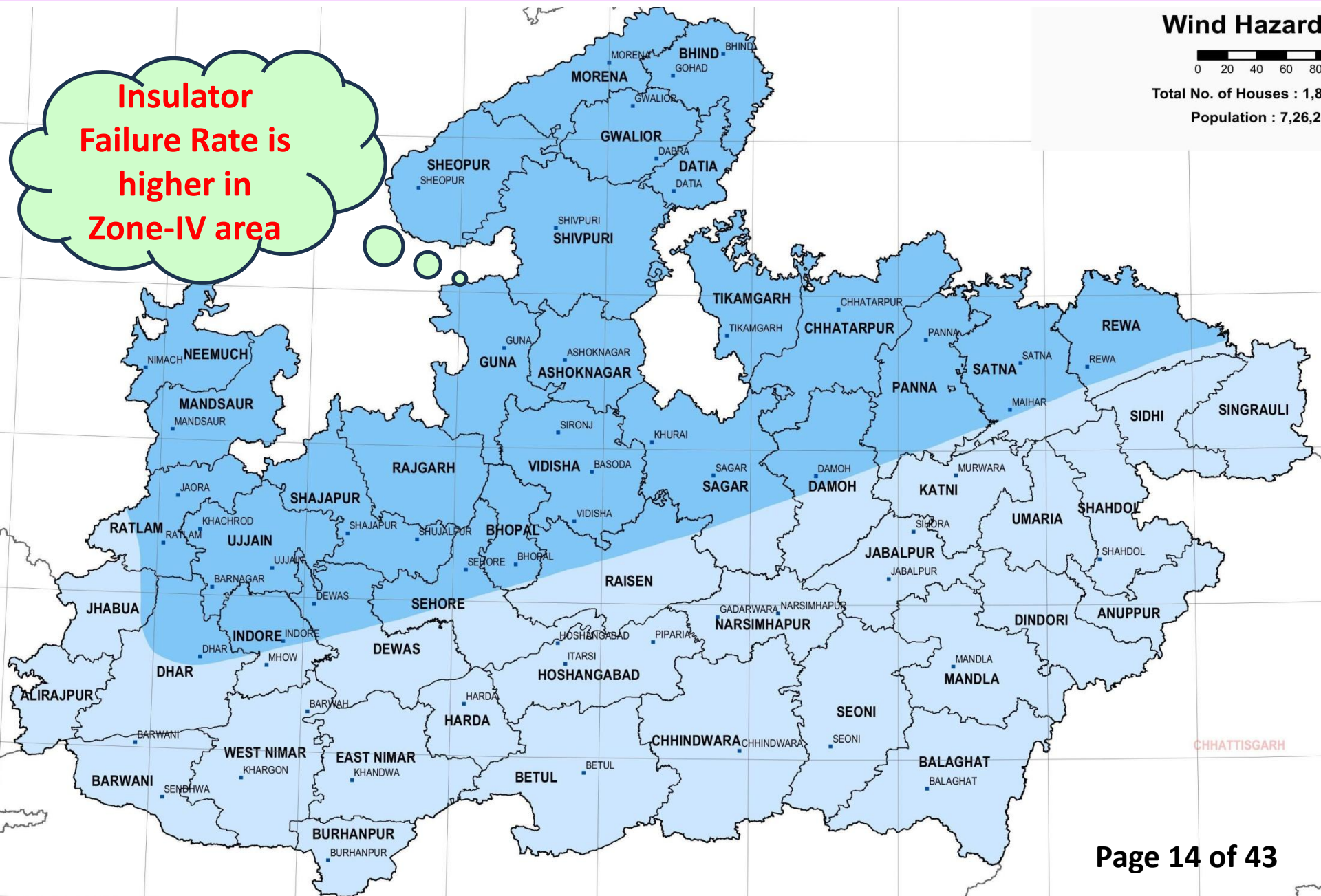
Wind Hazard



Total No. of Houses : 1,8

Population : 7,26,2

Insulator
Failure Rate is
higher in
Zone-IV area



CHHATTISGARH

Understand Failure Mechanism of Composite Insulators

**(Photo graphs do not pertains to MPPTCL. These are collected from
internet for study & training purpose only)**

Failure Mechanism of Composite Insulators

Part of Insulators	Nature of Faults
Core	Electrical failure of a core owing to splitting during line construction
	Initial and subsequent damage of core subjected to excessive bending load
	Typical fracture of a core by the stress corrosion (brittle fracture) mechanism
Housing	Punctured Silicon Rubber shed
	Chalking of shed material caused by leakage current activity
	Chalking of shed material caused by ultraviolet radiation
	Cracking of sheds
	Erosion due to UV, weathering and electrical activity etc.
	Hydrolysis of epoxy housing material
	Splitting of sheds owing to radial mechanical stress
	Exposure of core owing to shed movement

Failure Mechanism of Composite Insulators

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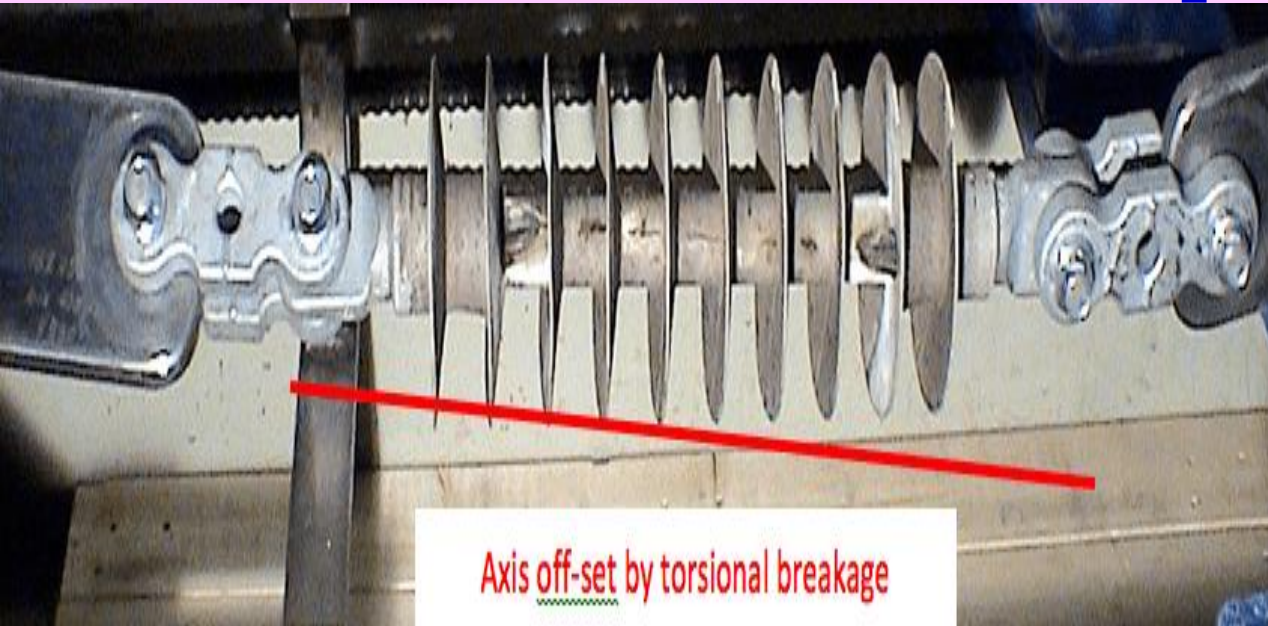
Annexure-II

Part of Insulators	Nature of Faults
Housing	Damages of Silicone rubber housings due to mis-handling
	Shed damage caused by birds, rodents and termites
	Mould (mold) Growths
Housing to core interface	Internal breakdown and fracture of the housing caused by tracking up the core/housing interface
	Puncture caused by tracking up the core/housing interface
End fitting	End fitting damage from power arc
Corona/ Power Arc Protection	Damage to seal and degraded shank surface without appropriate corona protection
	Damage to seal and degraded shank surface due to improper tightening of corona protection Ring(s) / Arcing Horn(s)

Failure Mechanism of Composite Insulators

Annexure-IV (Page 30 of 164)

Annexure-II



Composite insulator electrically failed by combined flashover and flash under caused by torsional rod crack



Damage to seal and degraded shank surface of tension insulator without appropriate corona protection

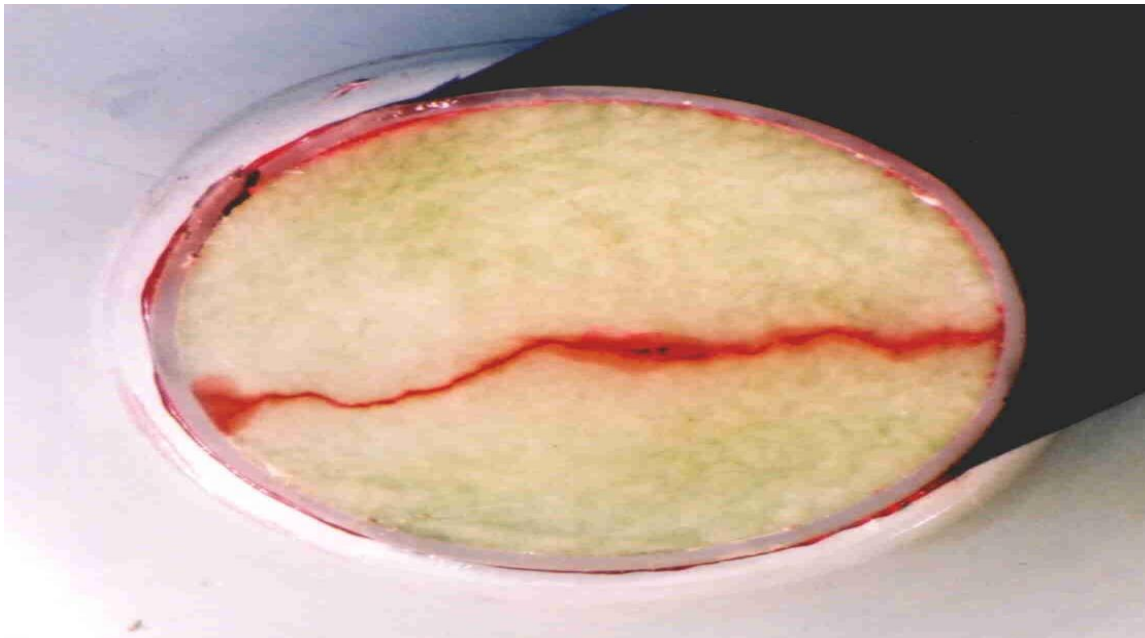
Failure Mechanism of Composite Insulators

Annexure-IV (Page 31 of 164)

Annexure-II

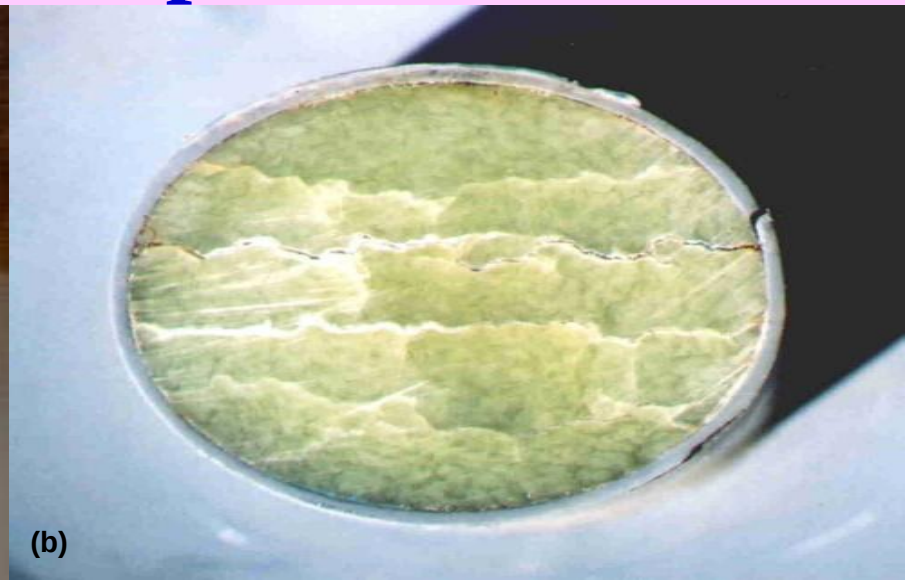


Electrical failure of a core owing to splitting during line construction



Failure Mechanism of Composite Insulators

Annexure-IV (Page 32 of 164)



Initial (a) and subsequent (b) damage of a line post core subjected to excessive bending load

Failure Mechanism of Composite Insulators



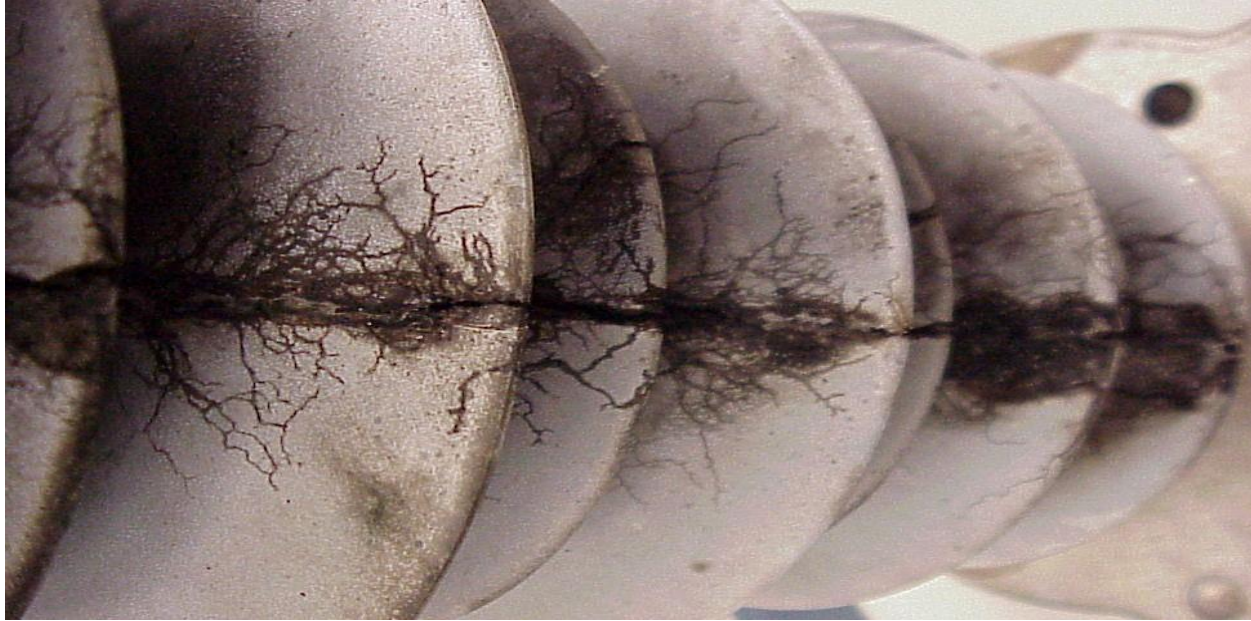
**Erosion of
Silicone rubber
housings**

Courtesy of Eskom

Failure Mechanism of Composite Insulators

Annexure-IV (Page 34 of 164)

Annexure-II



Tracking concentrated at the mould line on a Silicone Rubber Composite insulator

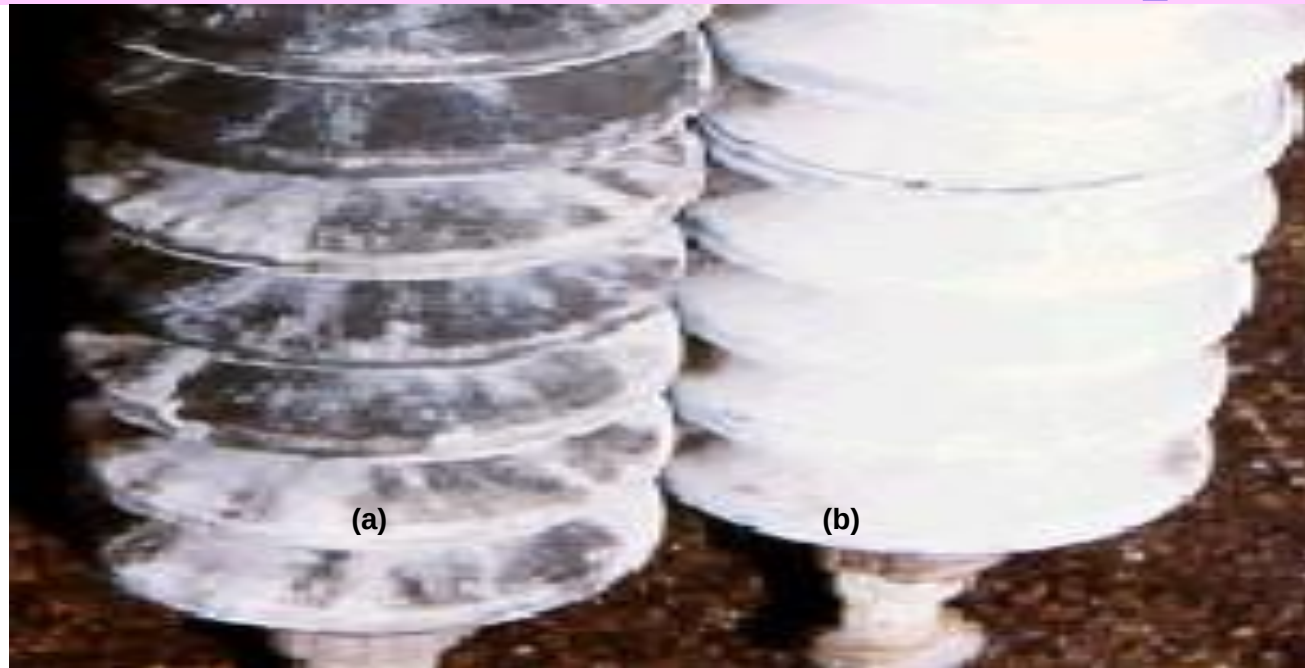


Punctured Silicone Rubber shed

Failure Mechanism of Composite Insulators

Annexure-IV (Page 35 of 164)

Annexure-II



Chalking of shed material caused by leakage current activity (a) and ultraviolet radiation (b)

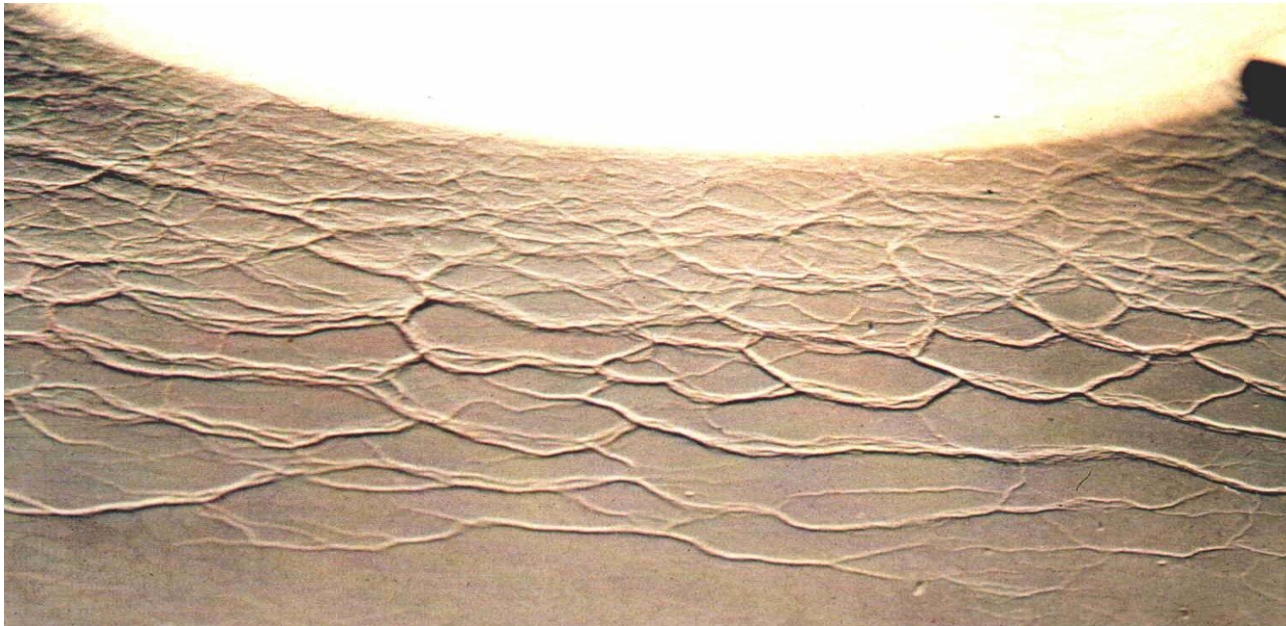


Crazing or cracking

Failure Mechanism of Composite Insulators



**Erosion
(alligatoring)
due to UV,
weathering
and
electrical
activity**



Failure Mechanism of Composite Insulators

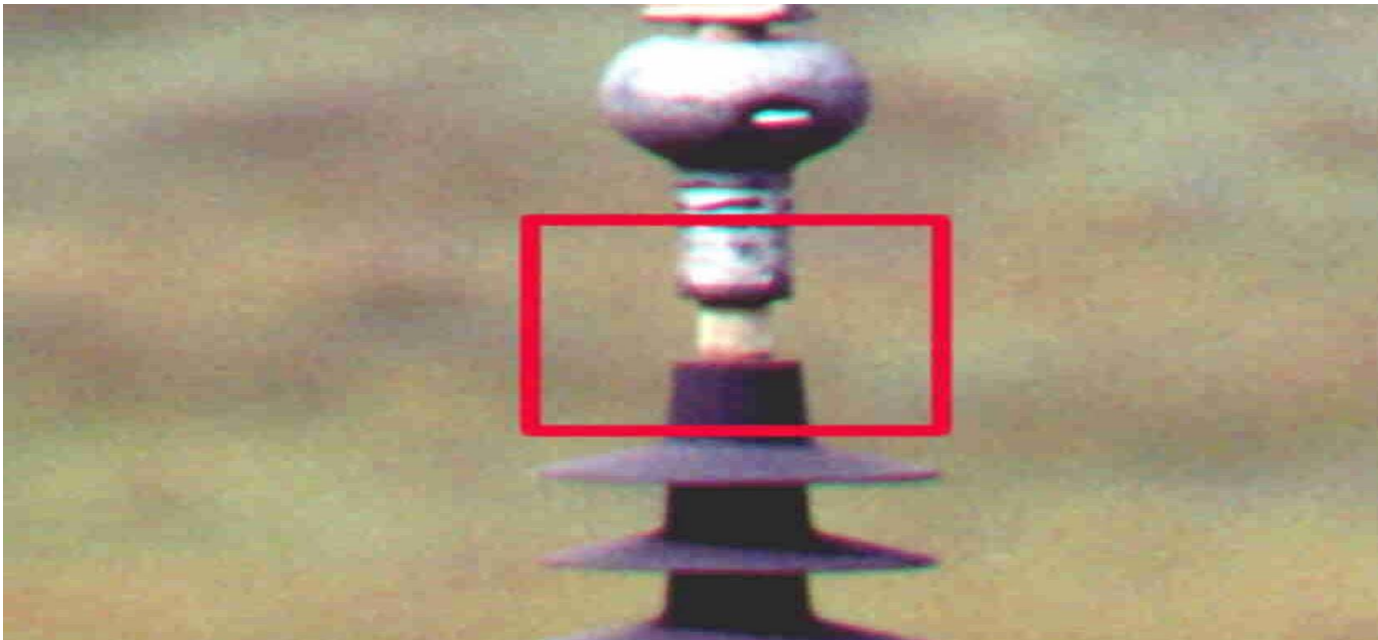
Annexure-IV (Page 37 of 164)

Annexure-II



Courtesy of J Frate

**Hydrolysis of
epoxy
housing
material**



**Exposure of
core owing to
shed
movement**

Failure Mechanism of Composite Insulators

Annexure-IV (Page 38 of 164)



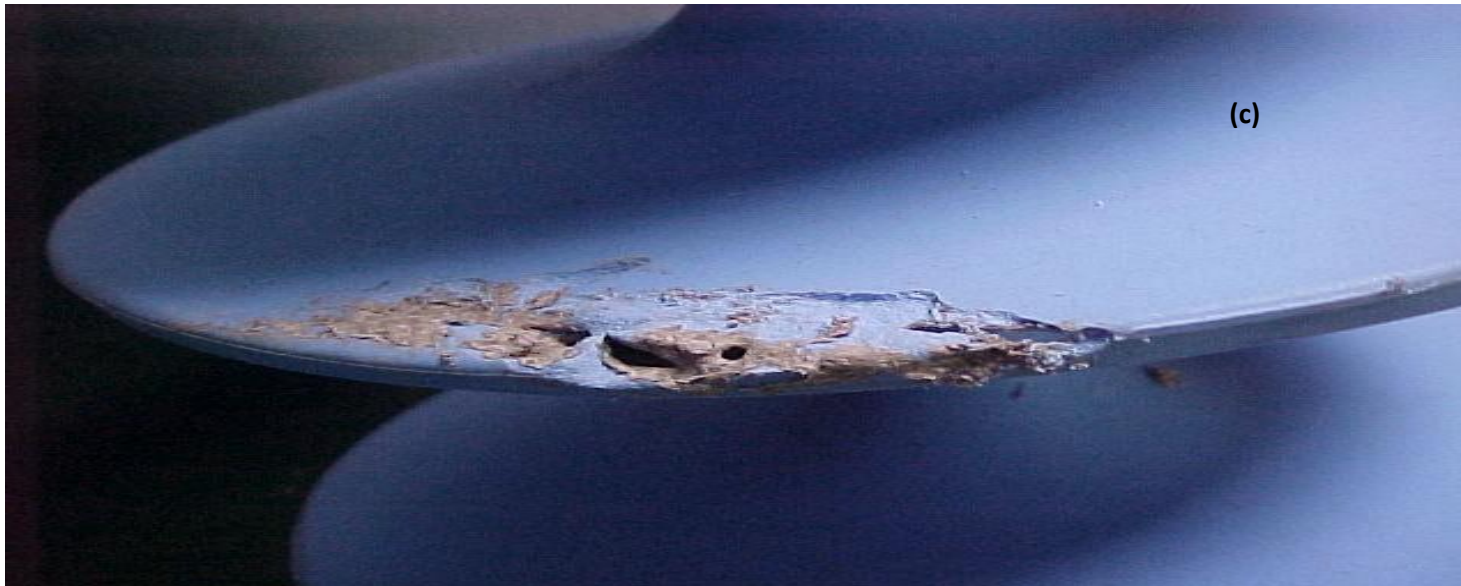
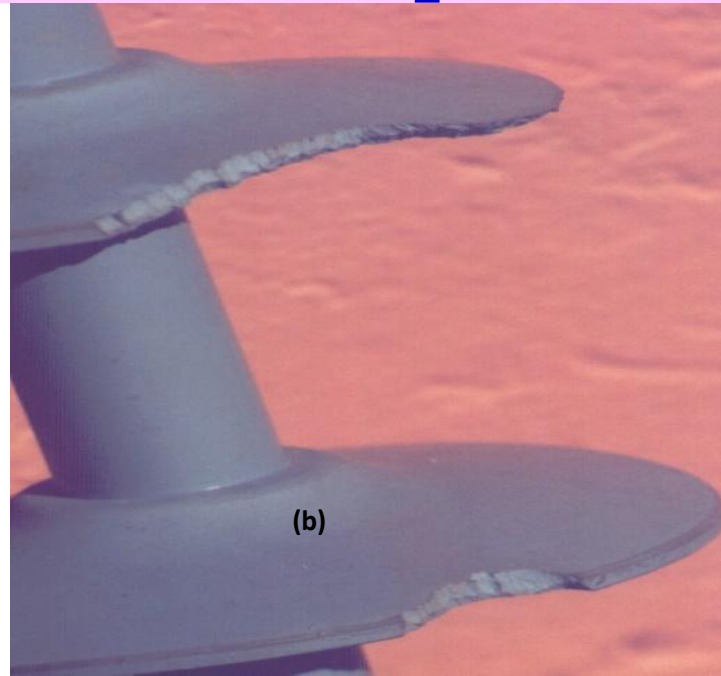
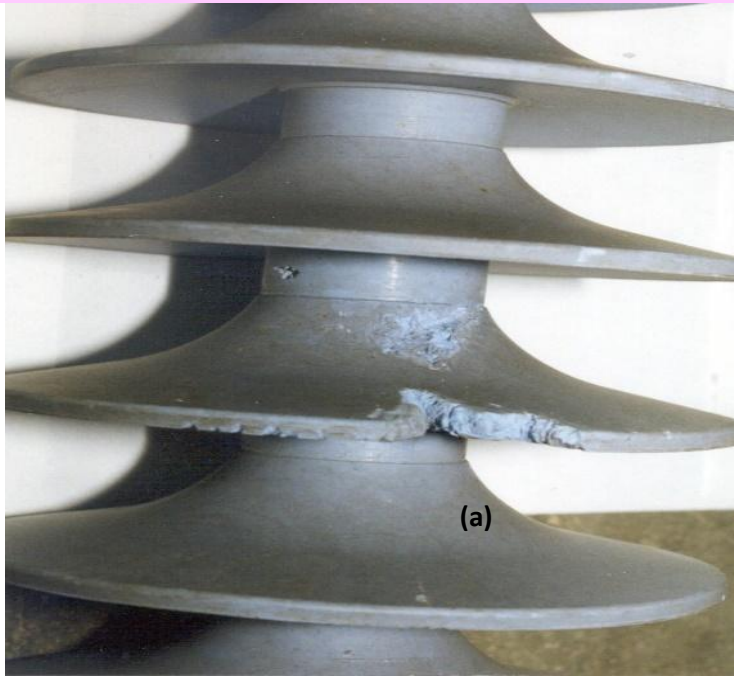
**Splitting of
sheds owing
to radial
mechanical
stress**



Failure Mechanism of Composite Insulators

Annexure-IV (Page 39 of 164)

Annexure-II



**Shed
damage
caused by
birds (a),
rodents (b) &
termites (c)**

Failure Mechanism of Composite Insulators

Annexure-IV (Page 40 of 164)

Annexure-II



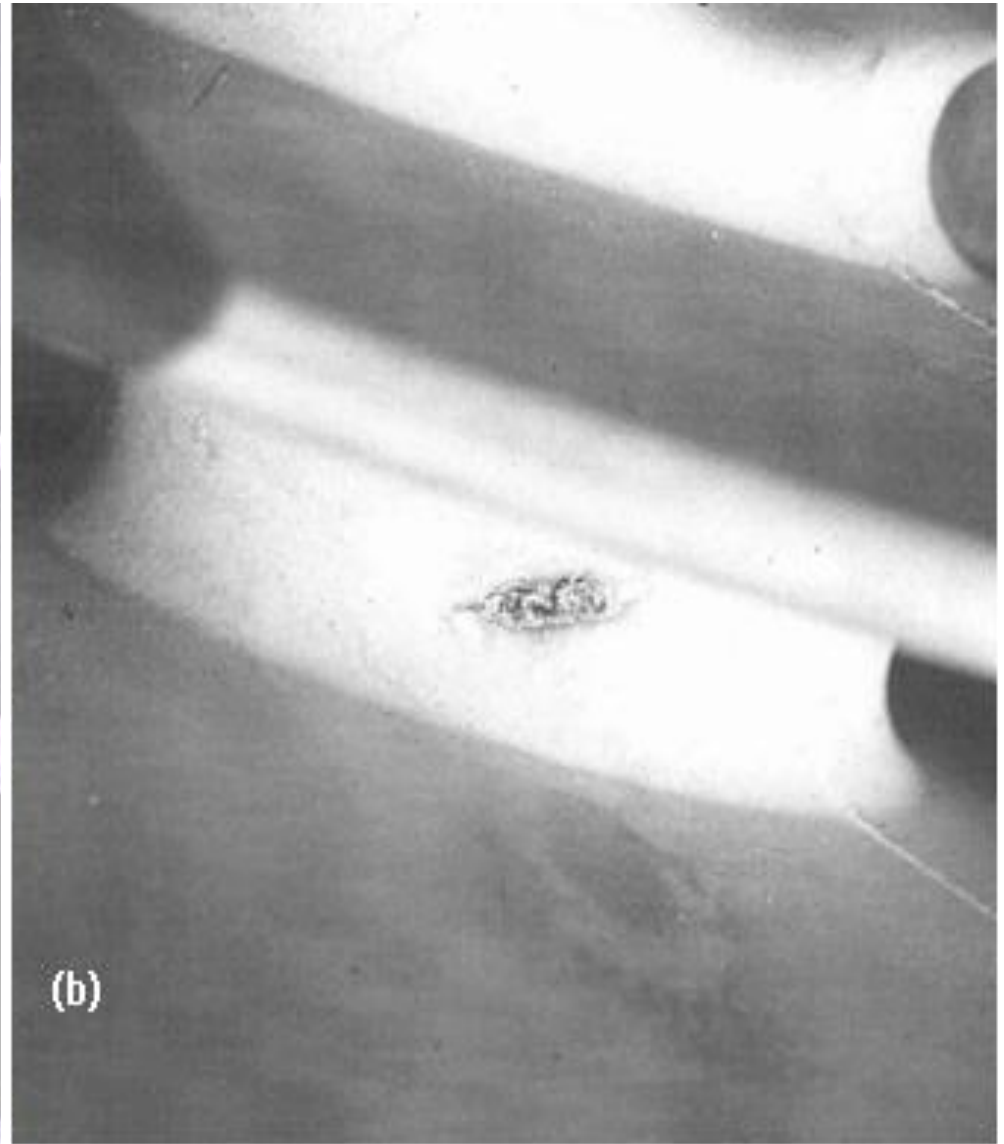
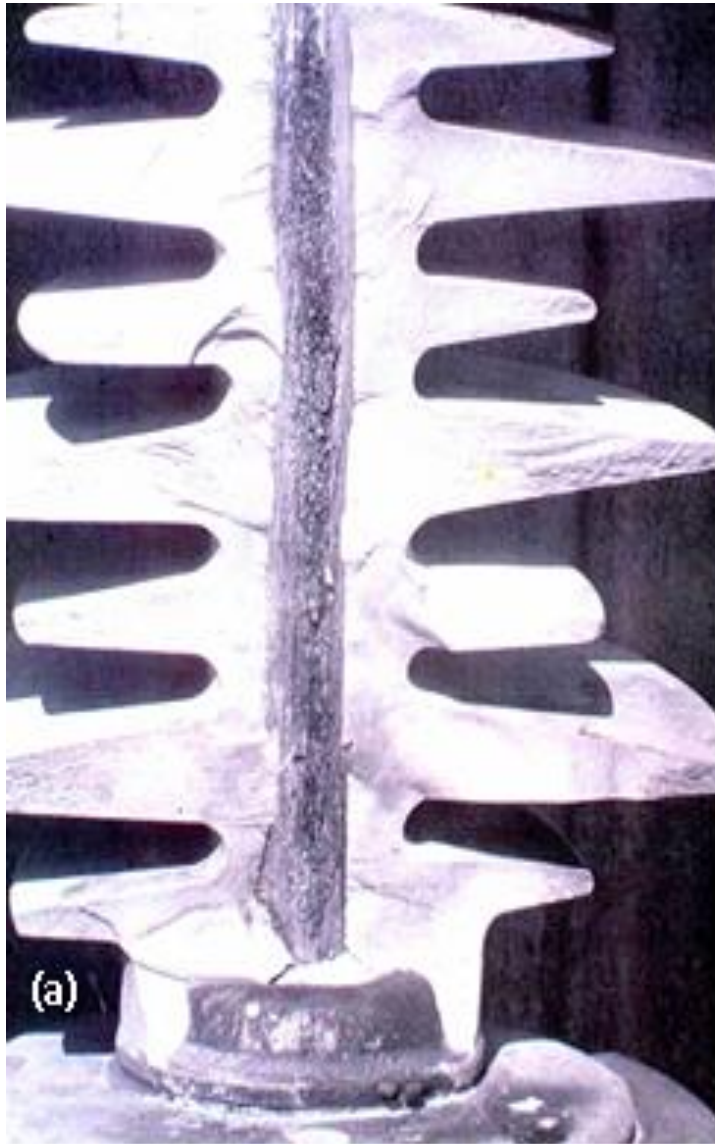
**Colonization by
Aspergillus niger
&
Cladosporium is
easily removed**



**Colonization by
Chaetomium,
Cladosporium and
Methylobacteria
leaves pinkish residue**

Failure Mechanism of Composite Insulators

Annexure-IV (Page 41 of 164)



Internal breakdown and fracture of the housing (a) and puncture (b) caused by tracking up the core/housing interface

Failure Mechanism of Composite Insulators

Annexure-IV (Page 42 of 164)



Housing to end fitting interface failure due to erosion



End fitting damage from power arc

Storage ...



Example of rodent attack



Nails protruding from a crate can lead to insulator damage



Insulators stored in plastic pipes

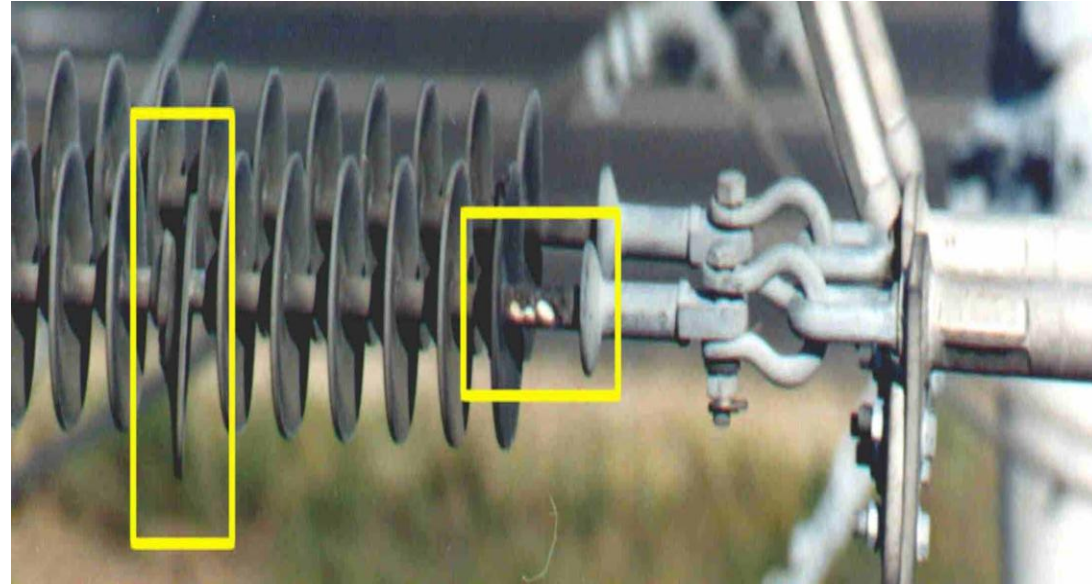


Poor stacking and storage

Conductor Stringing ...



Sheath damage due to rope abrasion



Shed and critical sheath damage on a composite strain insulator



Housing damage from lifting line



Courtesy of Eskom

Analysis of Failure of Composite Insulators in MPPTCL

Analysis of failure of Insulators in Year 2025

Observations on Failed Insulator	Polymer			
	132kV	220kV	400kV	Total
Exposure of core owing to shed movement	3	1	--	4
Internal breakdown caused by tracking up the core/housing interface	1	--	--	1
Punctured Silicon Rubber shed along moulding line	6	5	--	11
Punctured Silicon Rubber shed at both End-fittings	1	--	--	1
Punctured Silicon Rubber shed at End-fitting	15	2	--	17
Punctured Silicon Rubber shed at End-fitting & Splitting of sheds	1	--	--	1
Total	27	8	--	35

Possible cause of Polymer Insulator failure

- Improper design w.r.t. climatic conditions
- Inferior Raw Material
- Inferior Manufacturing Process
- Inadequate Quality Control mechanism
- Improper dispatching/transportation,
- Poor / Improper storage
- Mal practices & handling during construction & maintenance,
- Direct/indirect lightening strokes

Different coefficient of linear thermal expansion

- Because FRP and silicone rubber expand at different rates when exposed to intense heat during a lightning flashover, significant thermal stress is generated at the interface, which can damage the bond between the sheath and the FRP core.
- Breakdown of the interface allows moisture to penetrate along the FRP rod.
- Presence of moisture combined with electrical stress leads to internal partial discharges (PD).
- The long-term effects of PD and the resulting electrochemical degradation, oxidize and decompose the epoxy resin matrix of the FRP rod, weakening it structurally, which results in the brittle fracture of the core rod.

Preventive Measures may be considered to minimize Failure incident

Annexure-IV (Page 48 of 164)
Annexure-II

- Highest possible “Fibre to Resin ratio” for FRP rods.
- Increase Housing/Sheath thickness.
- Adopt measures to divert Arc Path away from shed/housing.
- Redesign of End-Fittings for mould anchoring mechanism.
- Compression of End-Fitting half way before moulding & remaining after moulding to minimize possibility of FRP slippage movement.
- Improve Quality Control Mechanism
- Awareness to handle Composite Insulators

- ✓ In a service environment, characterized by elevated humidity and temperature as well as the presence of various species of Mould/Rot, surfaces of composite insulators can become colonized.
- ✓ Mould growth occurred during long-term storage of composite insulators in wood crates exposed to rain and warm temperatures.
- ✓ **In the case of composite insulators, hydrophobic surfaces valued performance-enhancing characteristic can temporarily be diminished or even lost permanently i.e. performs as hydrophilic due to colonization of Mould/Rot.**

Preventive Measures taken in MPPTCL

Preventive Measures taken in MPPTCL

- Weekly online training & discussions regarding handling & store handling, transportation, construction & maintenance of transmission lines with Silicone Rubber Composite Insulators.
- Apart from Acceptance Tests, third party inspection on the samples selected randomly from the supplied Insulators.
- Constituted a Committee of Senior Level Officers to analyse root cause of Polymer Insulator failure and preventive measures to minimise incident of failure.
- Improvement in GTP based on recommendation of the Committee (under consideration)

Recommendation of the Committee (Under Consideration)

- Increase sheath/housing & shed thickness from 3 mm to 5 mm with thickness of 6 mm at base of longer sheds to provide aerodynamic shape.
- Inclusion of additional Acceptance tests in MPPTCL's specifications.
- Provide a circular shape Arcing Horns on tower side End-Fitting.
- Provide Corona Ring at conductor ends of polymer insulators installed on existing 132kV lines.
- Regular online training & discussions to increase awareness.

Recommendation of the Committee (Under Consideration)

- Specific standards/guidelines regarding compositions of raw material components used for manufacturing of Silicone Rubber and FRP Rods and its quality control.
- To provide specific standards/guidelines regarding manufacturing process of Silicone Rubber & FRP Rods and complete Silicone Composite Insulators.
- To frame & issue of Standard Operating Procedure (SoP) separately for store handling, transportation, construction & maintenance of transmission lines and substations.

THANKS



Second Meeting of the Committee to address the frequent Transmission line outages on account of Insulator failures Dt. 12.02.2026

Agenda Items for Deliberations

- 3) Failure Statistics**
- 4) Cross-Comparison of Various Tests generally Prescribed for Composite Polymer long-rod Insulators**
- 5) Cross-Comparison of Various Tests generally Prescribed for Porcelain long-rod Insulators**
- 6) Findings of MPPTCL Committee on Insulator Failures**
- 7) Requirement of Additional Type Tests & Acceptance Tests**
- 8) Improvements in Technical Specifications for Porcelain Long-rod Insulators**
- 9) Improvements in Technical Specifications for Composite Polymer Long-rod Insulators**
- 10) Format for Reporting various details of Insulator Failure Events**
- 11) Operation & Maintenance Practices/ measures being specifically followed by Utilities to eliminate or reduce Insulator failures**

Agenda Point No. 3



3) Failure Statistics

Voltage Level	Insulator Failure at 500/400/220 kV In Year 2025 (Under jurisdiction of MSETCL)	Major Reason For Breakdown
500 KV	5	Lightning/ Thunder storm, Heavy fault due to rain, Heavy foggy atmosphere, Pollution, Insulator disc flashover, Failure of insulator string, Manufacturing defect, De-capping, Fault due to birds, Ageing effect, Earth fault
400 kV	45	
220 kV	168	
132 kV	14	
100 kV	9	

Agenda Point No. 4



Cross-Comparison of Various Tests generally Prescribed for Composite Polymer long-rod Insulators.

a) Type Test Comparison		
Sr. No	Test Name	MSETCL's Reply
	On Composite Insulator Units	
1	Tests on interfaces and connections of metal fittings	<i>Prescribed in Specification as Design test as per IEC 61109</i>
2	Assembled core load time test	<i>Prescribed in Specification as Design test as per IEC 61109</i>
3	Damage limit proof test and test of tightness of interface between end fittings and insulator housing.	<i>Prescribed in Specification and Ref. Standard – IEC : 61109 Amendment 1 Cl. No. 6.4</i>
4	High Pressure washing test	<i>Mentioned in general requirement, withstand high pressure (3800 KPa) of water, However not Prescribed in Specification</i>
5	Brittle fracture resistance test	<i>Prescribed in Specification as Design test, 96 hrs. test duration</i>
6	Dye penetration test	<i>Prescribed in Specification as Design test , IEC 61109Cl. 5.4.1</i>

Agenda Point No. 4



Cross-Comparison of Various Tests generally Prescribed for Composite Polymer long-rod Insulators.

a) Type Test Comparison		
Sr. No	Test Name	MSETCL's Reply
	On Composite Insulator Units	
7	Water diffusion test	<i>Prescribed in Specification as Design test, IEC 61109Cl. 5.4.2</i>
8	Tracking and erosion test	<i>Prescribed in Specification as Design test, IEC 62217</i>
9	Hardness test	<i>Prescribed in Specification as test during manufacturing, ASTM D2240</i>
10	Accelerated weathering test	<i>Not Prescribed in Specification</i>
11	Flammability test	<i>Prescribed in Specification as Design test, IEC 61109, 62217, ASTM D2863</i>
12	Silicon content test	<i>Prescribed in Specification as test during manufacturing</i>
13	Recovery of Hydrophobicity test & Corona test	<i>Not Prescribed in Specification</i>
14	Torsion test	<i>Not Prescribed in Specification</i>

Agenda Point No.4



Cross-Comparison of Various Tests generally Prescribed for Composite Polymer long-rod Insulators.

a) Type Test Comparison		
Sr. No	Test Name	MSETCL's Reply
15	Ozone Resistance test	<i>Not Prescribed in Specification</i>
16	Water diffusion test followed by pull off test	<i>Prescribed in Specification as Design test, IEC 61109, Cl. 5.4.2</i>
	On the complete composite Long Rod Insulator String with Hardware Fittings	
17	Power frequency/ DC voltage withstand test with corona controlrings/grading ring and arcing horns under wet condition	<i>Prescribed in Specification as Type Test and Ref. Standard –IEC 383</i>
18	Switching surge voltage withstand test under wet condition (applicable for 400kV & above voltage level)	<i>Prescribed in Specification as Type Test and Ref. Standard –IEC 383</i>
19	Impulse voltage withstand test under dry condition	<i>Prescribed in Specification as Type Test and Ref. Standard –IEC 383</i>
20	Corona (AC/ DC) and RIV test under dry condition (applicable for 400kV & above voltage level)	<i>Prescribed in Specification as Type Test and Ref. Standard –IEC : 61109 Amendment 1</i>

Agenda Point No.4



Cross-Comparison of Various Tests generally Prescribed for Composite Polymer long-rod Insulators.

a) Type Test Comparison		
Sr. No	Test Name	MSETCL's Reply
21	Mechanical Strength test	<i>Prescribed in Specification as Type Test and Ref. Standard – IEC : 61109 Amendment 1 Cl. No. 6.4</i>
22	Vibration test	<i>Not Prescribed in Specification</i>
23	AC Salt-fog pollution withstand test/ DC Pollution withstand test	<i>Not Prescribed in Specification</i>

Agenda Point No.4



Cross-Comparison of Various Tests generally Prescribed for Composite Polymer long-rod Insulators.

b) Acceptance Test Comparision		
Sr. No.	Test Name	MSETCL's Reply
1	Verification of dimensions	<i>Prescribed in Specification and Ref. Standard – IEC : 61109 Cl. No. 7.2 as FAT</i>
2	Galvanizing test	<i>Prescribed in Specification and Ref. Standard – IEC : 383 as FAT</i>
3	Verification of end fittings	<i>Prescribed in Specification and Ref. Standard – IEC : 61109 Amendment 1 Cl. No. 7.4 as FAT</i>
4	Recovery of Hydrophobicity	<i>Not Prescribed in Specification as acceptance test</i>
5	Verification of tightness of interface between end fittings and insulator housing and of specified mechanical load	<i>Prescribed in Specification and Ref. Standard – IEC : 61109 Amendment 1 Cl. No. 7.4, not as FAT</i>
6	Tests on interfaces and connections of metal fittings	<i>Not Prescribed in Specification as acceptance test</i>

Agenda Point No. 4



Cross-Comparison of Various Tests generally Prescribed for Composite Polymer long-rod Insulators.

b) Acceptance Test Comparision

Sr. No.	Test Name	MSETCL's Reply
7	Silicon content test	<i>Not Prescribed in Specification as acceptance test</i>
8	Brittle Fracture Resistance Test	<i>Not Prescribed in Specification as acceptance test</i>
9	Dye Penetration Test	<i>Not Prescribed in Specification as acceptance test</i>
10	Water Diffusion Test	<i>Not Prescribed in Specification as acceptance test</i>
11	Hardness test	<i>Not Prescribed in Specification as acceptance test</i>
12	Water diffusion test followed by pull off test	<i>Not Prescribed in Specification as acceptance test</i>

Agenda Point No.4



Cross-Comparison of Various Tests generally Prescribed for Composite Polymer long-rod Insulators.

C) Manufacturing Test Comparison	
Test Name	MSETCL's Reply
Chemical analysis of zinc used for galvanizing	<i>Prescribed in Specification and Ref. Standard – IS: 209</i>
Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.	<i>Prescribed in Specification as manufacturing test</i>
Chemical analysis hardness tests and magnetic particle inspection for forgings	<i>Prescribed in Specification as manufacturing test</i>
Tracking and erosion test on insulating material	<i>Not Prescribed in Specification as Manufacturing Test</i>
SEM (Scanning Electron Microscopic) Analysis with EDS (Energy Dispersive Spectroscopy) on FRP rod cross-section, Surface analysis by optical spectrograph, FTIR Signature analysis.	<i>Not Prescribed in Specification as Manufacturing Test</i>

Agenda Point No.5



Cross-Comparison of Various Tests Generally Prescribed for Porcelain long-rod Insulators

a) Type Tests Comparison:		
Sr. No.	Test Name	MSETCL's Reply
	On Unit Disc Insulators	
1	Verification of dimensions	<i>Prescribed in specification as type test as per IS 731</i>
2	Power frequency voltage withstand and flashover test under (i) dry & (ii) wet condition	<i>Prescribed as type test- IEC 60383</i>
3	Impulse voltage withstand and flashover test (dry)	<i>Prescribed as type test- IEC 60383</i>
4	Visible Discharge test (dry)	<i>Prescribed in specification as type test as per IS 731</i>
5	RIV test (dry)	<i>Prescribed as type test- IEC 60437</i>
6	Impact Test (For Disc Insulators only)	N.A.
7	Thermal mechanical performance test	<i>Prescribed in specification as type test as per IS 575</i>
8	Residual strength Test (For Disc Insulators only)	N.A.
9	Steep wave front Test (For Disc Insulators only)	N.A.

Agenda Point No.5



Cross-Comparison of Various Tests Generally Prescribed for Porcelain long-rod Insulators

a) Type Tests Comparison:		
Sr. No.	Test Name	MSETCL's Reply
	On Complete Insulator String	
10	Power frequency voltage withstand test with corona control rings/grading ring and arcing horns under wet condition	<i>Prescribed as type test- IEC 60383</i>
11	Switching surge voltage withstand test under wet condition (for 400 kV & above voltage level line only)	<i>Prescribed as type test- IEC 60383</i>
12	Impulse voltage withstand test under dry condition	<i>Prescribed as type test- IEC 60383</i>
13	Voltage distribution test (for disc insulators only)	<i>N.A.</i>
14	Corona and RIV test under dry condition (for 400 kV & above voltage level line only)	<i>Prescribed in specification as type test</i>
15	Mechanical Strength test	<i>Prescribed in specification as type test</i>
16	Vibration test	<i>Prescribed in specification as type test</i>
17	Power Arc Test (for 400 kV voltage level line only)	<i>Not prescribed in specification</i>

Agenda Point No.5



Cross-Comparison of Various Tests Generally Prescribed for Porcelain long-rod Insulators

b) <u>Acceptance Tests Comparison</u>		
Sr. No.	Test Name	MSETCL's Reply
1	Visual examination	<i>Prescribed in specification as per IS 731</i>
2	Verification of dimensions	<i>Prescribed in specification as per IS 731</i>
3	Temperature cycle test	<i>Prescribed in specification as per IS 731</i>
4	Galvanising test	<i>Prescribed in specification as per IS 731</i>
5	Mechanical performance test	<i>Prescribed in specification as per IEC 60575</i>
6	Test on locking device for ball and socket coupling	<i>Prescribed in specification as per IS 2486 (IV)</i>
7	Eccentricity test	<i>Prescribed in specification as per IEC 60383/60168</i>
8	Residual Strength Test (For Disc)	<i>N.A.</i>
9	Metallurgical Test (For metal fittings only in blackcondition)	<i>Not prescribed in specification</i>
10	IR Measurement	<i>Not prescribed in specification</i>

Agenda Point No.5



Cross-Comparison of Various Tests Generally Prescribed for Porcelain long-rod Insulators

b) <u>Acceptance Tests Comparison</u>		
Sr. No.	Test Name	MSETCL's Reply
11	Impact Test	<i>Not prescribed in specification</i>
12	Steep Wave front test	<i>N.A.</i>
13	Thermal Mechanical performance test	<i>Not prescribed in specification</i>
14	Electro-mechanical strength test (for porcelain disc insulators)	<i>Prescribed in specification as per IS 731</i>
15	Porosity test (for porcelain disc insulators)	<i>N.A.</i>
16	Puncture test (for porcelain disc insulators)	<i>N.A.</i>

Agenda Point No.5



Cross-Comparison of Various Tests Generally Prescribed for Porcelain long-rod Insulators

c) <u>Manufacturing Test Comparision</u>	
Test Name	MSETCL's Reply
Chemical analysis of zinc used for galvanizing	<i>Prescribed in specification as manufacturing test as per IS 209</i>
Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.	<i>Prescribed in specification as manufacturing test</i>
Chemical analysis hardness ztestsand magnetic particle inspection for forgings	<i>Prescribed in specification as manufacturing test</i>
Hydraulic Internal Pressure tests on disc insulator shells	<i>Not prescribed in specification</i>
Autoclave Test on Cement	<i>Not prescribed in specification</i>

Agenda Point No. 6



Findings of MPPTCL Committee on Insulator Failures : -

- Not applicable to MSETCL.

Agenda Point No. 7



Requirement of Additional Type Tests & Acceptance Tests

MSETCL's Reply

Following Type tests/acceptance tests to be included in Technical Specification

- 1) Ozone resistance test as per IEC 61854, Clause 7.6.4 to be included in Type test
- 2) Recovery of Hydrophobicity test & Corona test as per relevant IEC/IS.
- 3) Tests on FRP rod and silicon rubber compound
- 4) Accelerated ageing test of 5000 Hrs as per relevant IEC/IS

Agenda Point No. 8



Improvements in Technical Specifications for Porcelain Long-rod Insulators

MSETCL's Reply

Following Type tests/acceptance tests needs to be included in specifications :-

- 1) Power Arc Test as per IEC- 61467
- 2) Thermal Mechanical performance test as per IEC-60575

Agenda Point No. 9



Improvements in Technical Specifications for Composite Polymer Long-rod Insulators

Test / Aspects	MSETCL's Reply
Accelerated Ageing Test	To be included in specification
Sheath thickness	To be included in specification
End Fitting moisture ingress	To be included in specification
FRP rod Tg	To be included in specification
Provision of Grading Ring	Included

Agenda Point No. 10



Format for Reporting various details of Insulator Failure Events

Name of Zone	Name of the line	Voltage level of the line	Date of Insulator Failure	Reason for insulator failure	Year of commissioning of Insulator	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite)	Make of the Insulator	Prevailing climatic conditions at the time of failure

Agenda Point No. 11



Operation & Maintenance Practices/ measures being specifically followed by Utilities to eliminate or reduce Insulator failures

MSETCL's Reply

O&M Practices/ measures being specifically followed by MSETCL:-

- 1) Hot-Line Washing
- 2) Cold-Line Washing
- 3) Hotline Maintenance / Puncture Insulator Detection (PID)
- 4) Remote Airborne Inspection & Scanning System (RAISS) using drone
- 5) Thermo scanning
- 6) Tower Footing Resistance Measurement
- 7) Tower leakage Resistance Measurement

THANK YOU

INPUTS AS PER AGENDA POINTS FOR 2ND MEETING DATED 12.02.2026**A. Composite Longrod Insulators.**

a) Type tests: -

- On Composite Insulator Units**

	Tests	Ref
1.	Tests on interfaces and connections of metal fittings	IS 16784
2.	Assembled core load time test	IS 16784
3.	Damage limit proof test and test of tightness of interface between end fittings and insulator housing.	IS 16784
4.	High Pressure washing test	As per procedure given in TS
5.	Brittle fracture resistance test	As per procedure given in TS
6.	Dye penetration test	IS 16784 & IEC 62217:2012
7.	Water diffusion test	IS 16784
8.	Tracking and erosion test	IS 16784
9.	Hardness test	IS 16784
10.	Accelerated weathering test	IS 16784
11.	Flammability test	IS 16784
12.	Silicone content test	As per procedure given in TS
13.	Recovery of Hydrophobicity test & Corona test	As per procedure given in TS
14.	Torsion test	As per procedure given in TS
15.	Ozone Resistance test	IEC 61854; Clause 7.6.3 (on thin rectangular test

INPUTS AS PER AGENDA POINTS FOR 2ND MEETING DATED 12.02.2026

		strip clamped at a static elongation of 20%)
16.	Water diffusion test followed by pull-off test	As per procedure given in TS

- **On the complete composite Long Rod Insulator String with Hardware fittings:**

Sl. No.	Tests	Ref
17.	Power frequency / DC voltage withstand test with corona control rings/grading ring and arcing horns under wet condition	IEC 383: 1993/ IEC 60-1
18.	Switching surge voltage withstand test under wet condition (applicable for 400kV & above voltage level)	IEC 383:1993
19.	Impulse voltage withstand test under dry condition	IEC 383:1993
20.	Corona (AC/ DC) and RIV test under dry condition (applicable for 400kV & above voltage level)	As per procedure given in TS
21.	Mechanical Strength test	As per procedure given in TS
22.	Vibration test	As per procedure given in TS
23.	AC Salt-fog pollution withstand test/ DC Pollution withstand test	As per procedure given in TS

b) Acceptance Tests

1.	Verification of dimensions	IS 16784
2.	Galvanising test	IEC 60383

INPUTS AS PER AGENDA POINTS FOR 2ND MEETING DATED 12.02.2026

3.	Verification of end fittings	IS 16784
4.	Recovery of Hydrophobicity	As per procedure given in TS
5.	Verification of tightness of interface between end fittings and insulator housing and of specified mechanical load	IS 16784
6.	Tests on interfaces and connections of metal fittings	IS 16784
7.	Silicone content test	As per procedure given in TS
8.	Brittle Fracture Resistance Test	As per procedure given in TS
9.	Dye Penetration Test	IS 16784
10.	Water Diffusion Test	IS 16784
11.	Hardness test	IS 16784
12.	Water diffusion test followed by pull-off test	As per procedure given in TS

c) Tests During Manufacture

Chemical analysis of zinc used for galvanizing	As per procedure given in TS
Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.	As per procedure given in TS
Chemical analysis hardness tests and magnetic particle inspection for forgings	As per procedure given in TS
Tracking and erosion test on insulating material	IEC 60587

INPUTS AS PER AGENDA POINTS FOR 2ND MEETING DATED 12.02.2026

SEM (Scanning Electron Microscopic) Analysis with EDS (Energy Dispersive Spectroscopy) on FRP rod cross-section, Surface analysis by optical spectrograph, FTIR Signature analysis	As per procedure given in TS
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B. Porcelain longrod Insulators.**a. Type tests:**

- On unit Disc Insulators**

1.	Verification of dimensions	As per IEC :60383
2.	Power frequency voltage withstand and flashover test under (i) dry & (ii) wet condition	As per IEC : 60383
3.	Impulse voltage withstand and flashover test (dry)	As per IEC : 60383
4.	Visible Discharge test (dry)	As per IS:731, Cl. 10.2
5.	RIV test (dry)	As per IEC:60437
6.	Impact Test (For Disc Insulators only)	As per procedure given in TS
7.	Thermal mechanical performance test	As per procedure given in TS
8.	Residual strength Test (For Disc Insulators only)	As per procedure given in TS
9.	Steep wave front Test (For Disc Insulators only)	As per procedure given in TS

- On the complete Insulator String with Hardware Fittings:**

	Tests	Ref
10.	Power frequency voltage withstand test with corona control rings/grading ring and arcing horns under wet condition	As per IEC:383
11.	Switching surge voltage withstand test under wet condition (for 400 kV & above voltage level line only)	As per IEC:383
12.	Impulse voltage withstand test under dry condition	As per IEC:383
13.	Voltage distribution test (for disc insulators only)	As per procedure given in TS

INPUTS AS PER AGENDA POINTS FOR 2ND MEETING DATED 12.02.2026

14.	Corona and RIV test under dry condition (for 400 kV & above voltage level line only)	As per procedure given in TS
15.	Mechanical Strength test	As per procedure given in TS
16.	Vibration test	As per procedure given in TS
17.	Power Arc Test (for 400 kV voltage level line only)	As per procedure given in TS

b. Acceptance tests:

1.	Visual examination	:As per IEC : 60383
2.	Verification of dimensions	:As per IEC : 60383
3.	Temperature cycle test	:As per IEC : 60383
4.	Galvanising test	:As per IEC : 60383
5.	Mechanical performance test	As per IEC:60575Cl 4.0
6.	Test on locking device for ball and socket coupling	As per IEC:60372
7.	Eccentricity test	As per IEC:60383
8.	Residual Strength Test	As per IEC:797 Clause 4.4 & 4.5
9.	Metallurgical Test (For metal fittings only in black condition)	As per procedure given in TS
10.	IR Measurement	As per procedure given in TS
11.	Impact Test	As per procedure given in TS
12.	Steep Wave front test	As per procedure given in TS
13.	Thermal Mechanical performance test	As per procedure given in TS
14.	Electro-mechanical strength test	As per procedure given in TS
15.	Porosity test	As per IEC : 60383
16.	Puncture test	As per IEC : 60383

INPUTS AS PER AGENDA POINTS FOR 2ND MEETING DATED 12.02.2026**c. Tests During Manufacture:**

Chemical analysis of zinc used for galvanising	As per procedure given in TS
Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.	As per procedure given in TS
Chemical analysis hardness tests and magnetic particle inspection for forgings	As per procedure given in TS
Hydraulic Internal Pressure tests on disc insulator shells	As per procedure given in TS
Autoclave Test on Cement	As per procedure given in TS

C. Requirement of Additional Type Tests & Acceptance Tests:

- a. Ozone resistance test as per IEC 61854, Clause 7.6.4 to be included in type test.
- b. Recovery of Hydrophobicity test & Corona test as per relevant IEC/IS.
- c. Tests on FRP rod and silicon rubber compound.
- d. Accelerated ageing test of 5000 hrs. as per relevant IS/ IEC]

Note: All these tests are already covered in our latest technical specifications.

D. Improvements in Technical Specifications for Composite Polymer Long-rod Insulators:

Test/Aspects	Remarks
Accelerated Ageing Test	Already covered in latest TS
Sheath thickness	Increased in latest TS from 3mm to 5mm.
End Fitting moisture ingress	Already covered in latest TS. Over moulding design is being used.
FRP rod Tg	Tg of 140 deg c is specified in latest TS.
Provision of Grading Ring	Design of grading rings are being carried out in line with the IEEE2 015 transaction, where in EFM limits have been made more stringent.

12th February, 2026
Second Meeting

CEA,
Manthan Conference Hall, 2nd floor, Sewa Bhawan,
R.K. Puram, New Delhi, 110066



Committee to Address the Frequent Transmission Line Outages on Account of Insulator Failures (TC-Insulators)

Under the Chairmanship of Member (Power Systems), CEA



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About the Presenter

NEELESH ARORA

- **Global Standardization Efforts**
 - Principal Member, BIS expert panel on “HTM Insulators”
 - Committee Member and Co-author, CIGRÉ TB 837, CIGRÉ TB 838
 - Indian Nominee to IEC TC 36 Committee “Insulators”
 - Contributor: IEEE 1523: 2018
- **Author**
 - Several publications pertaining to HTM Insulators and Polysiloxanes (Silicone Rubber Materials), including for CIGRE, IEEE, INMR, IGCC, and ICHVET
 - +++
- **Speaker**
 - Several tutorials and talks on HTM Insulators globally
- **Director and CEO, Epsilon Asia**

Epsilon Insulator Advisory Group



- Focus on Insulator Performance in Transmission Grids
- Raised concerns pertaining to expected insulator failures, in 2015
- Knowledge Partner: I²G Sweden; Prof. (Dr.) EA Cherney
- Advising 10+ TSOs in the EU and globally on Insulator Strategies, Diagnostics & Risk Evaluation
- Involved in nearly all IEC and CIGRE Insulator activities

I²G INDEPENDENT
INSULATION
GROUP



“Insulator Deployment Optimization, Risk Evaluation and Failure Diagnostics” Projects in the EU

1. APG (Austria)
2. Energinet (Denmark)
3. E.ON (Germany)
4. Fingrid (Finland)
5. Red Eléctrica (Spain)
6. RTE (France)
7. Statnett (Norway)
8. Svk (Sweden)
9. TenneT (Germany)
10. Amprion (Germany)
11. 50Hertz (together with Elia, both Elia Group)



Before we begin...

- My sincere thanks to CEA, Member (Power Systems), Utilities and OEMs
- “Electricity is the new Oil”. The topic for this committee is financially trivial on the scale of transmission corridor projects, yet has a direct and significant impact to reaching a 5T \$ economy
- Due to trivial insulator costs, issues not expensive to remedy, but extremely expensive if ignored
- Data presented by TRANSCOS offer inland, coastal and a CTU’s perspectives – a welcome start
- Insulator policies worldwide issue. Adequate global experience/data available



Asset Management Principles & Outcomes (ISO 55000: 2024)

Principles	Value	Asset management focuses on the value assets provide to the organization over time.
	Alignment	Asset management aligns financial, technical and operational decisions with the organizational objectives, promoting vertical and horizontal coordination.
	Leadership	Leadership establishes clear direction, roles, responsibilities, and authorities, and promotes a collaborative culture that is aligned to organizational success.
Outcomes	Assurance	Asset management provides organizational oversight and accountability to assure that the assets can fulfill their required purposes over the required timeframes.
	Adaptability	Asset management enables organizations to adapt more rapidly and effectively to changes in internal and external context.
	Sustainability	Asset management promotes long-term thinking, considering future impacts, risks, uncertainties, and opportunities to realize value. It considers environmental, social, and economic sustainability, spanning the entire asset life cycle and beyond.

How the committee defines “LONG TERM” and “RISK IMPACT” shapes the outcome

Sample Risk Assessment Chart



Level		Description
Almost Certain	5	Likelihood of occurrence is expected - it is a continual or repeating experience.
Frequent	4	Likelihood of occurrence is very likely - it is a common occurrence.
Probable	3	Likelihood of occurrence is possible - it is known to occur.
Infrequent	2	Likelihood of occurrence is not likely - it is not likely to occur under normal circumstances.
Rare	1	Likelihood of occurrence is remote - it is not expected to occur but still possible.

Score	Impact	Description
5	Severe	Loss of Life (falling conductors, death of O&M crews, etc.) Severe Reputational Damage Political commentary/parliamentary debate Loss of Operating license Downtime exceeding ____ hrs. Loss in INR ____ (define value)
4	Critical	Severe Injury to public or O&M crews National press coverage Loss of Reputation Downtime exceeding ____ hrs. Loss in INR ____ (define value)
3	Significant	Hospitalization Fines/penalties Downtime exceeding ____ hrs. Loss in INR ____ (define value)
2	Moderate	Mild injury Sustained social media issue Downtime exceeding ____ hrs. Loss in INR ____ (define value)
1	Minor	Minor social media comments Downtime exceeding ____ hrs. Loss in INR ____ (define value)

RECAP: INSULATOR DUTIES



Mechanical Duty



Electrical Duty



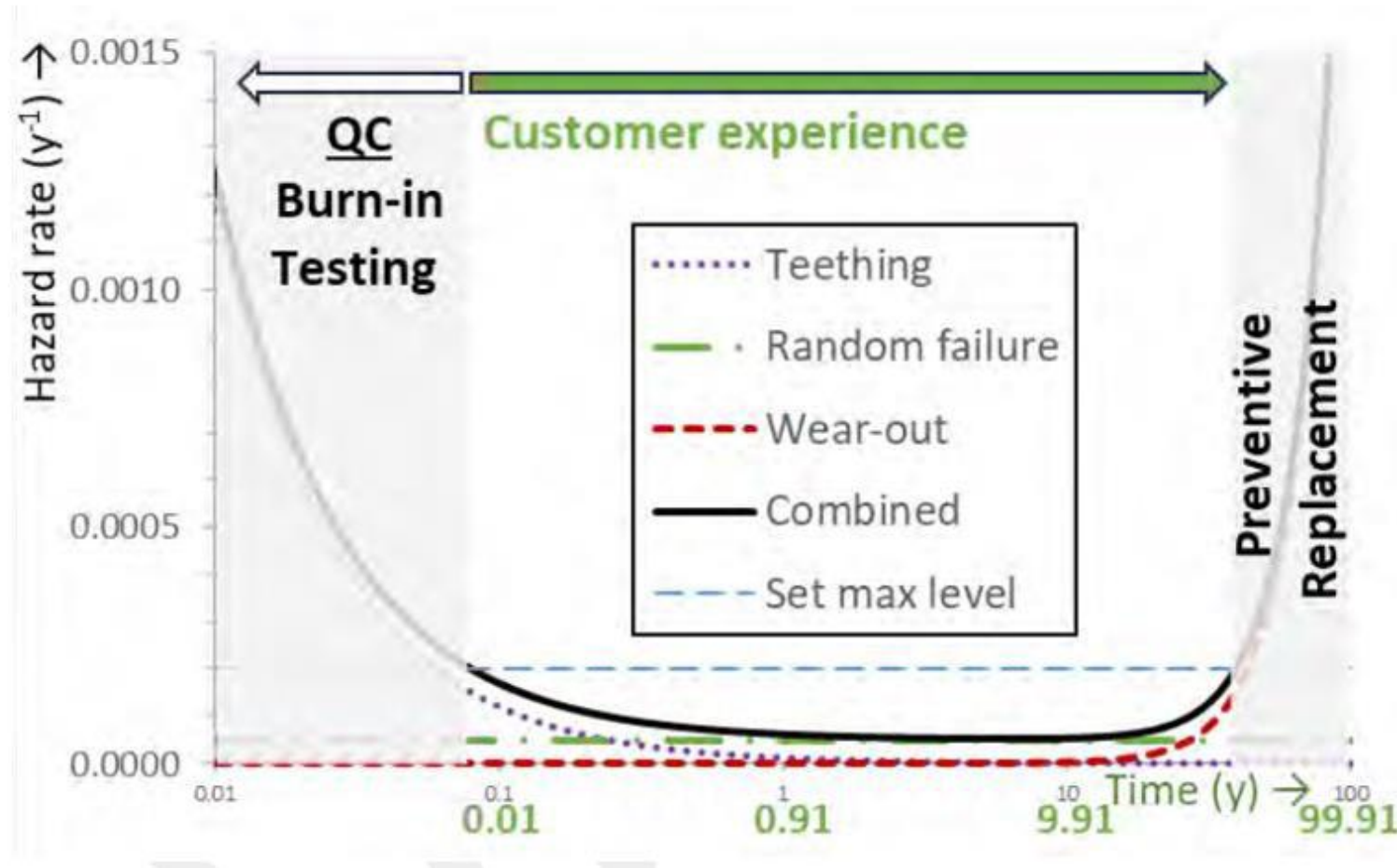
Even if an insulator fails electrically, mechanical failure must be avoided

HTM Insulators:

- **IEC and CIGRE: Two categories of Insulators**
 1. “Hydrophobic Transfer Material” [HTM] Insulators
 2. Non-HTM Insulators [ceramic]
- **HTM-Insulators**
 - Backbone of several grids, globally
 - Chosen for their significantly better pollution performance due to hydrophobic surface
 - Silicone is the prevalent material of choice to lend HTM-properties to insulator surfaces
 - Types: Composite Rubber (SRI/CLR), hybrid and, RTV-Silicone coated-ceramic
- **Silicone Aging Concerns**
 - Severe, When Specific Deposit Density (SDD) $> 1 \text{ mg/cm}^2$ [CIGRE TB 837]
 - In High-UV Index operating environments
 - In coastal and industrial zones



Insulator Lifecycle



Preliminary Observations

- Private TRANSCOS not restricted by L1 compulsions also struggling with crippling Insulator failures; unable to identify and resolve in 14 days
- **Failure management as critical as failure prevention:** Existing asset deterioration could outpace practical ability to replace assets
- Sibling aging (same DNA & operating environment): Cluster-Insulator failures could overwhelm O&M crews and cripple the system
- Increasing environmental stresses, climate change, constraints on shutdowns, and ROW-issues make O&M burden recurring. Globally, these criteria shape insulator policy



Preliminary Observations

- As per data presented, Insulators failing in Early-life & mid-life, between 5% to 33% of desired life.
- Specification tweaking usually provides incremental life enhancement.
- Rationalize expectations
- Failure database should be with drop-down options for better analysis (consistent nomenclature)
- Harsh operating conditions may require alternate solutions and a **deep policy review examining global experiences, comparing different kinds of insulators (material, geometry and type)**



Define Desired and Accepted Parameters

	Unit	Target	Acceptable
Useful Life	Years		
Failure Rate	10^{-n}		
Number of Failure Events across the grid	Nos./yr		
Fault Identification and Resolution Time	Days		
Maintenance Intervention Frequency	Per string, per Year		
Maintenance cost per string, per year	INR		
Mechanical Failure Risk (% of failures)	%		
Acceptable planned outage	Days/yr		
Acceptable unplanned outage	Days/yr		
Other, to be defined by the committee			



INDIAN CONDITIONS ARE NOT GENERIC

Many global assumptions break down here



Some of Wettest Places in the World

Mawsynram and Cherrapunji, Meghalaya
~ 11,800 mm/rainfall/
year



Some of the Driest Places in the World

Jaisalmer, 210 mm
rainfall/year
Thar Desert, and the
Rann of Kutch



Highest Mountains in the World

7 distinct ranges in India,
including the Himalayas



7,516 km of Coastline

Mostly Inhabited

Global UV Index Map

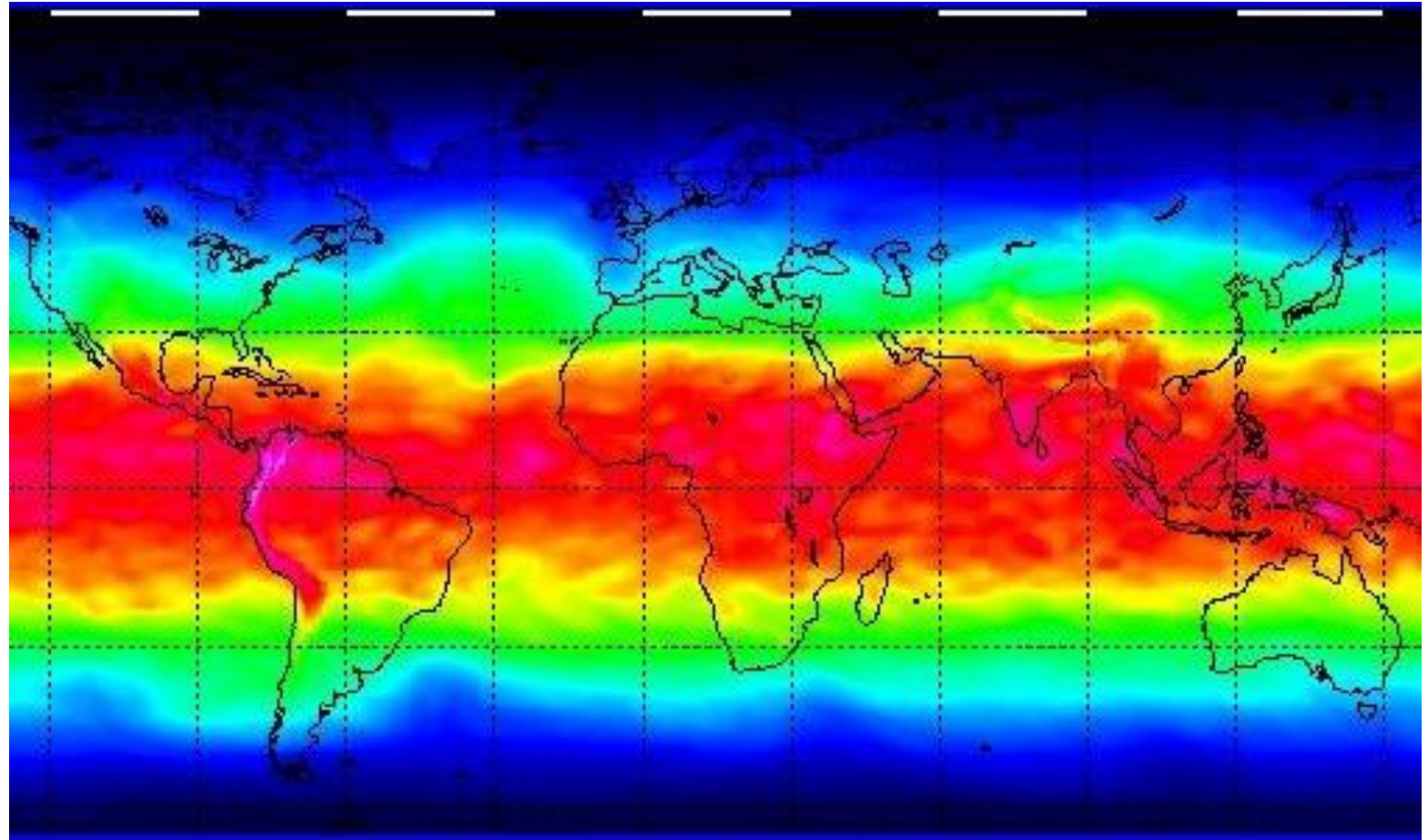
India

Latitude $\sim 8^\circ$ to 23° N

UVI: Very High to Severe (8-12)

Coastal India: Minimal seasonal change

UV effect is unrelenting irrespective of seasonal changes

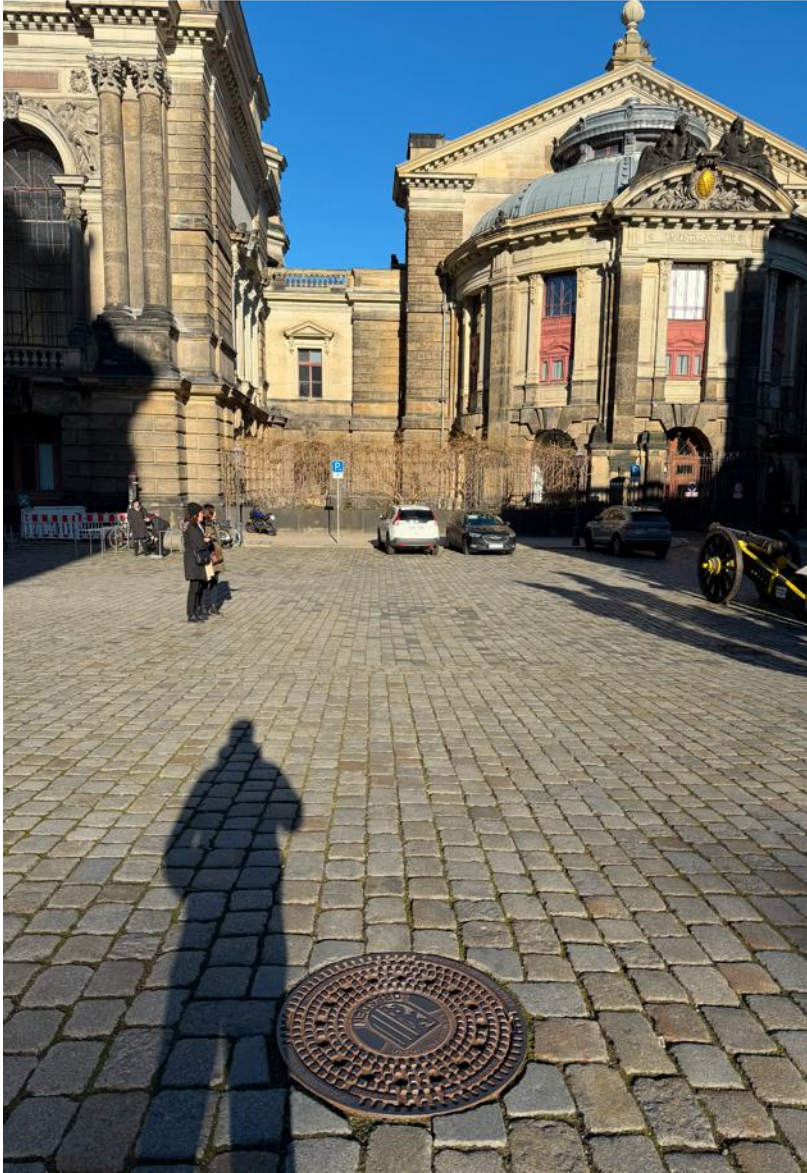


Sunday 12:11

UV Index in North Europe

In theory, bond strength of silicone rubber is stronger than Sunlight energy $398 \text{ kJ/mol} < \text{Silicone Si-O Bond: } 444 \text{ kJ/mol}$

Practically, conditions are very different!



Dresden, Germany

Latitude: $\sim 48^\circ$ to 55° N

UV Index (7) Moderate in summer (1-5) very low in winter

Observe the length of the shadow at 12:11 PM (Jan 2025)

CLIMATE CHANGE, POLLUTION AND INDIA

Ranked 7th in “most affected country by the devastating impact of climate change”

65 of the top 100 of world's most polluted cities are in India

Several climate records broken yearly, many on a 'since records began' basis

70 Indian cities with 1,000,000 population by 2050

UV & HTM SILICONES

Silicones exhibit low surface energy → High Hydrophobicity

LMW Siloxane chains → surface migration → sustained Hydrophobicity

Si-O bonds > UV strength, but fillers needed in the formulation

Now, UV matters. Silicone polymers degrade under UV conditions

Silicone polymers often include TiO_2 for several advantages (TiO_2 is used in sunblock!)

Different formulations respond to UV differently – hence 1000h tests

High UV → high silicone polymer damage potential



ACID RAIN & HTM SILICONES

1. ATH dissolves in acid rain ($\text{H}_2\text{O} + \text{SO}_x/\text{NO}_x$)
2. Dry band arcing increases discharge heat
3. Irreversible ATH breakdown
4. Hydrophobic groups of hydrocarbon branch (methyl) in SR degrade
5. Aged HTM surface roughens
6. Hydrophobicity degradation
7. Surface discharge current increases
8. Insulator life decreases



WHAT HAPPENS AT SILICONE “END OF LIFE”?



All HTM silicone compounds have a finite end-of-life dependent that are proportionate to electromechanical stresses, UV & pollution levels.

1. End of Hydrophobicity
2. Silicone failure
3. Possible insulator destruction
4. Possible Failure of mechanical duty

TCO: INSULATOR REPLACEMENT FREQUENCY AS PER PRESENTED DATA

Costs and number of instances of replacing aging HTM Insulators to be considered

“End-of-life” insulators must be replaced BEFORE estimated end-of-life

Time and costs across India, and ROW?

Cost of line outages?

Tension Strings Replacement: How many can be replaced in a day?

Recorded Insulator Life	No. of replacements through TL lifecycle
5 years	6 times
8 years	4 times
10 years	3 times
15 years	2 times
20 years	1 time

Transmission Line Assumed Life: 35 yrs



Insulator Failure Analysis

N.V. Ramkumar

Head of Operations – Modern Composites

Sr. Vice President (T&D, QA) – Modern Insulators

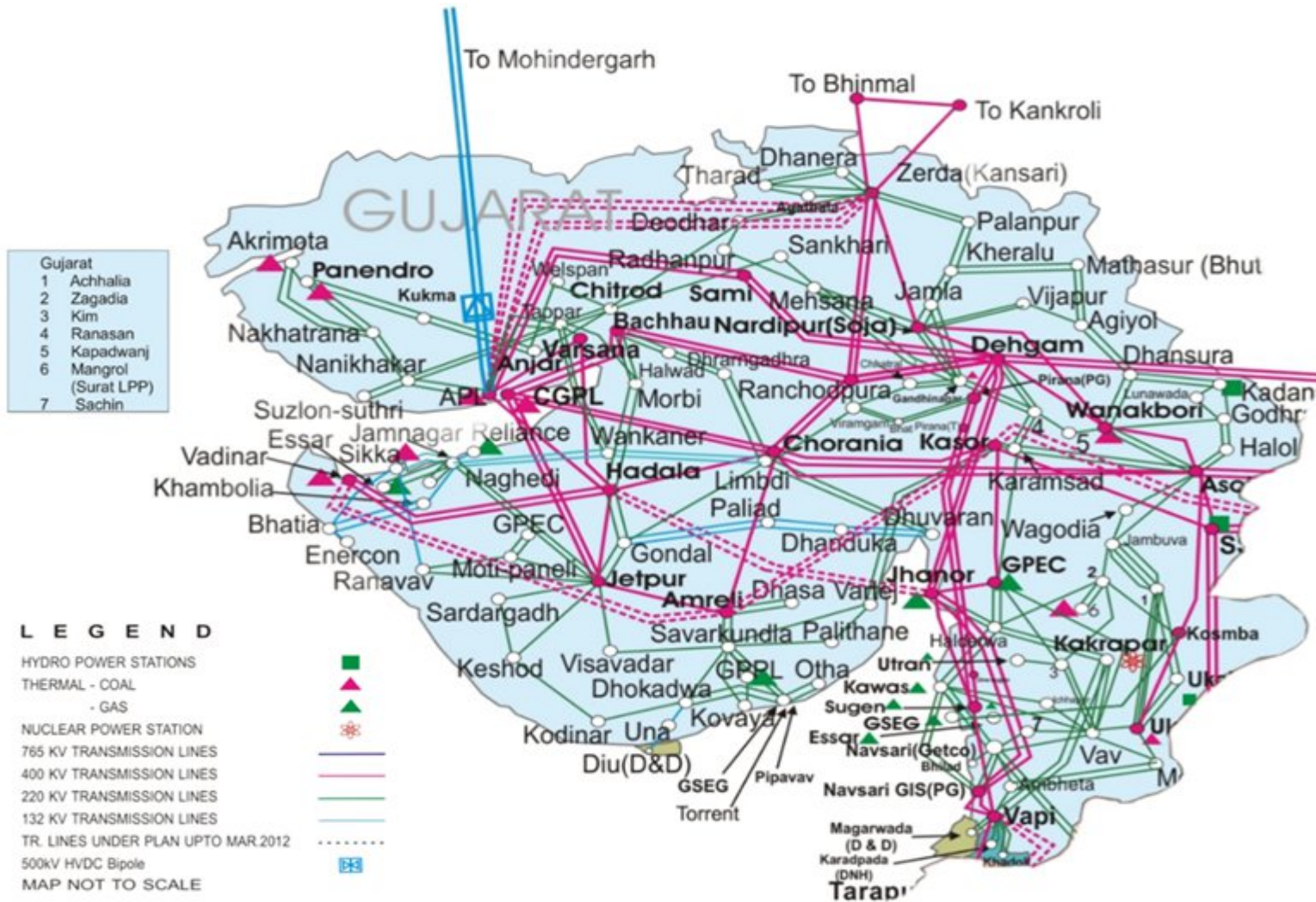
nvramkumar@moderninsulators.com

Dr Sudalai Shunmugam S

Joint Vice President (T&D)

Modern Insulators Limited

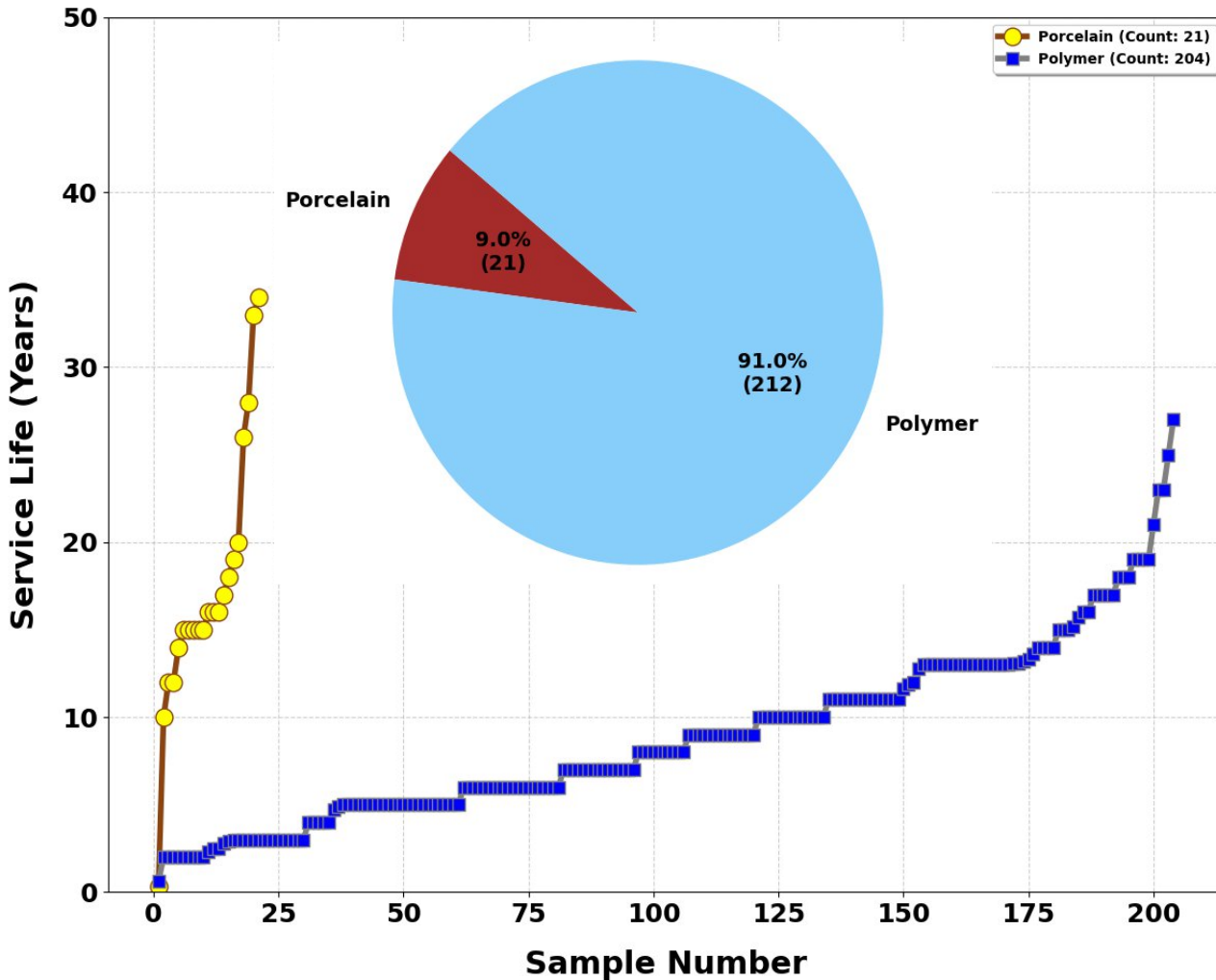
sudalaishunmugams@moderninsulators.com



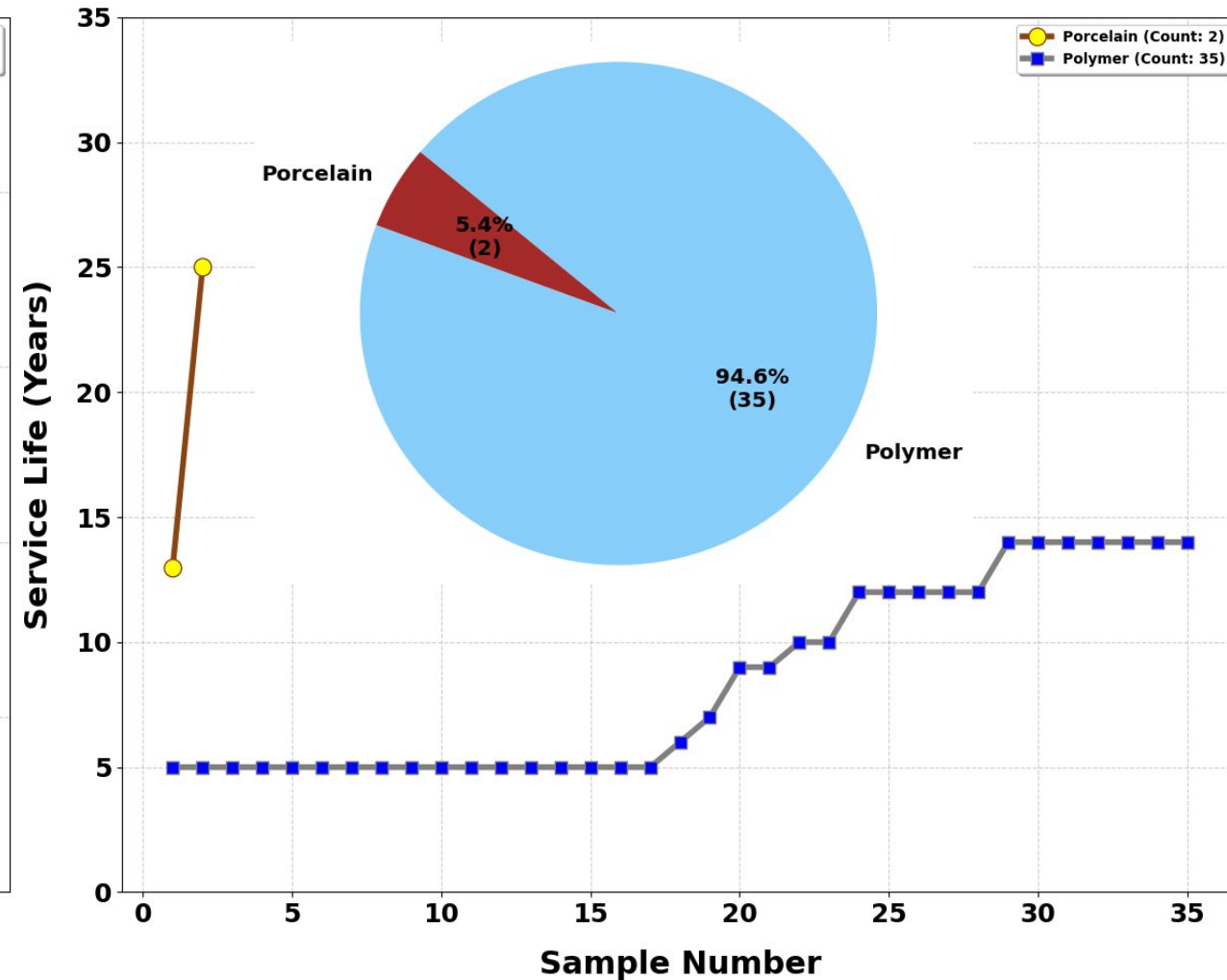
GETCO Insulator Failures during 2025

GETCO Asset - Service Life of Insulator Strings

Service Life Distribution: 220 kV

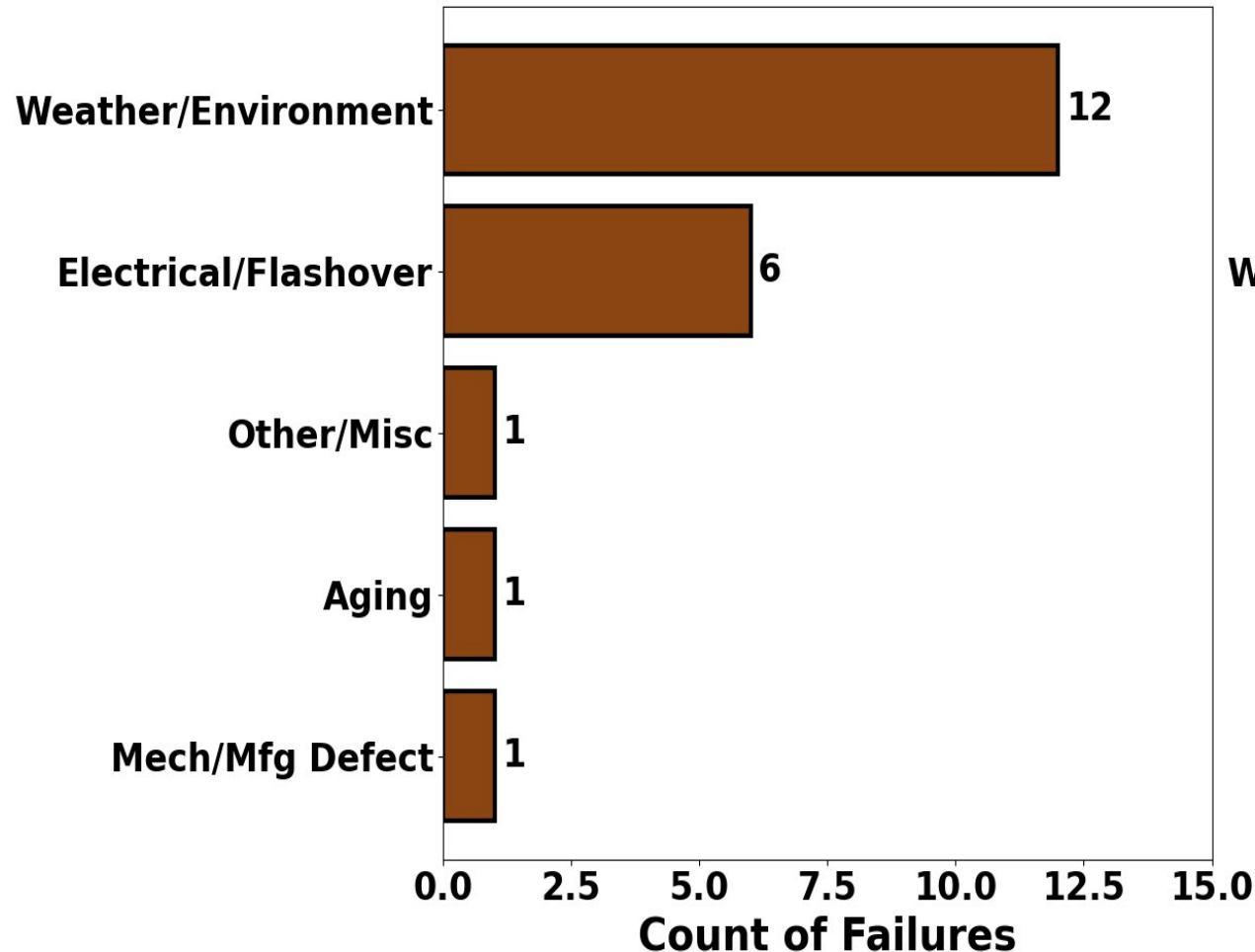


Service Life Distribution: 400 kV

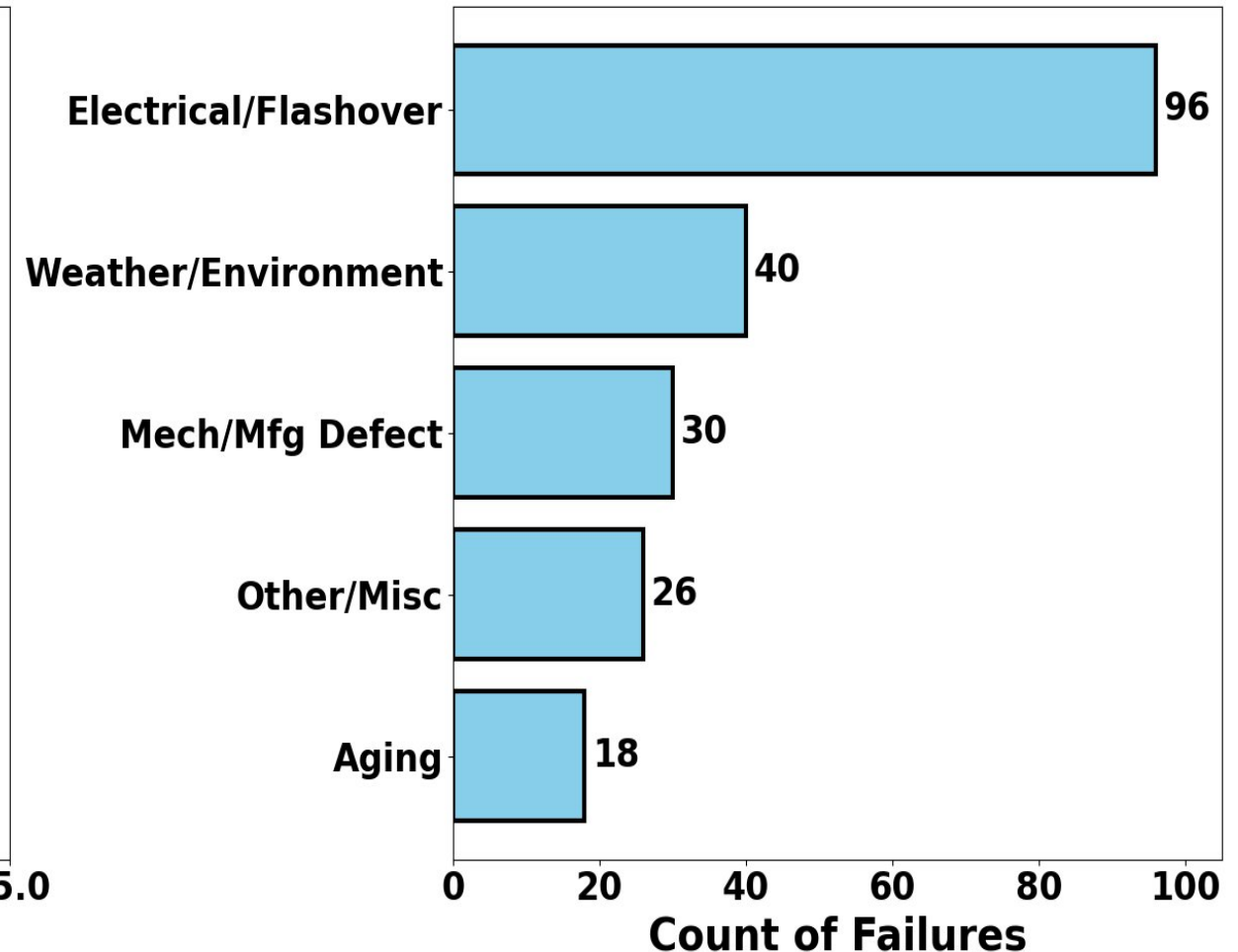


GETCO Insulator Failures Analysis during 2025 – 220 kV System Voltage

Porcelain Failures

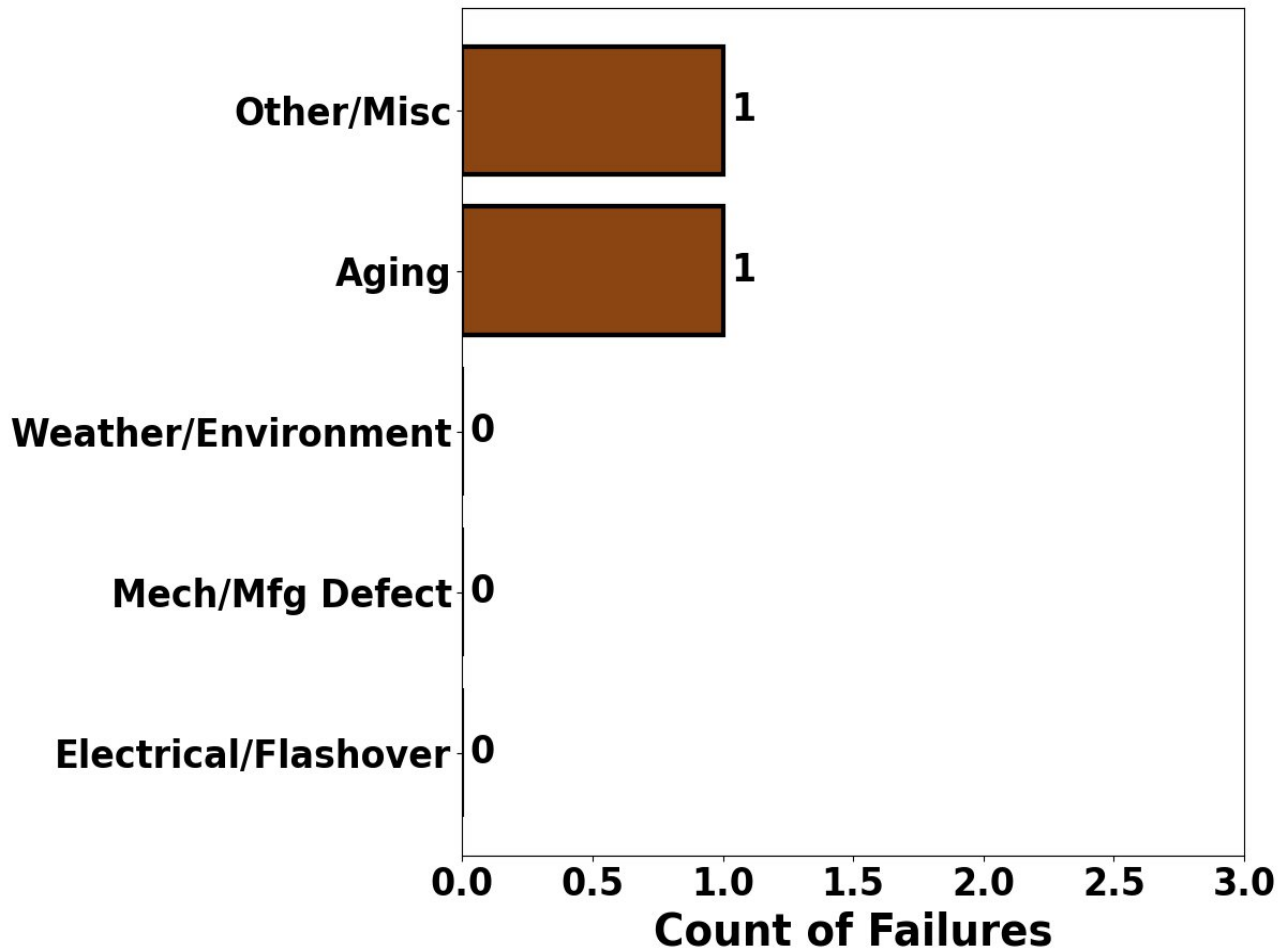


Polymer Failures

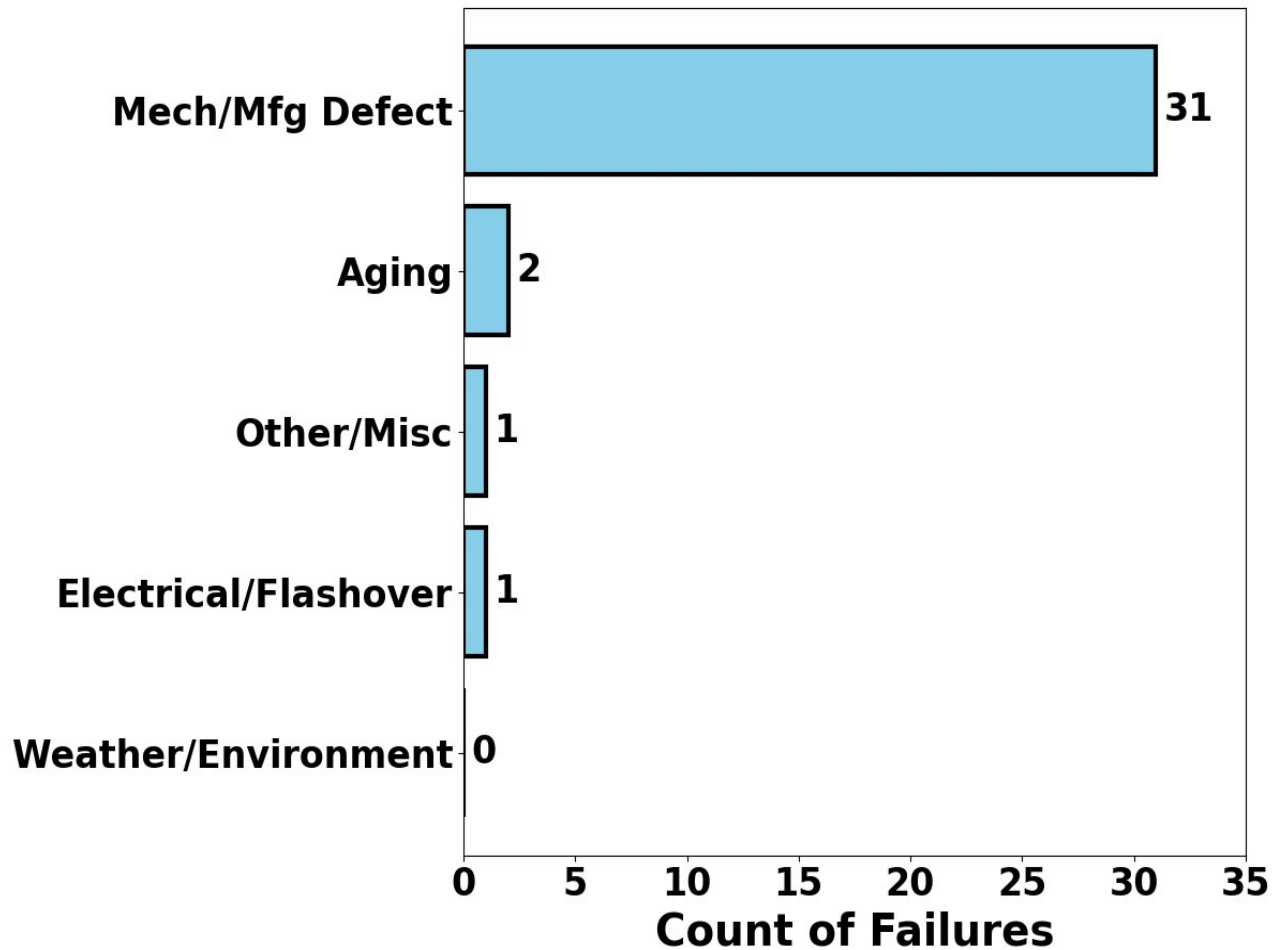


GETCO Insulator Failures Analysis during 2025 – 400 kV System Voltage

Porcelain Failures



Polymer Failures

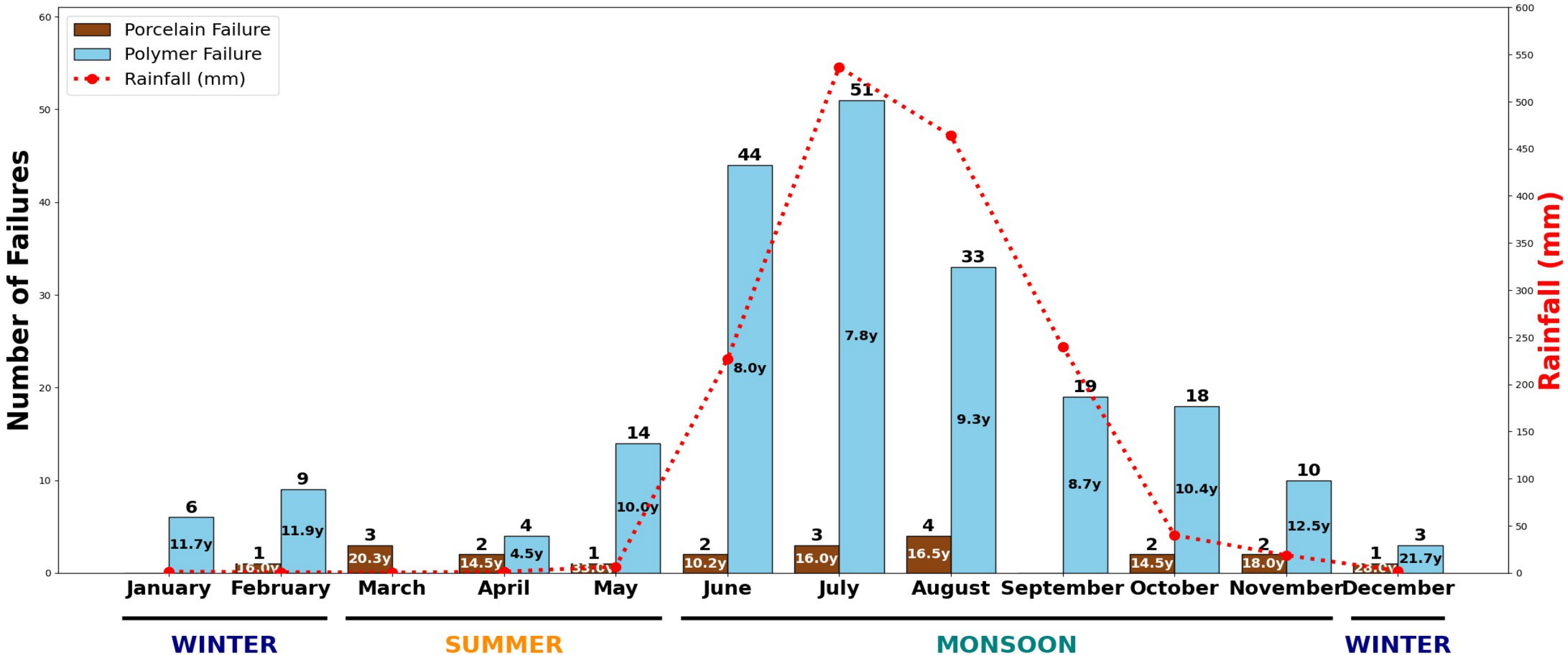




Insulator Failure Analysis

Annexure-IV (Page 110 of 164)

GETCO Asset Failures 2025 – Month wise Distribution of 220 kV System Voltage

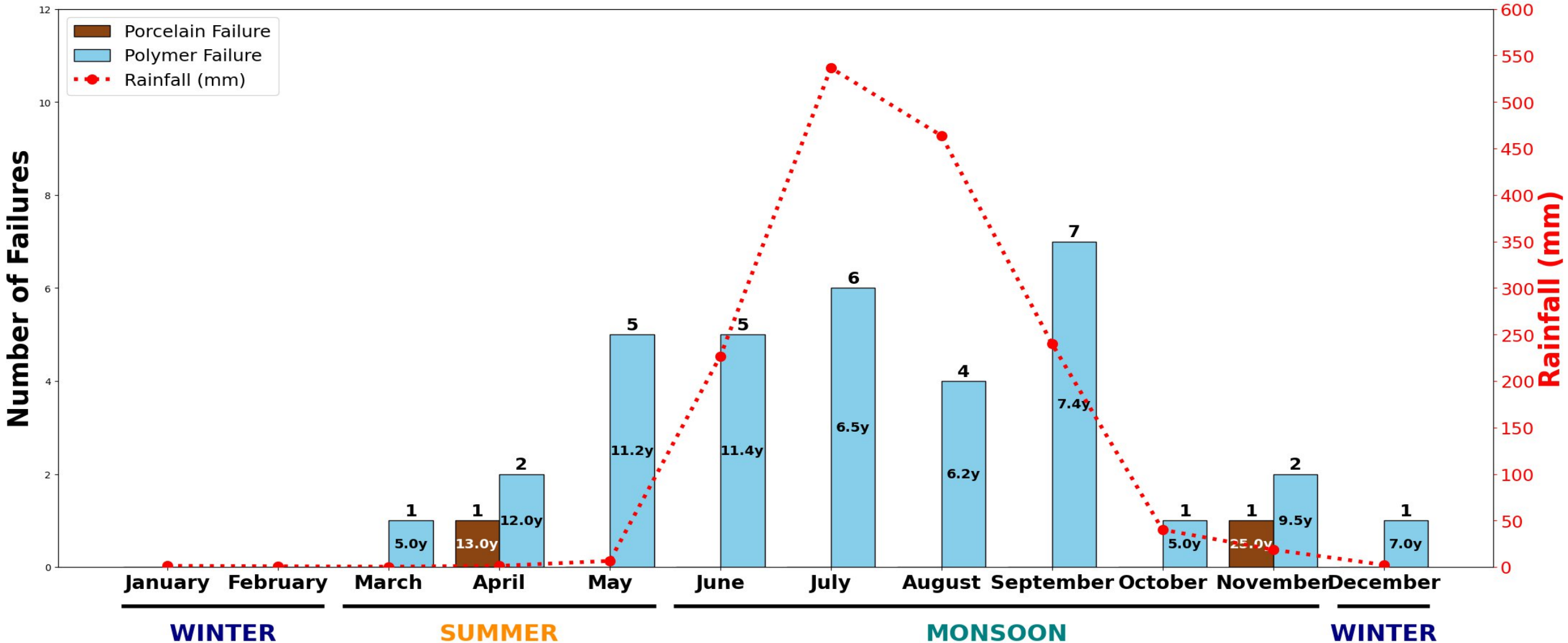




Insulator Failure Analysis

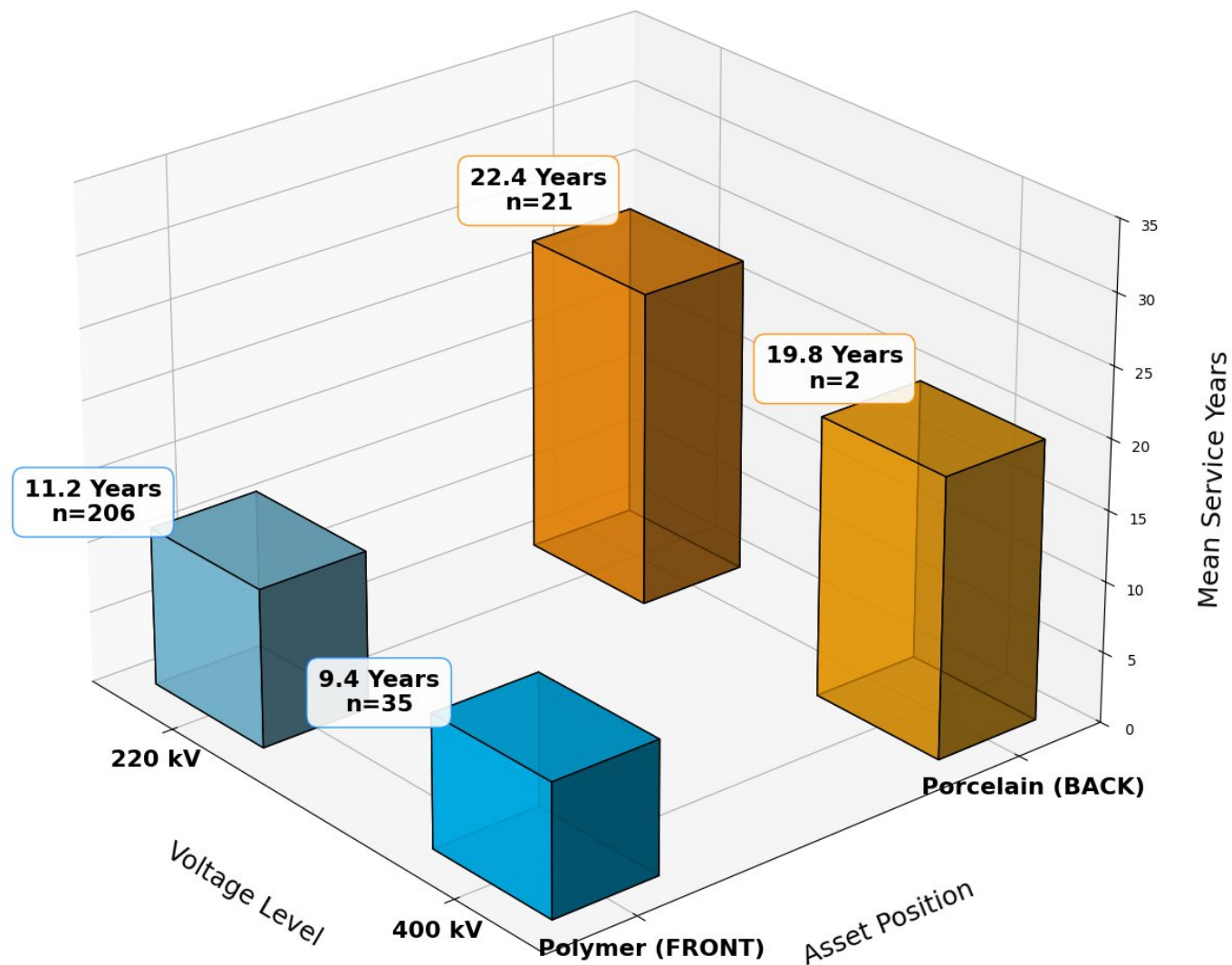
Annexure-IV (Page 111 of 164)

GETCO Asset Failures 2025 – Month wise Distribution of 400 kV System Voltage



Insulator Failure Analysis

GETCO Asset Failure Landscape (3D)



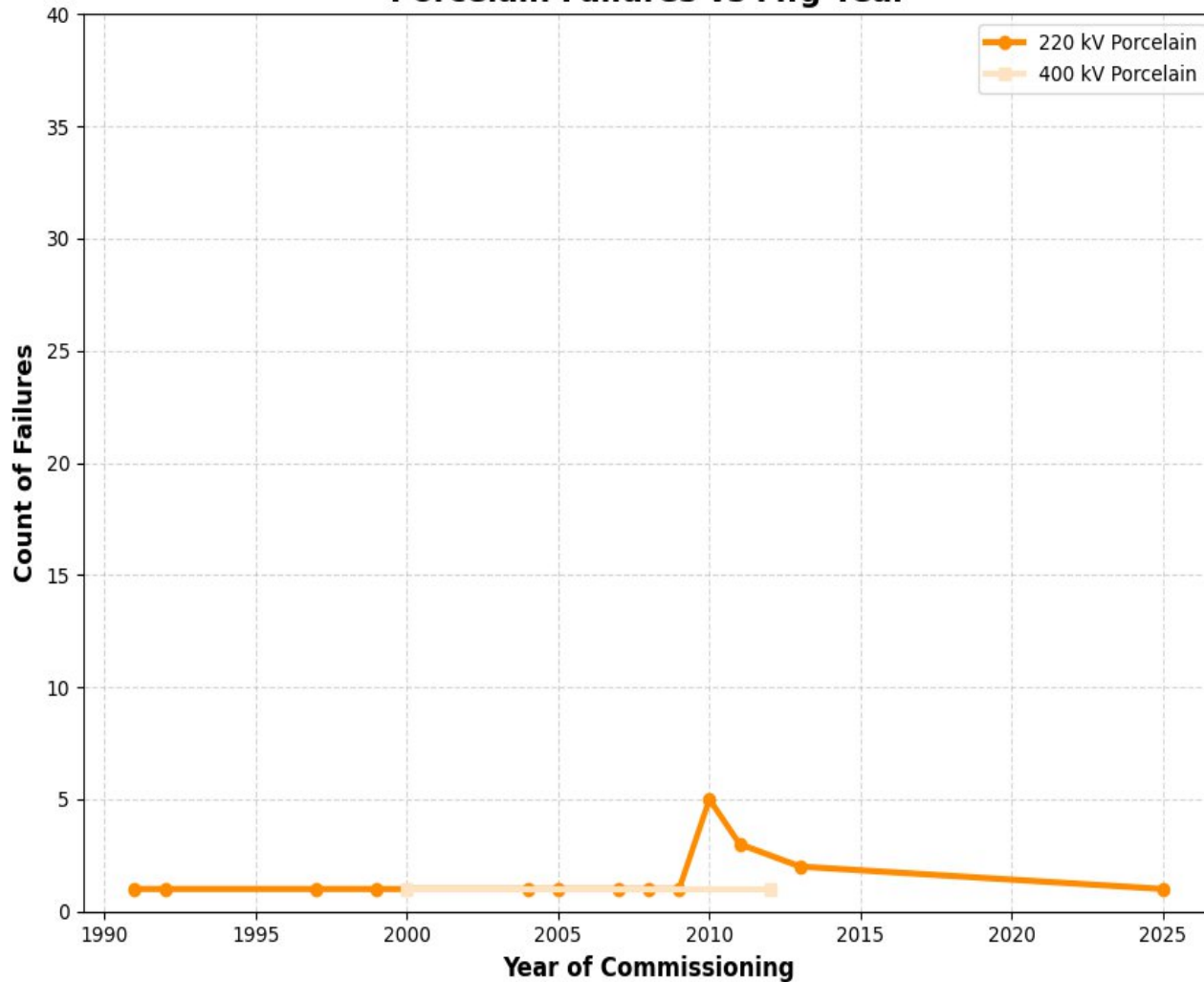


Insulator Failure Analysis

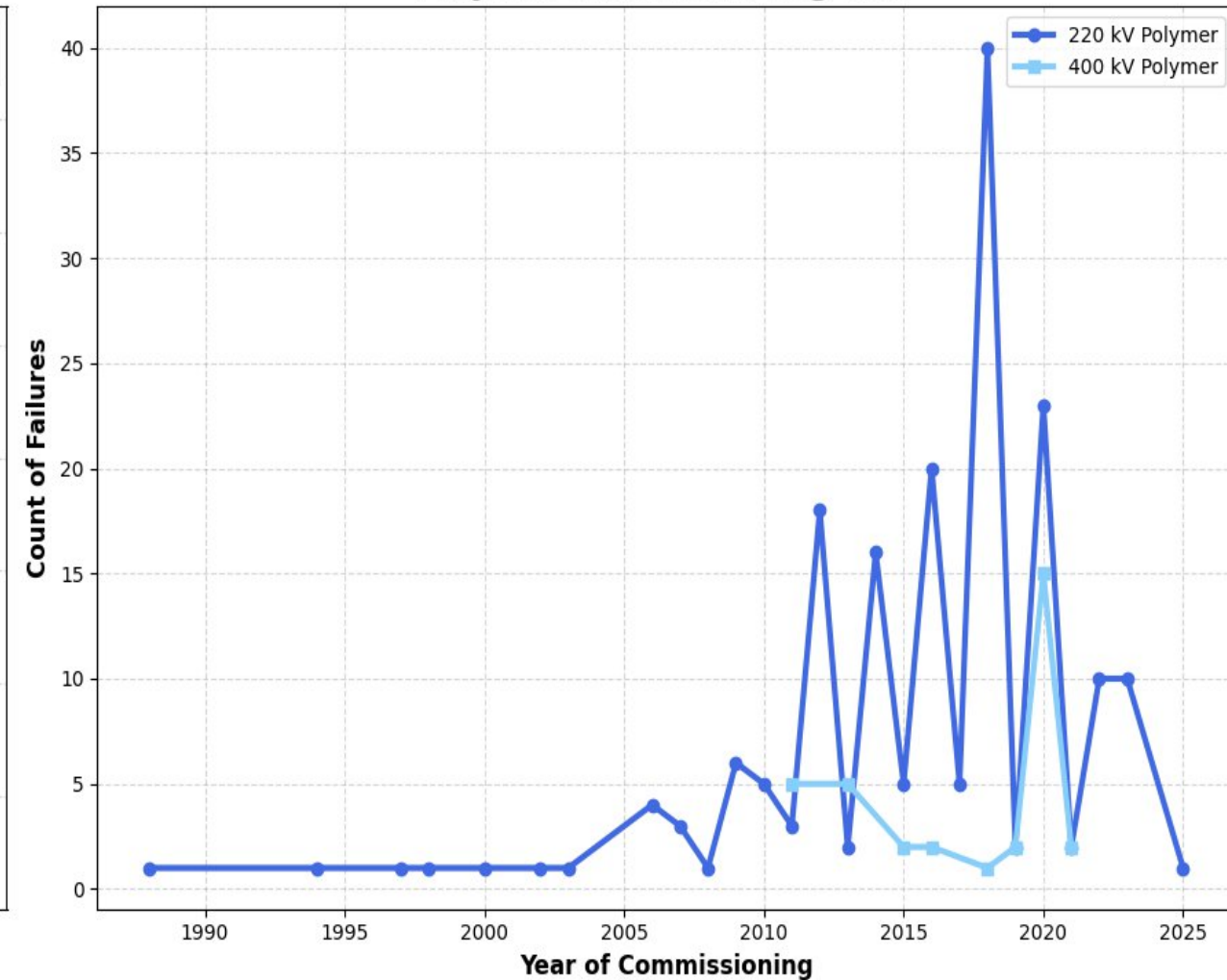
Annexure-IV (Page 113 of 164)

GETCO Asset – Mfg. Year vs Number of Failures

Porcelain Failures vs Mfg Year



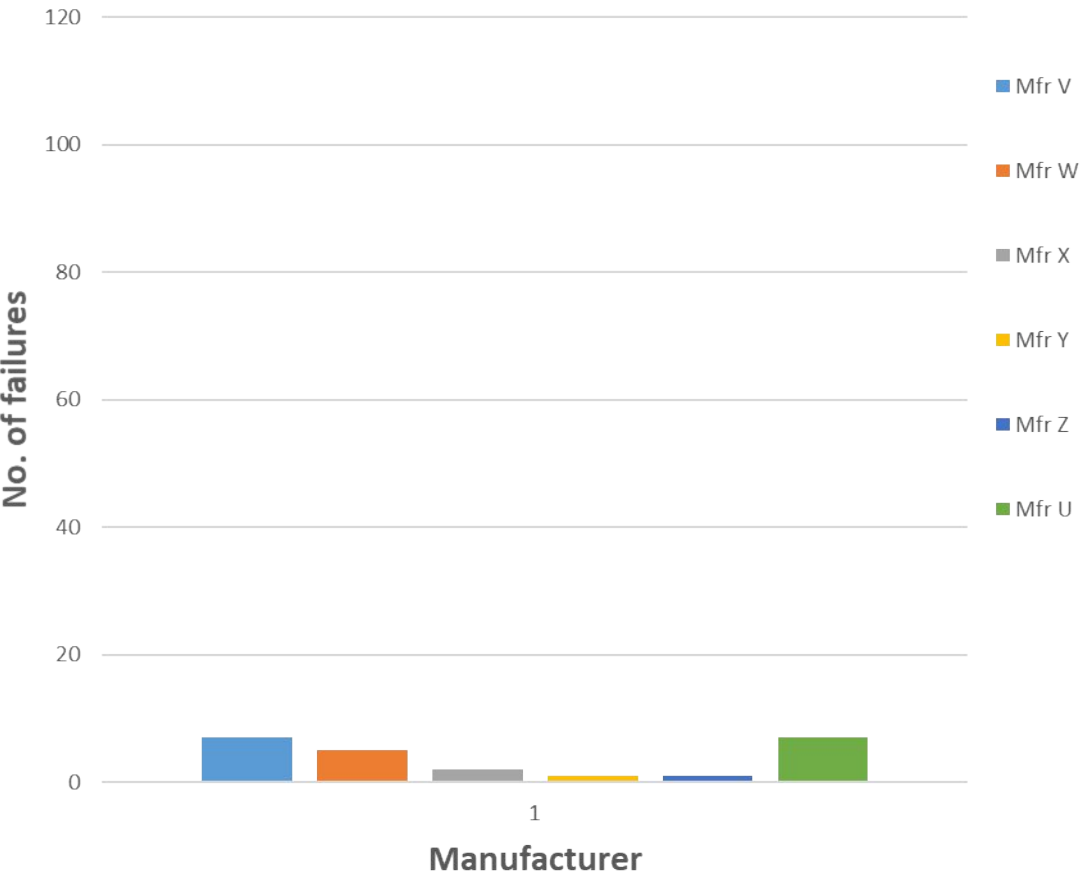
Polymer Failures vs Mfg Year



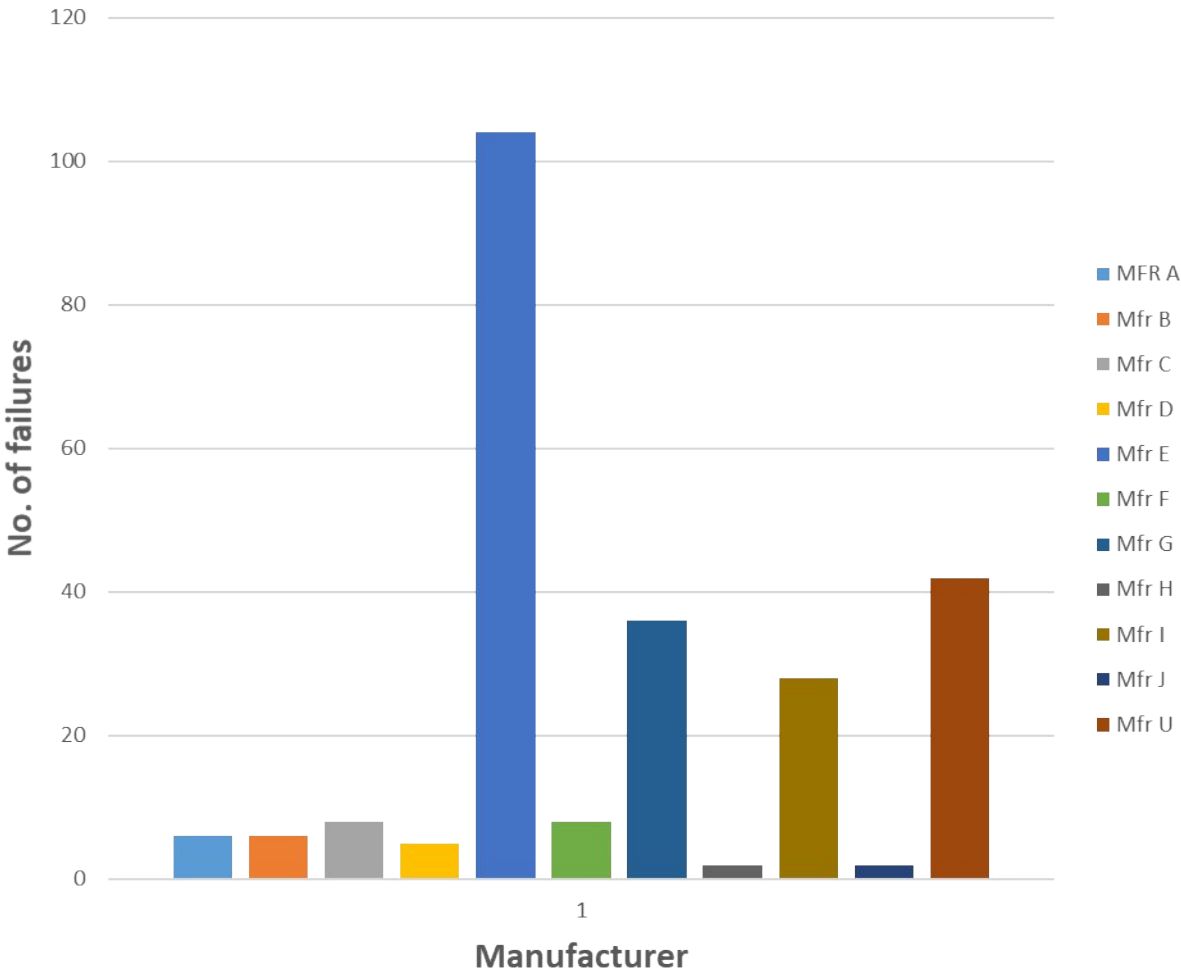
Insulator Failure Analysis

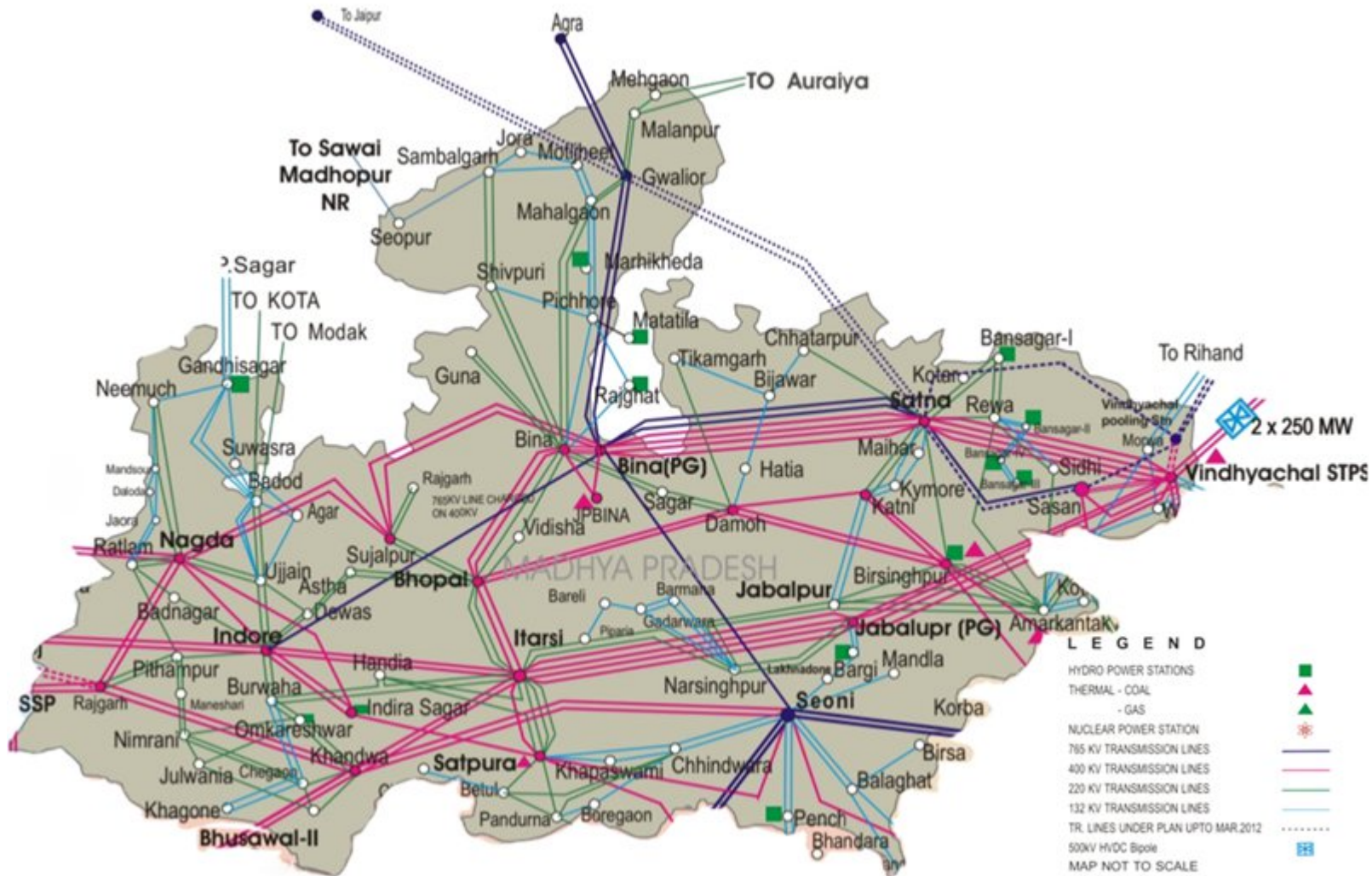
GETCO Asset – Failures Manufacturer-wise

GETCO porcelain failures - Manufacturer-wise



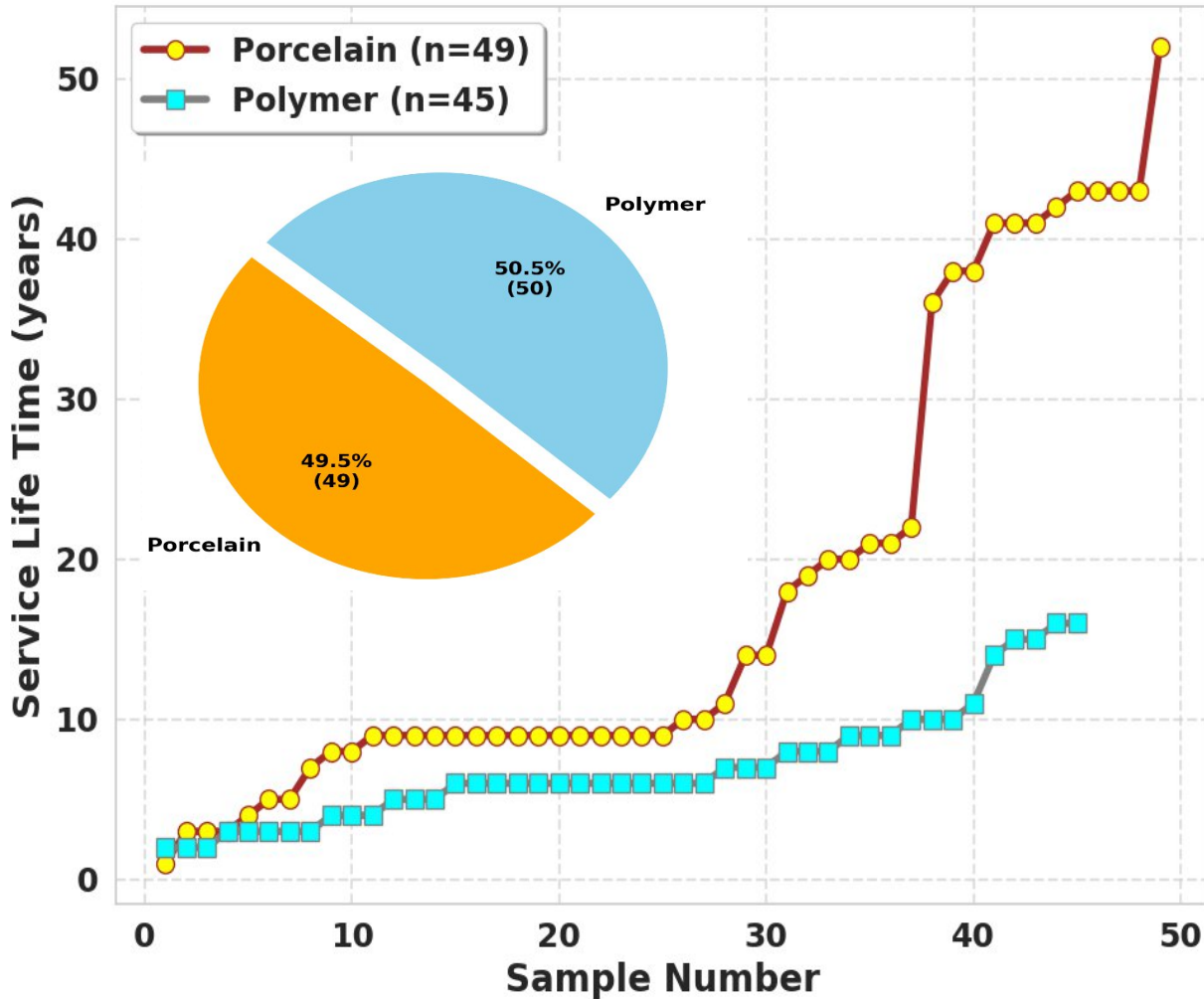
GETCO composite failures - Manufacturer-wise



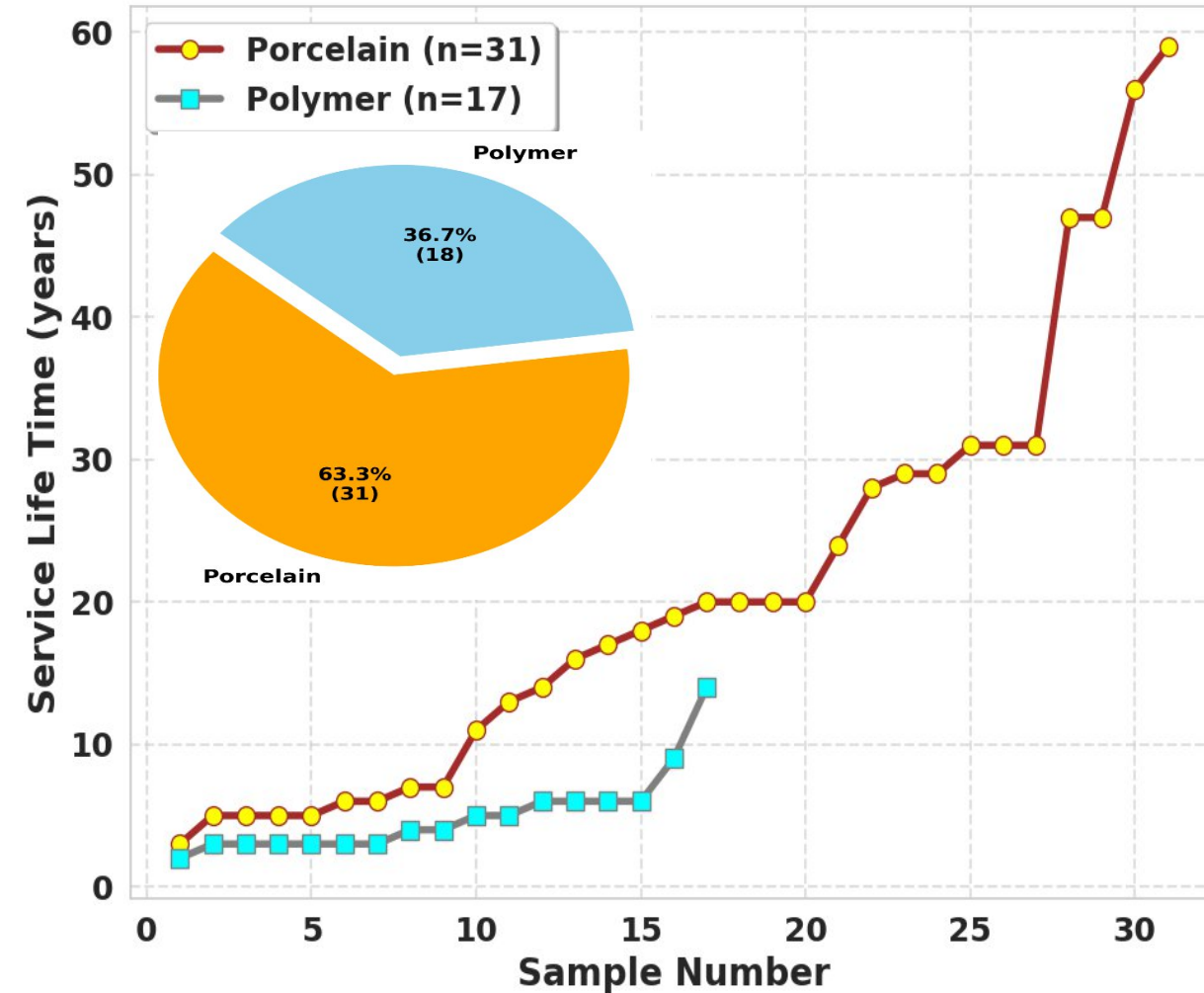


MPPTCL Asset - Service Life of Insulator Strings

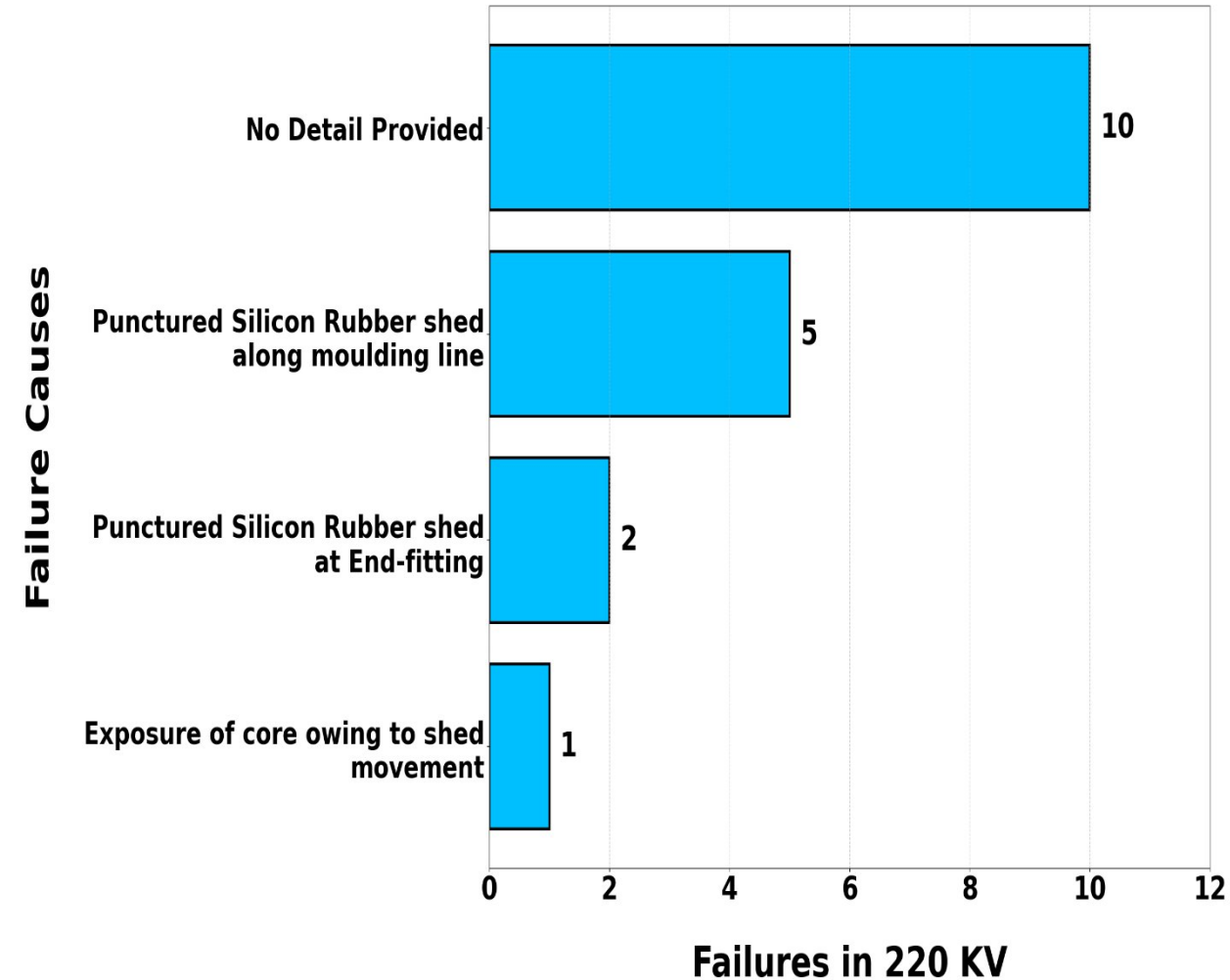
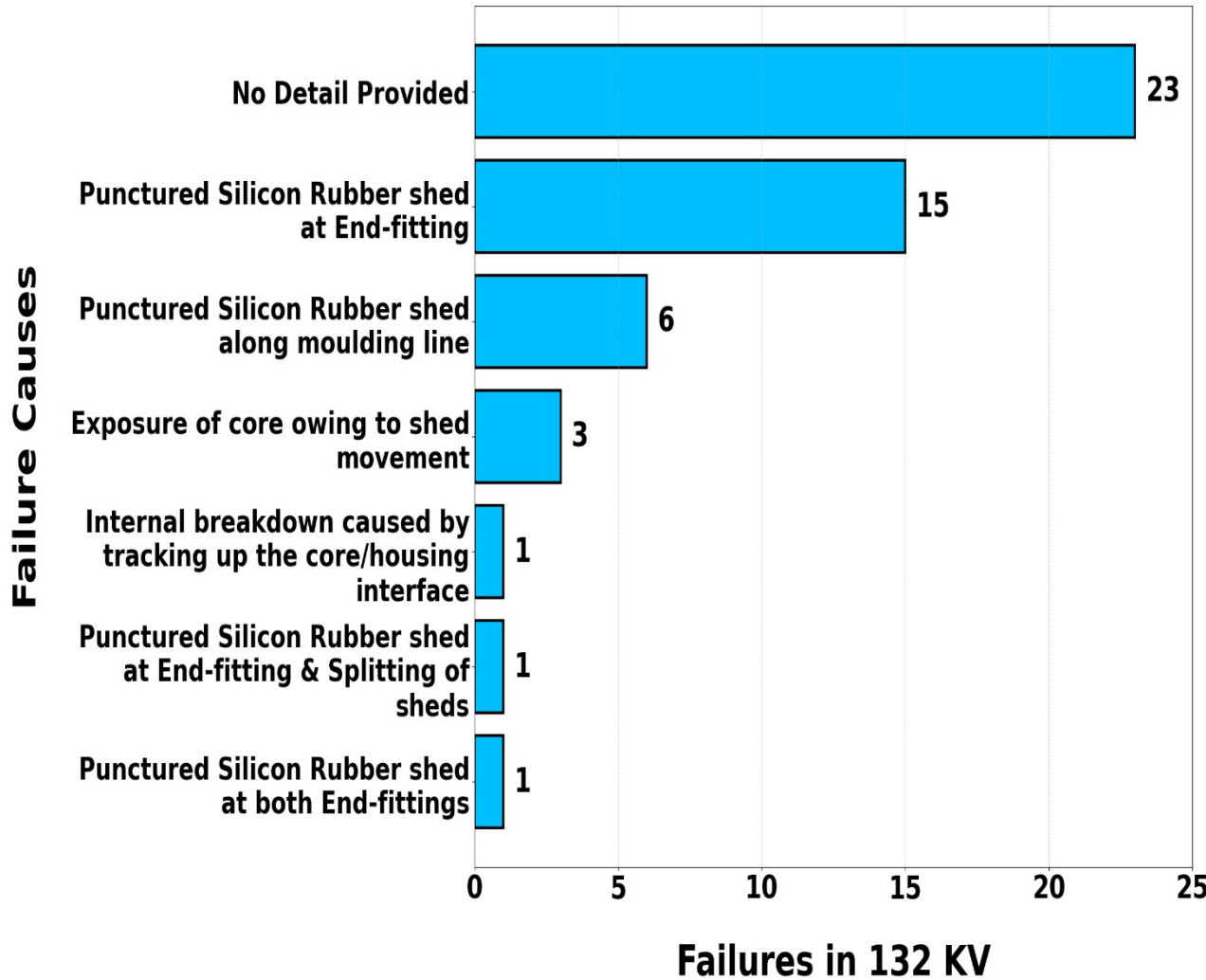
132 kV System



220 kV System

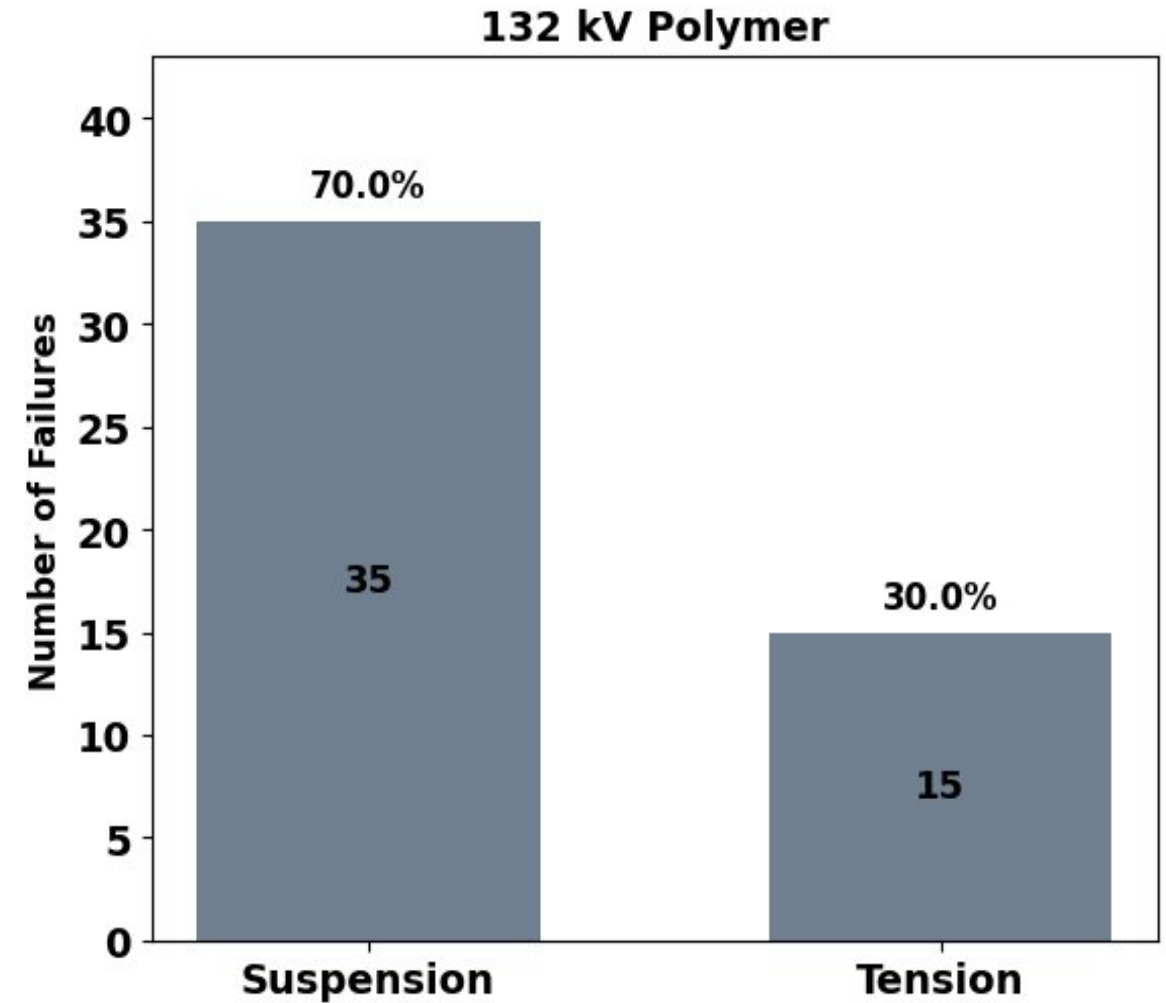
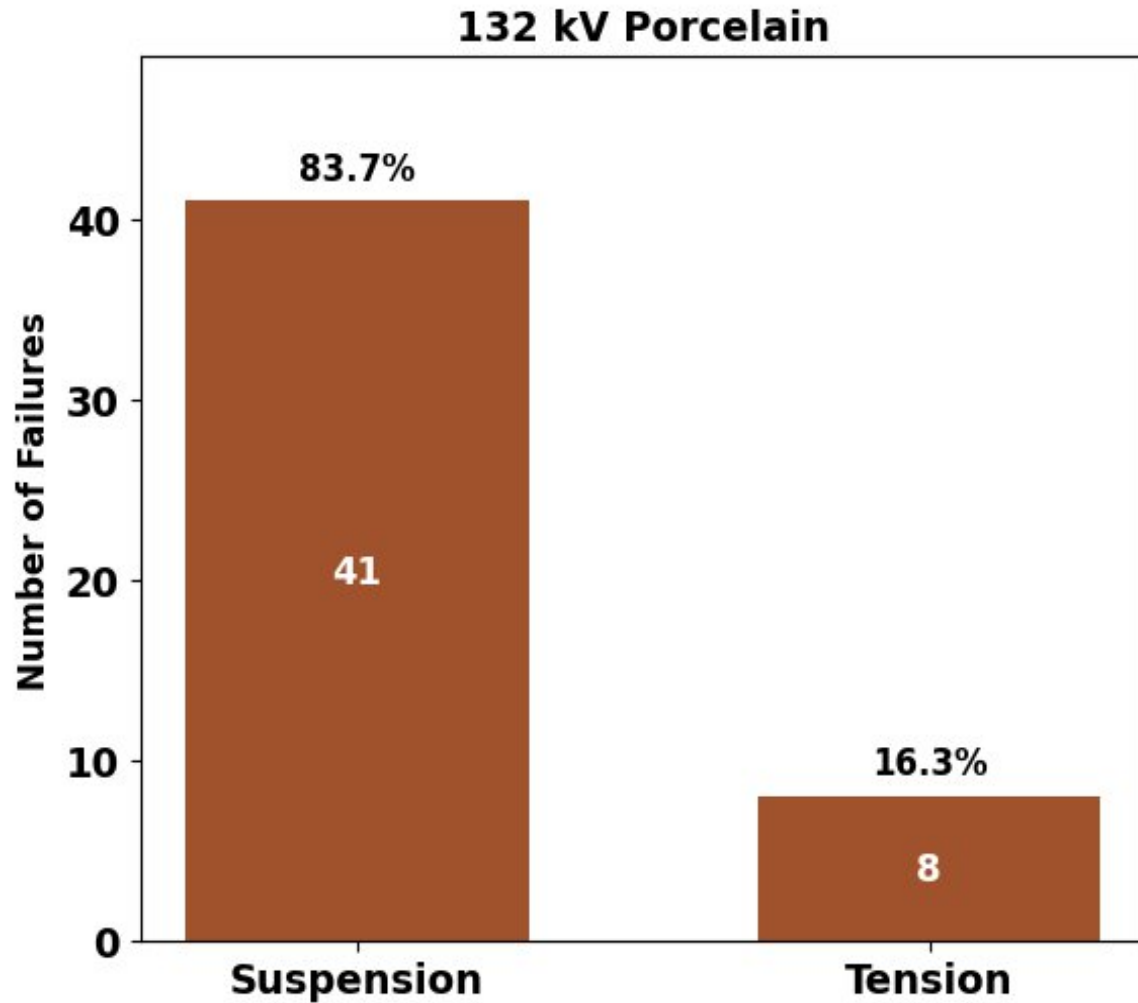


MPPTCL Polymer Asset - Failure & Causes for 132 kV & 220 kV Voltage Class

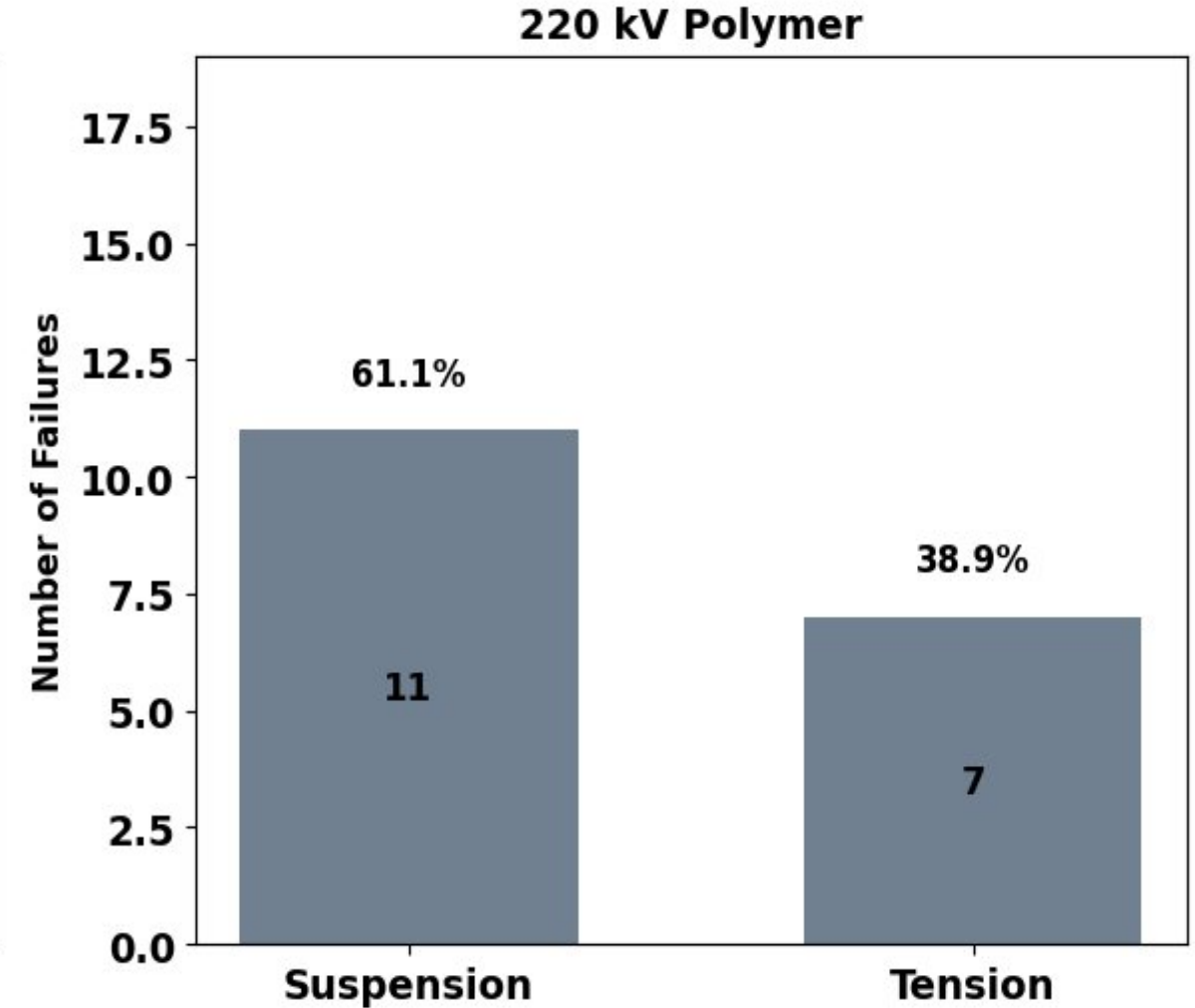
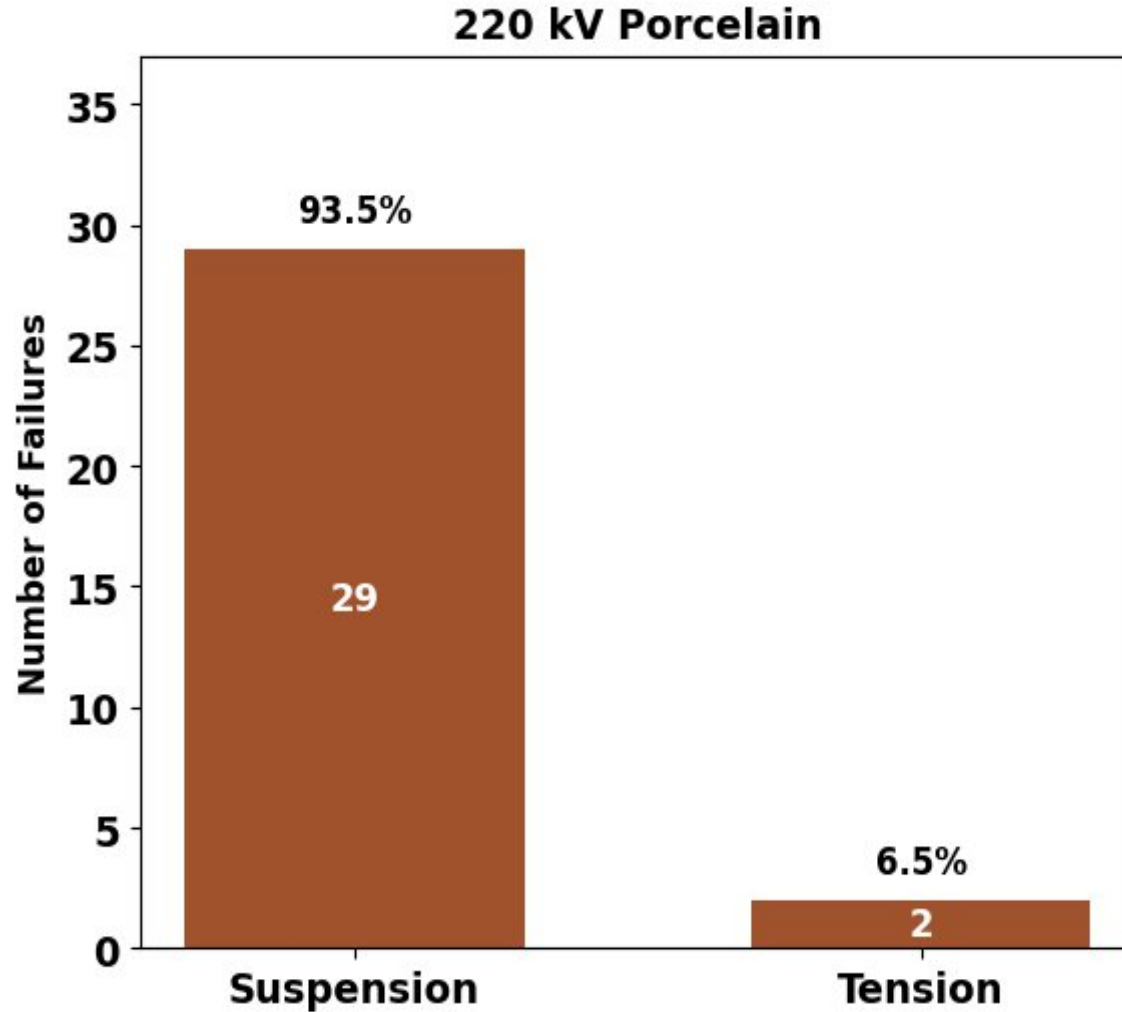


Note: Porcelain insulator failure causes are not available

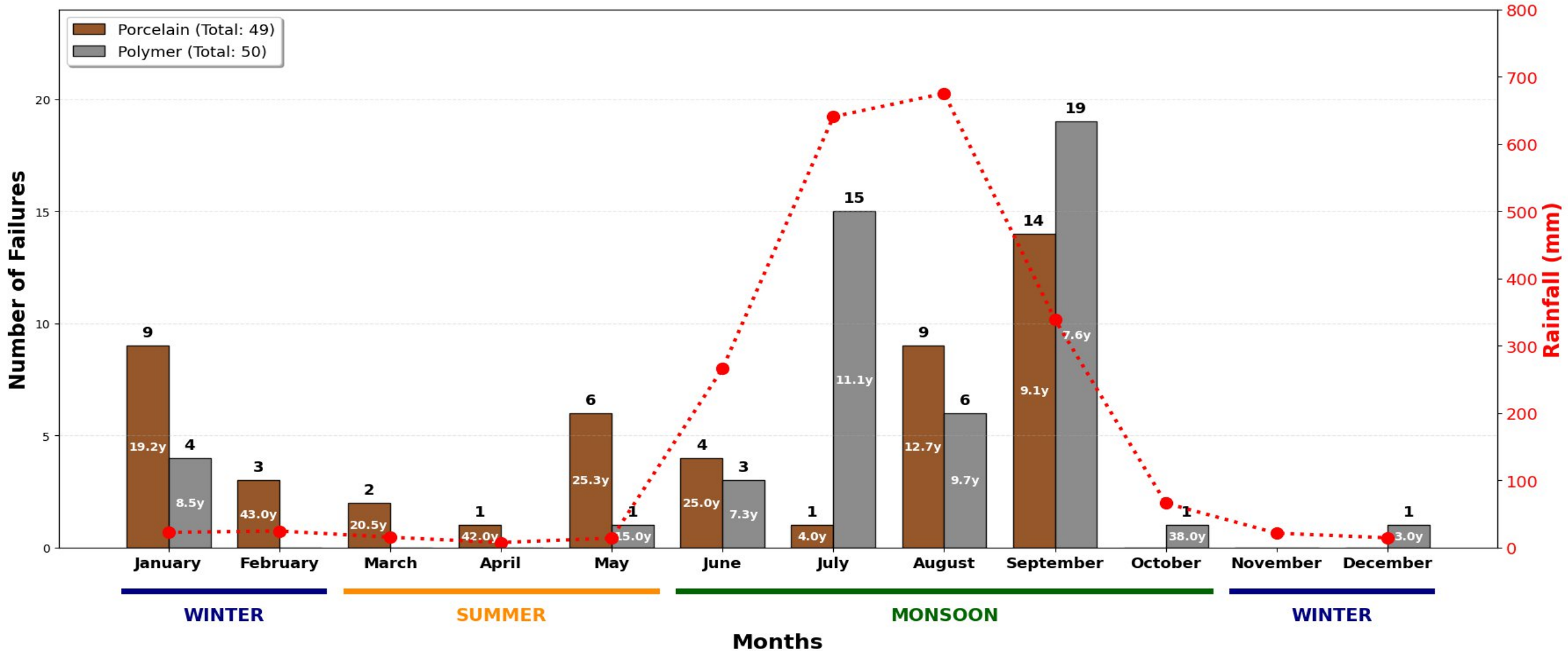
MPPTCL Insulator Failures – based on String Configuration



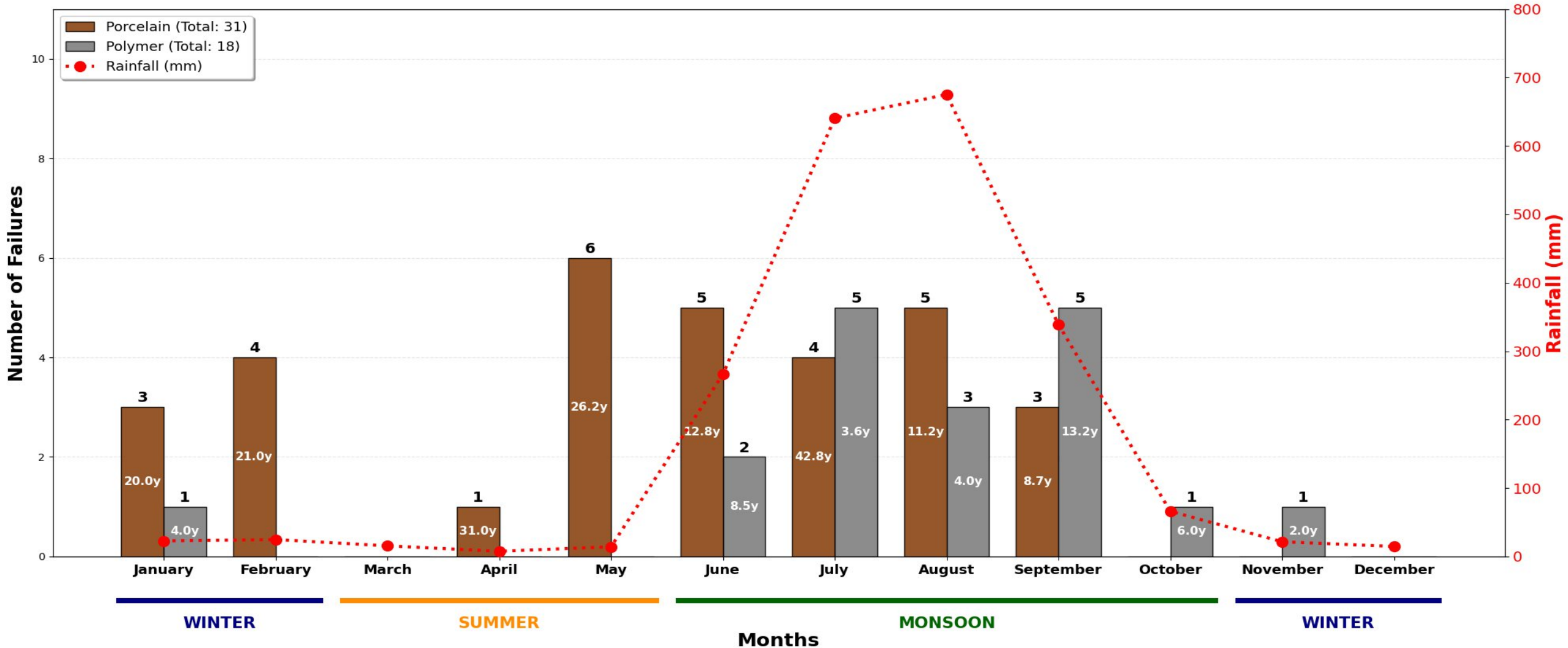
MPPTCL Insulator Failures – based on String Configuration



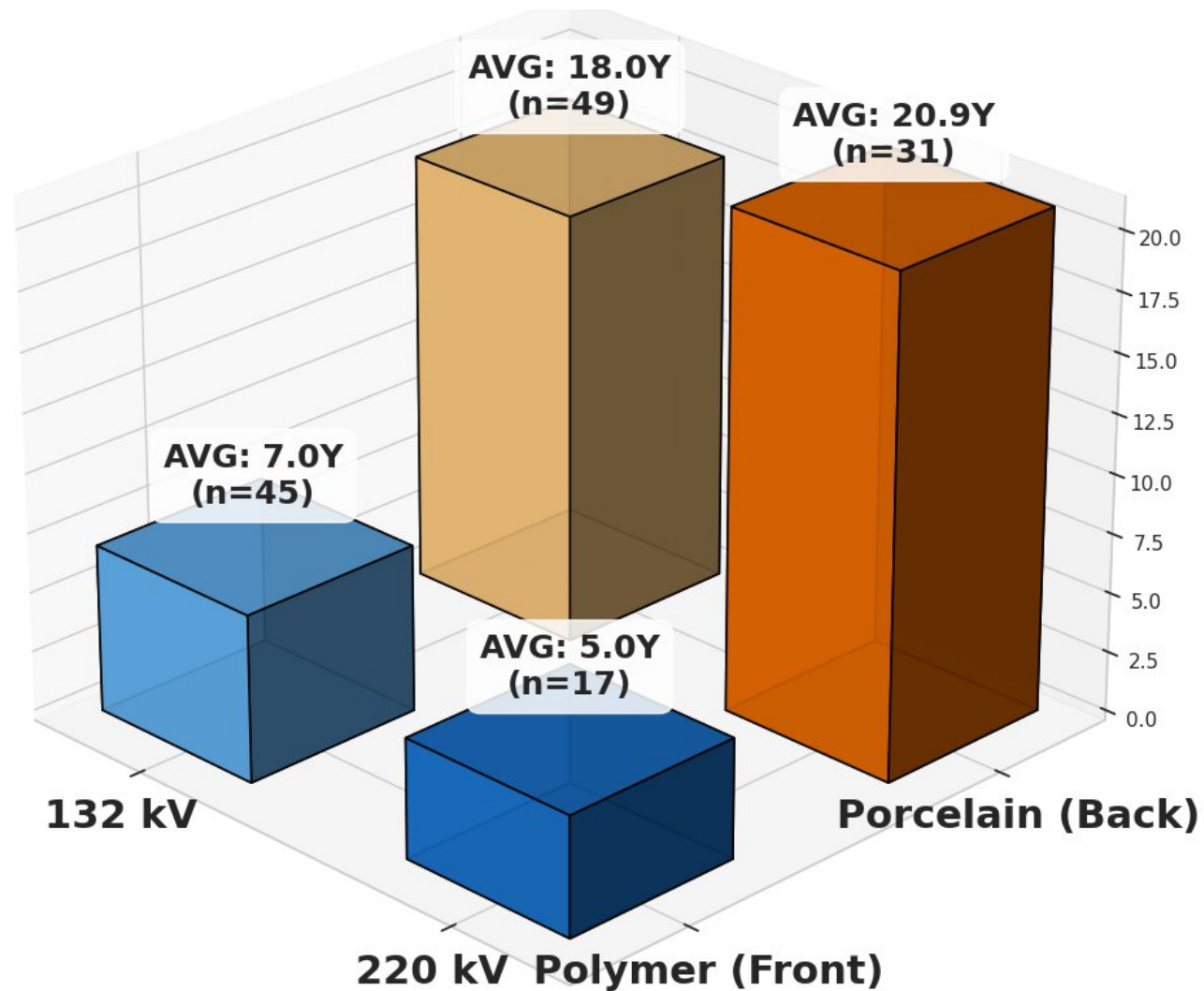
MPPTCL Insulator Failures – 132 kV Seasonal Variation



MPPTCL Insulator Failures – 220 kV Seasonal Variation



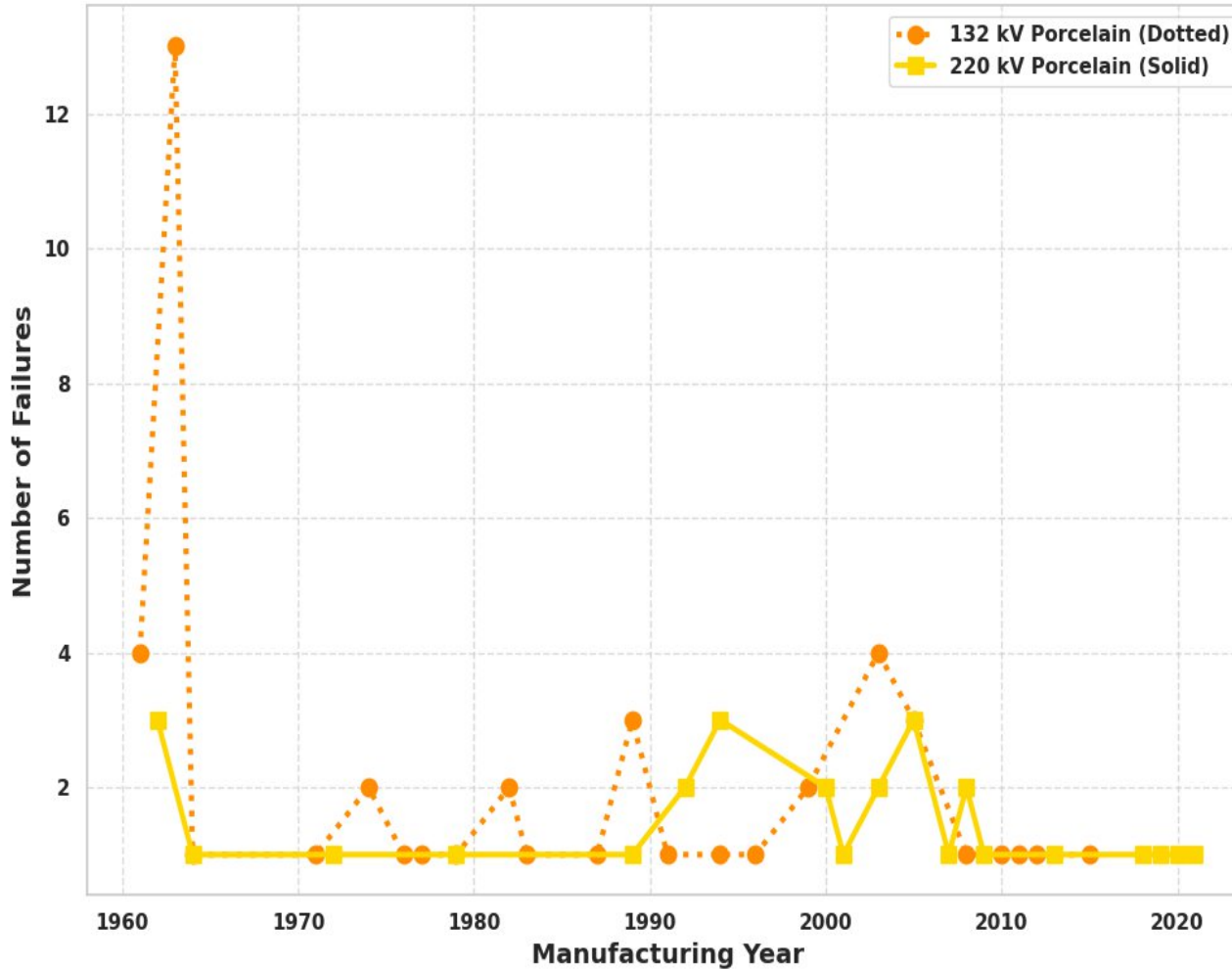
MPPTCL Asset Failure Landscape (3D)



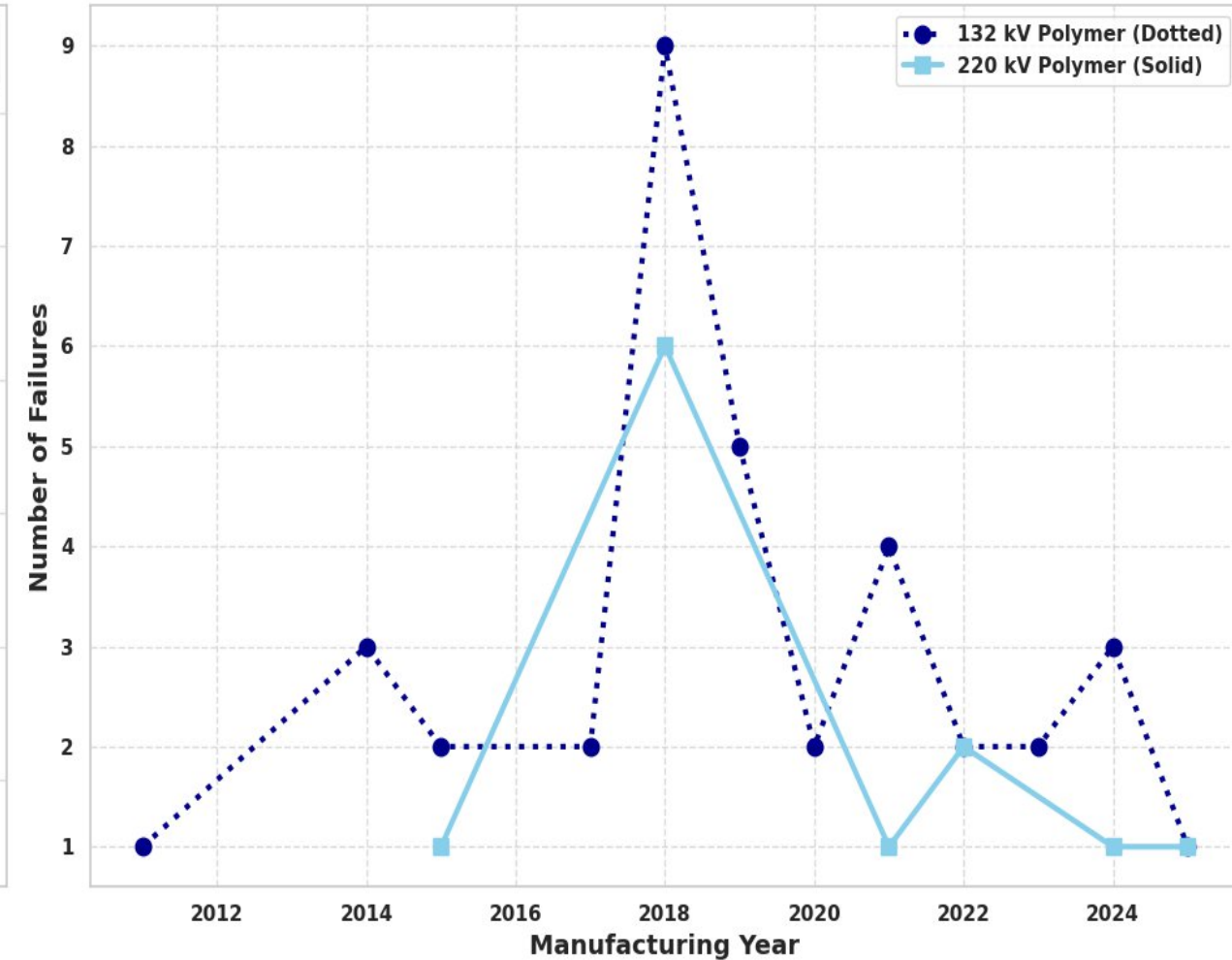
Insulator Failure Analysis

MPPTCL Asset – Mfg. Year vs Number of Failures

PORCELAIN INSULATOR FAILURES



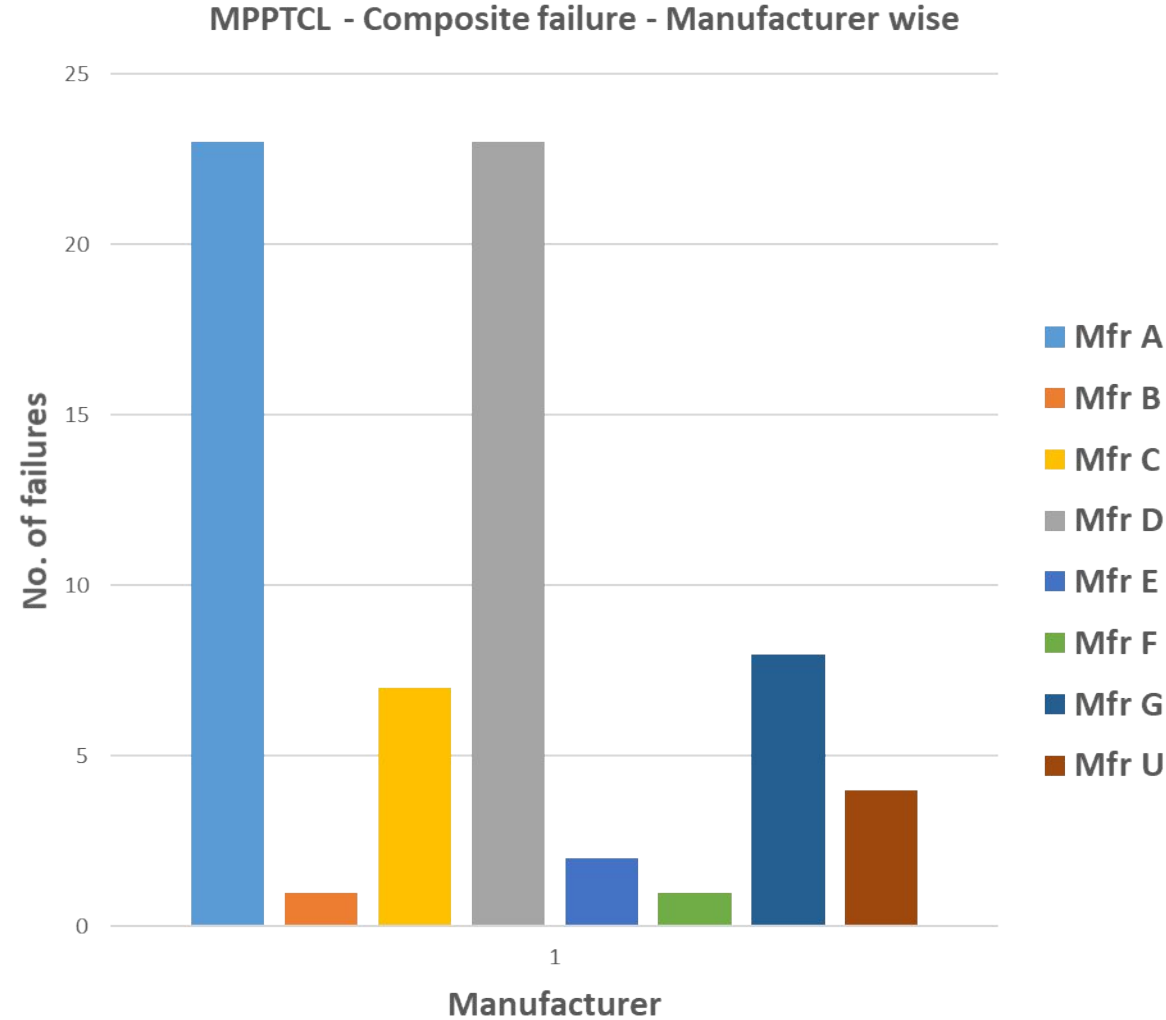
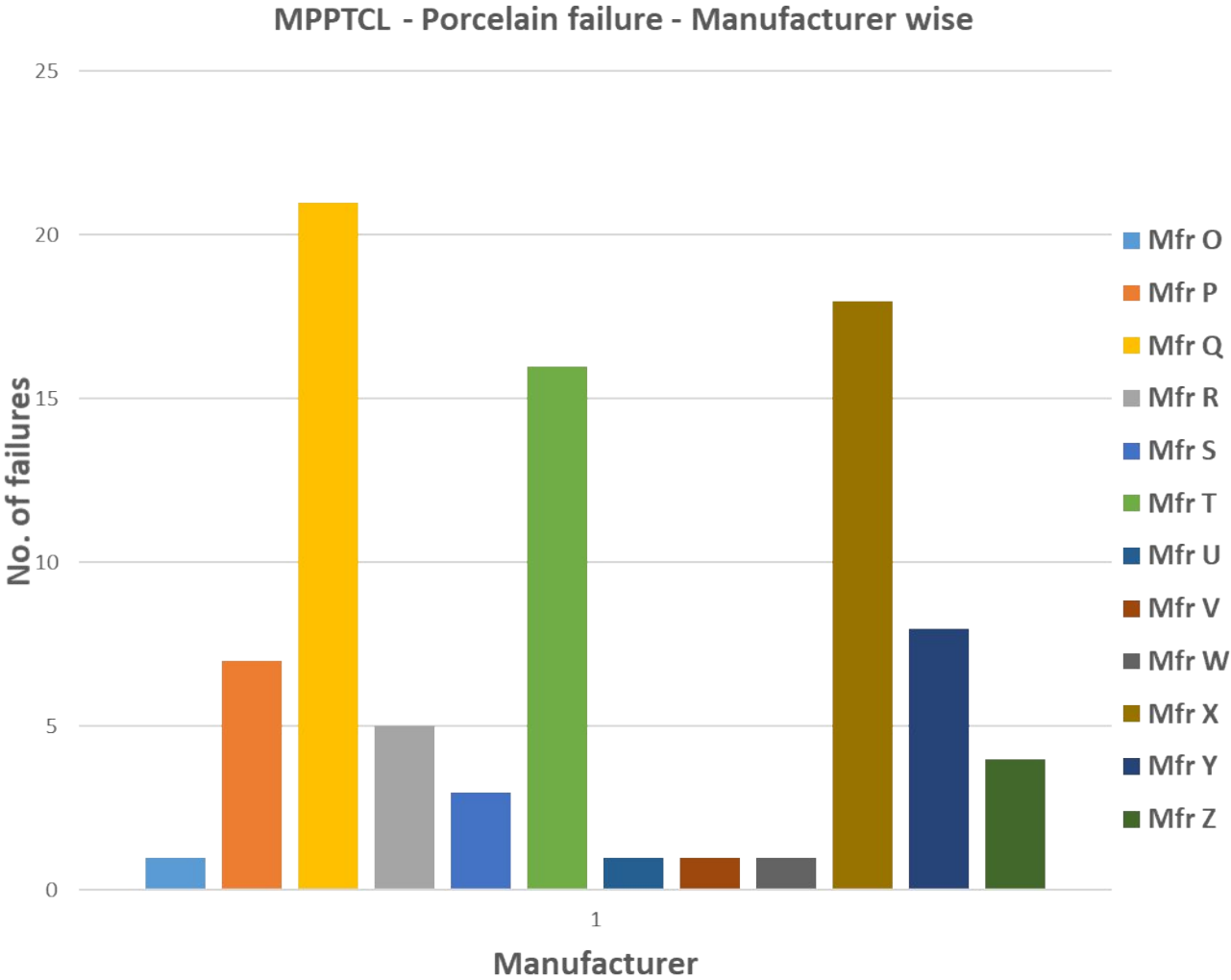
POLYMER INSULATOR FAILURES



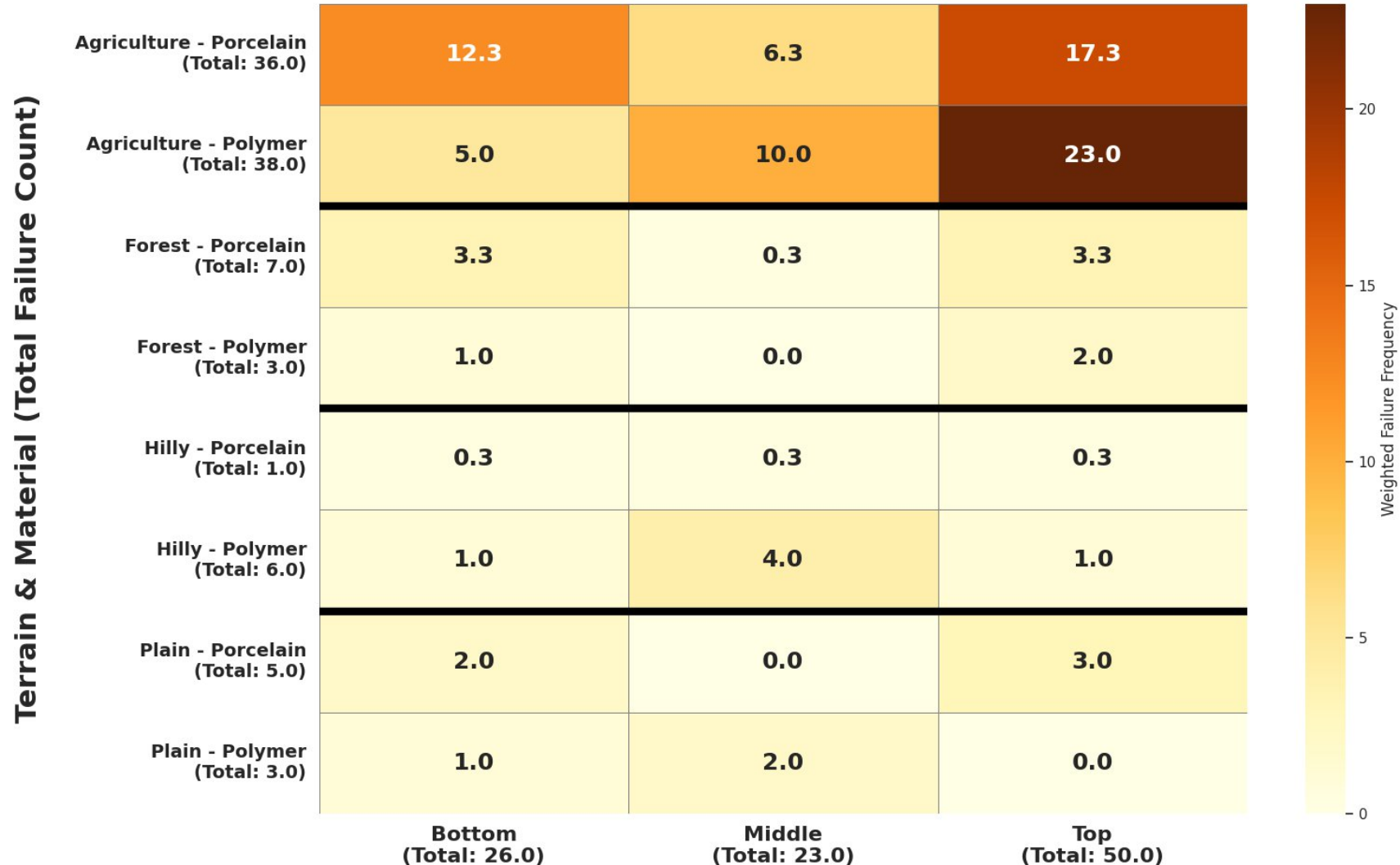
Annexure-IV (Page 124 of 164)

Insulator Failure Analysis

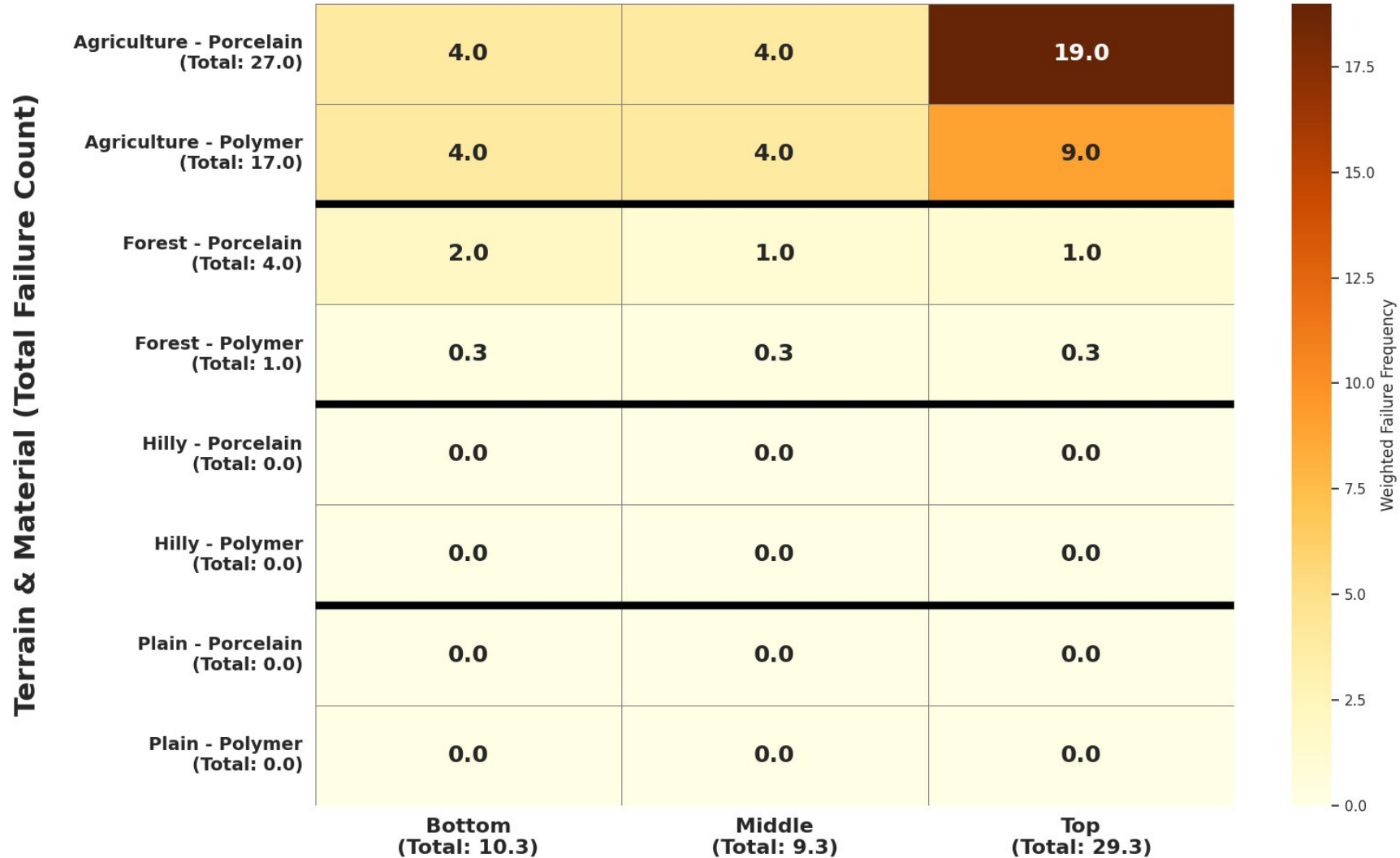
MPPTCL Asset – Failures Manufacturer-wise



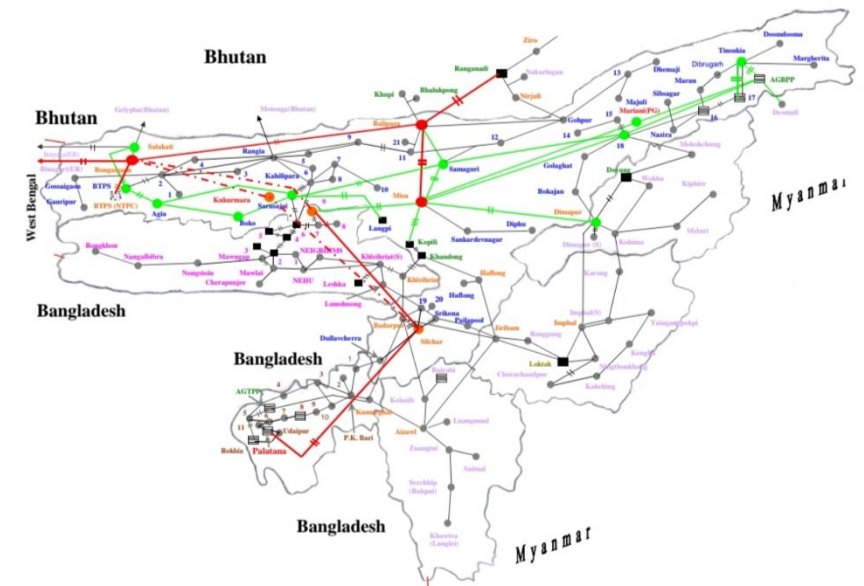
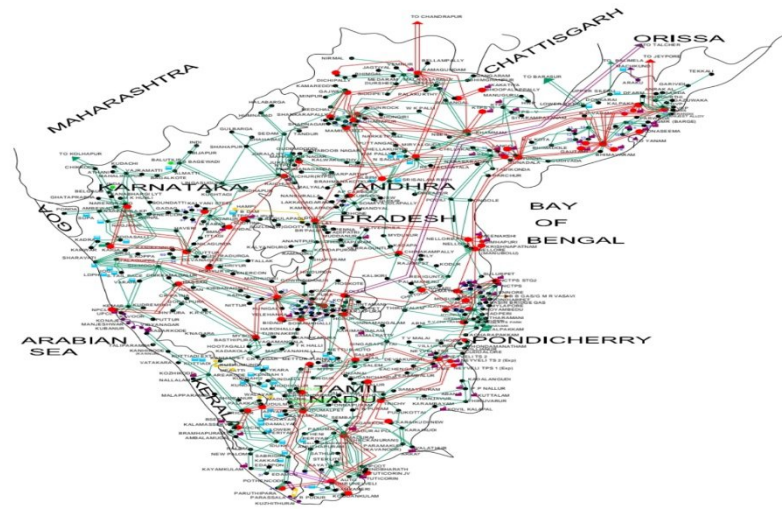
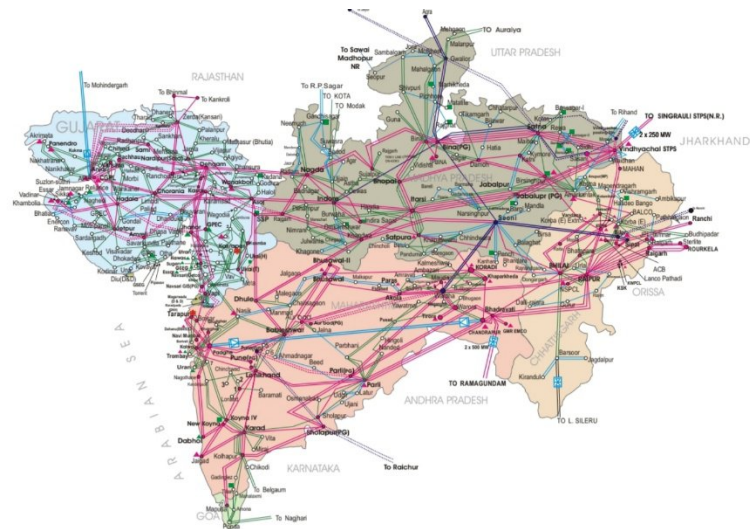
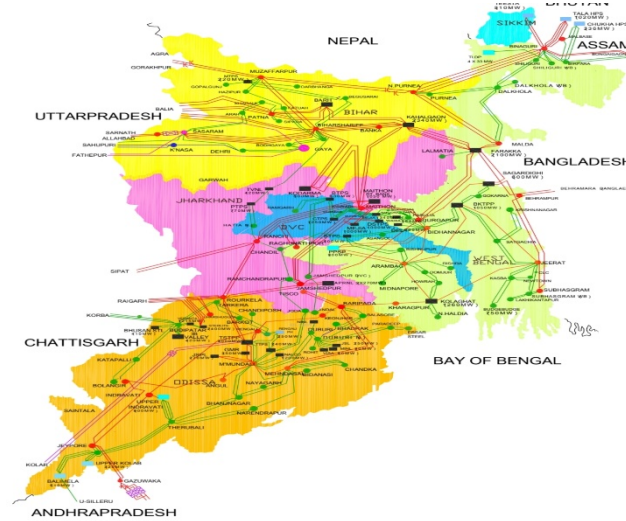
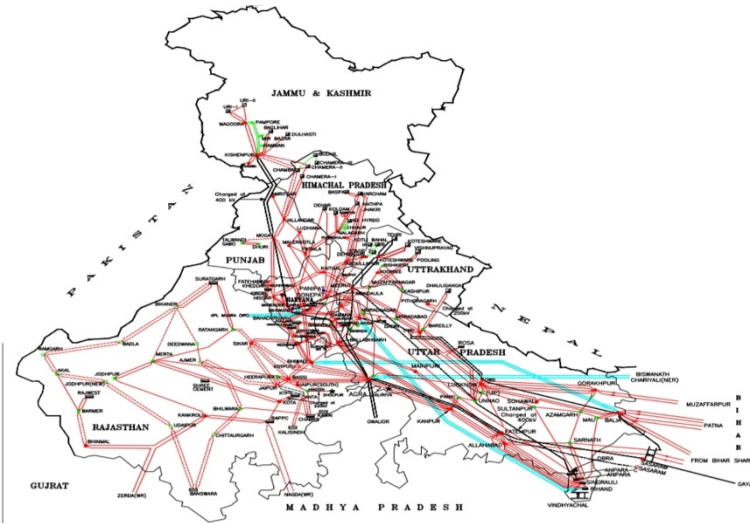
MPPTCL Asset – 132 kV Line, Terrain vs Phases



MPPTCL Asset – 220 kV Line, Terrain vs Phases

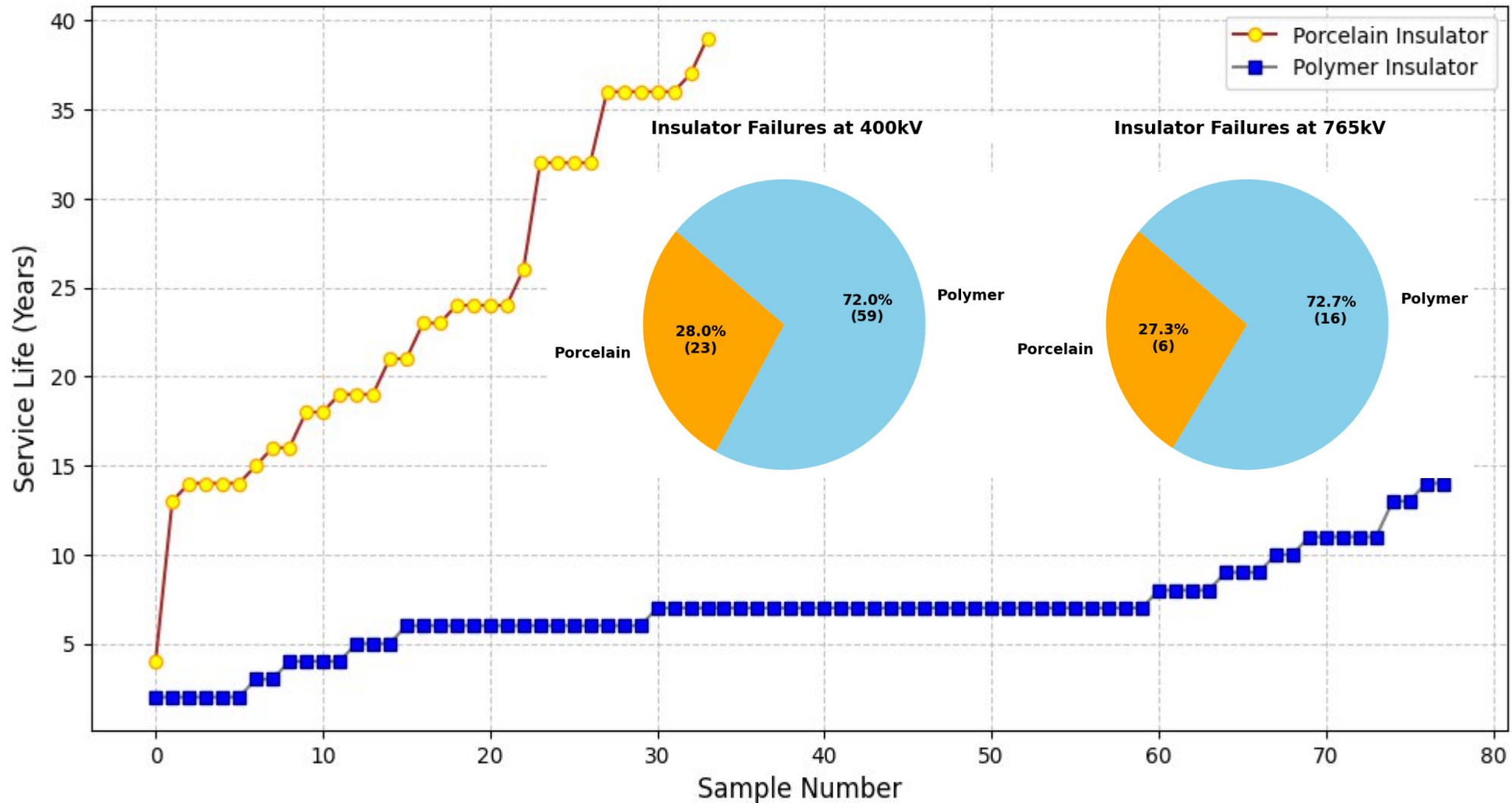


PGCIL Insulator Failures during 2025



Insulator Failure Analysis

PGCIL Asset - Service Life of Insulator Strings

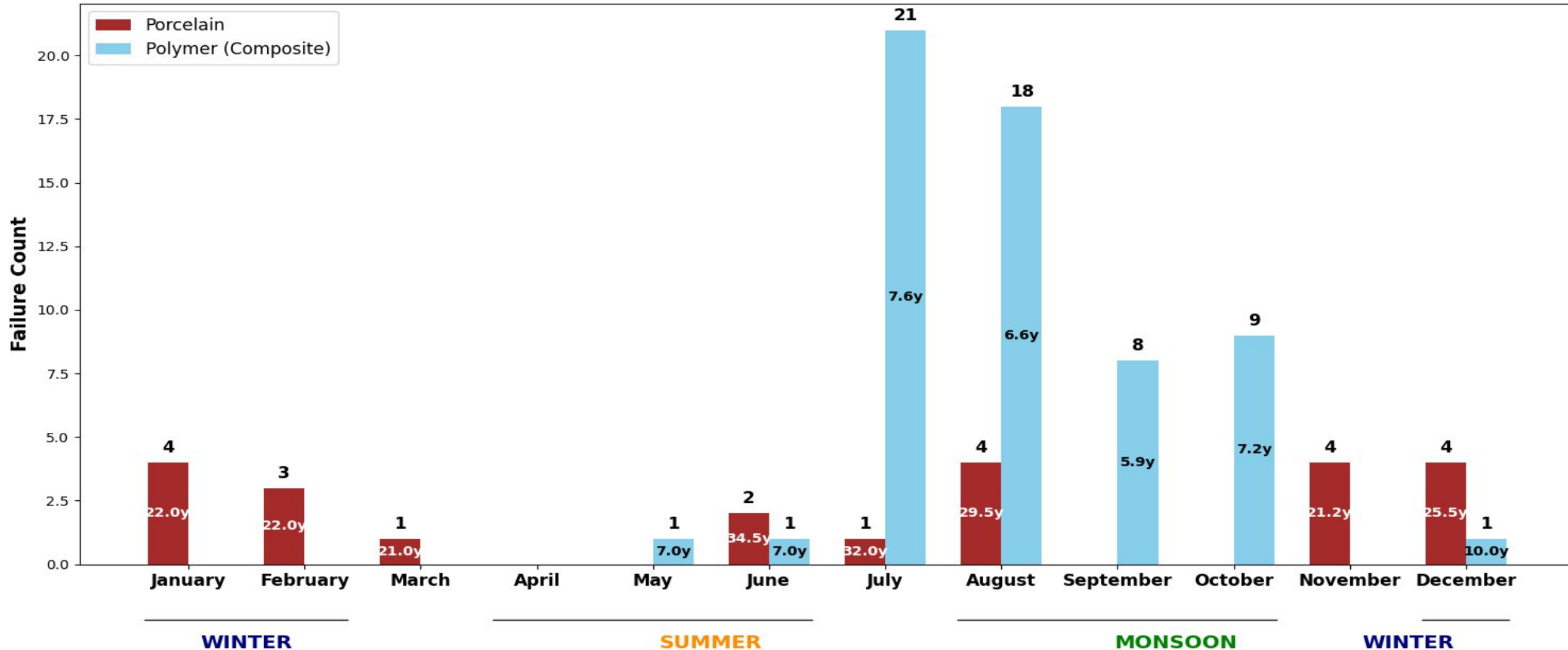




Insulator Failure Analysis

Annexure-IV (Page 129 of 164)

PGCIL Asset Failures 2025 – Month wise Distribution of 400 kV System Voltage

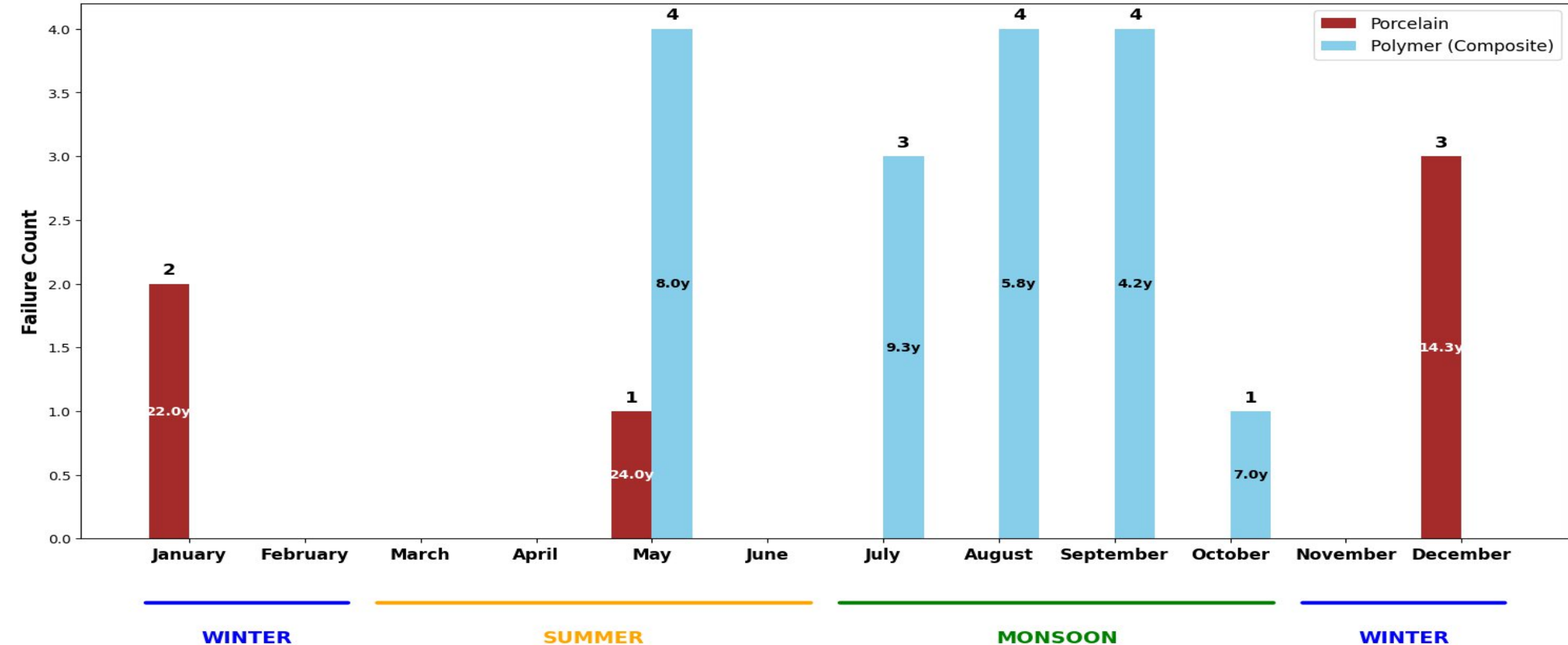




Insulator Failure Analysis

Annexure-IV (Page 130 of 164)

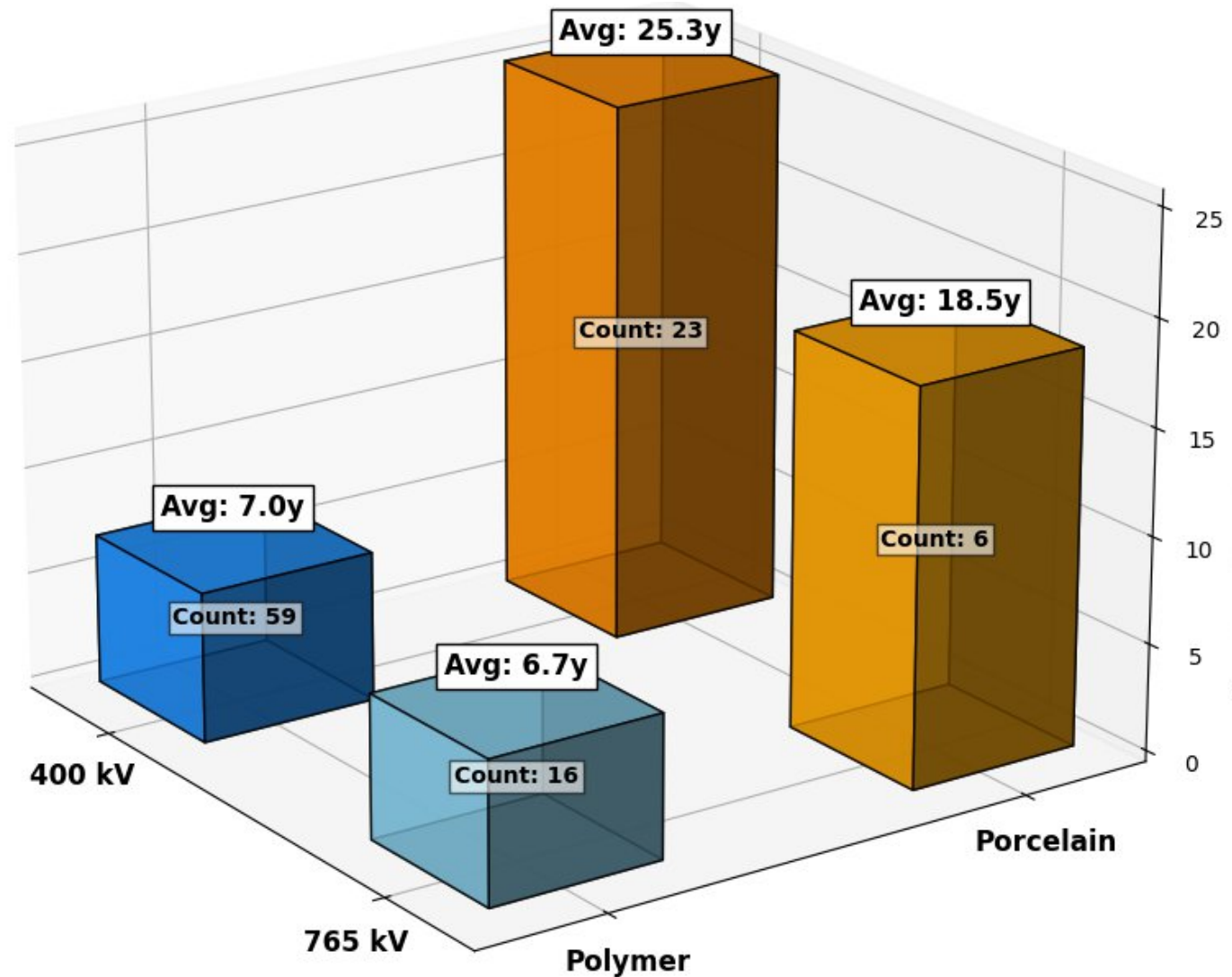
PGCIL Asset Failures 2025 – Month wise Distribution of 765 kV System Voltage



Annexure-IV (Page 131 of 164)

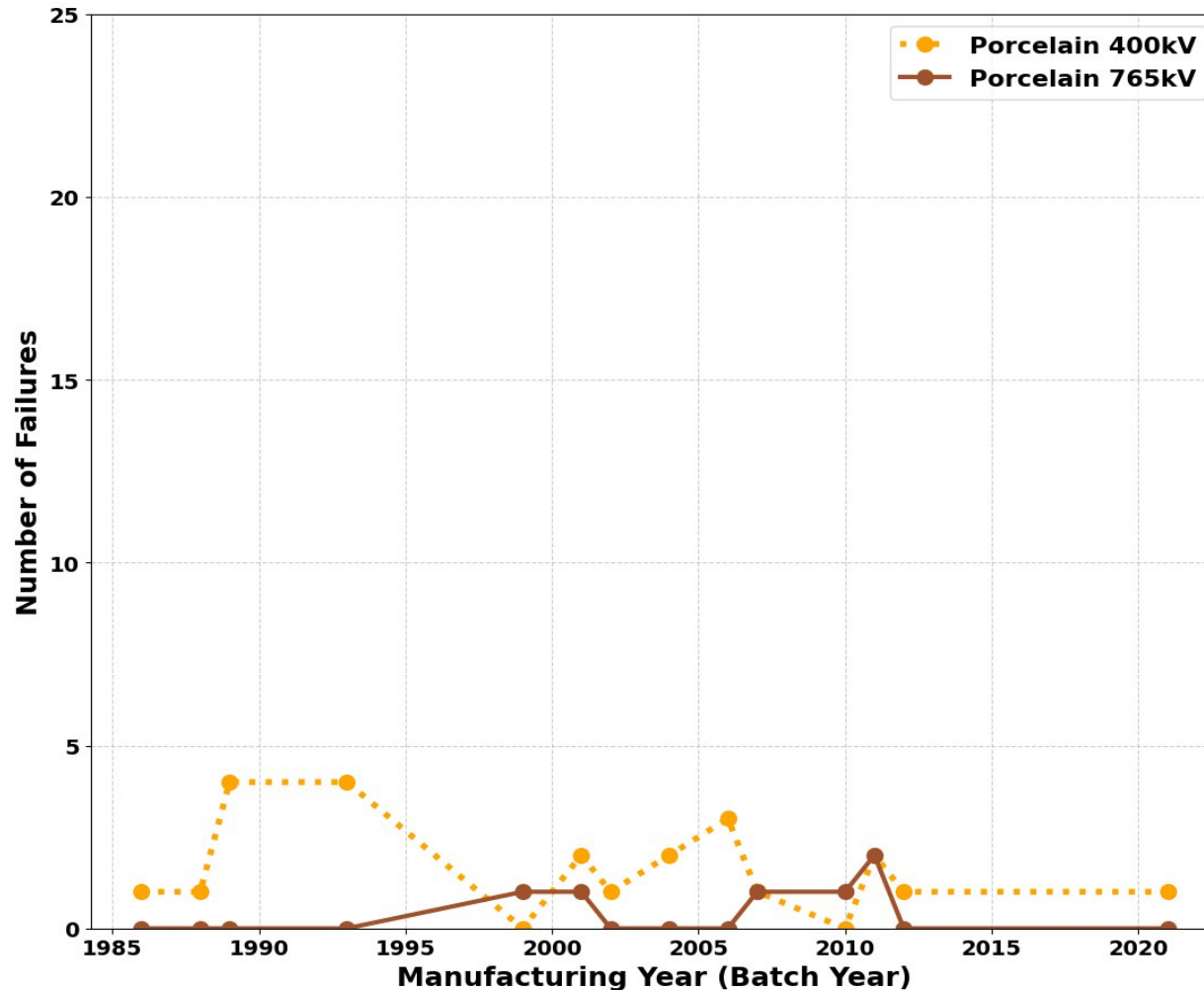
Insulator Failure Analysis

PGCIL Asset Failure Landscape (3D)

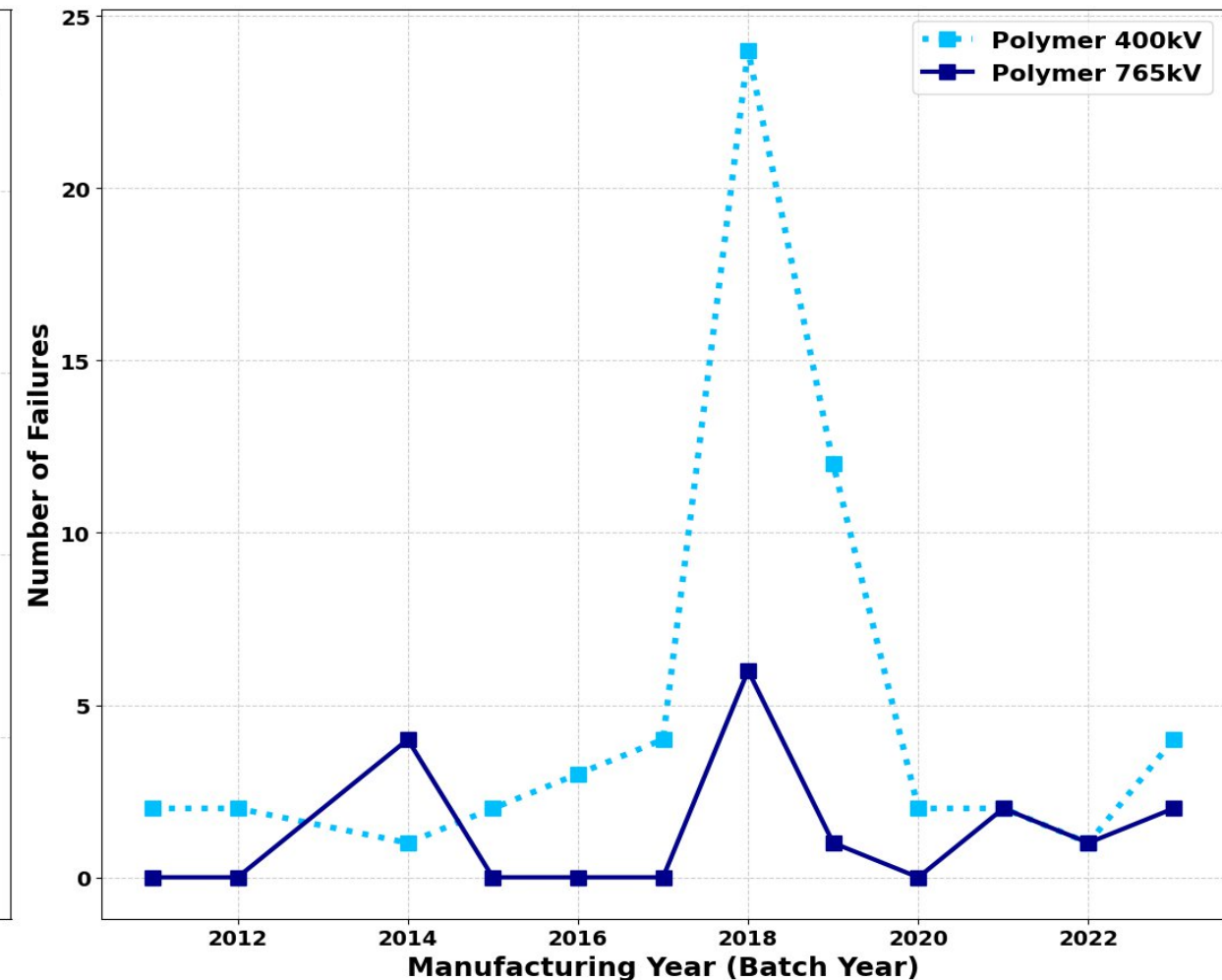


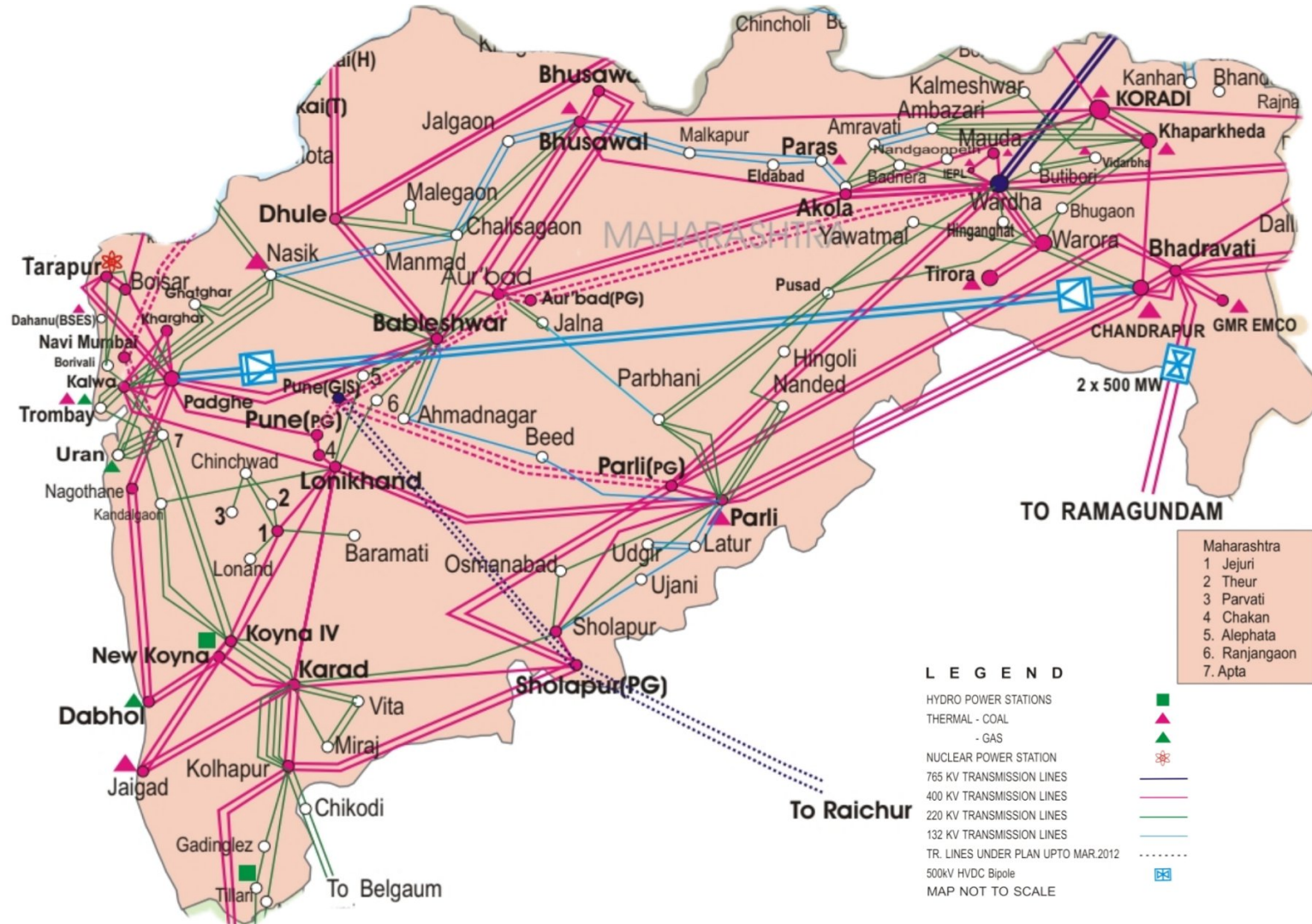
PGCIL Asset – Mfg. Year vs Number of Failures

Porcelain Insulators: Failures vs Batch Year



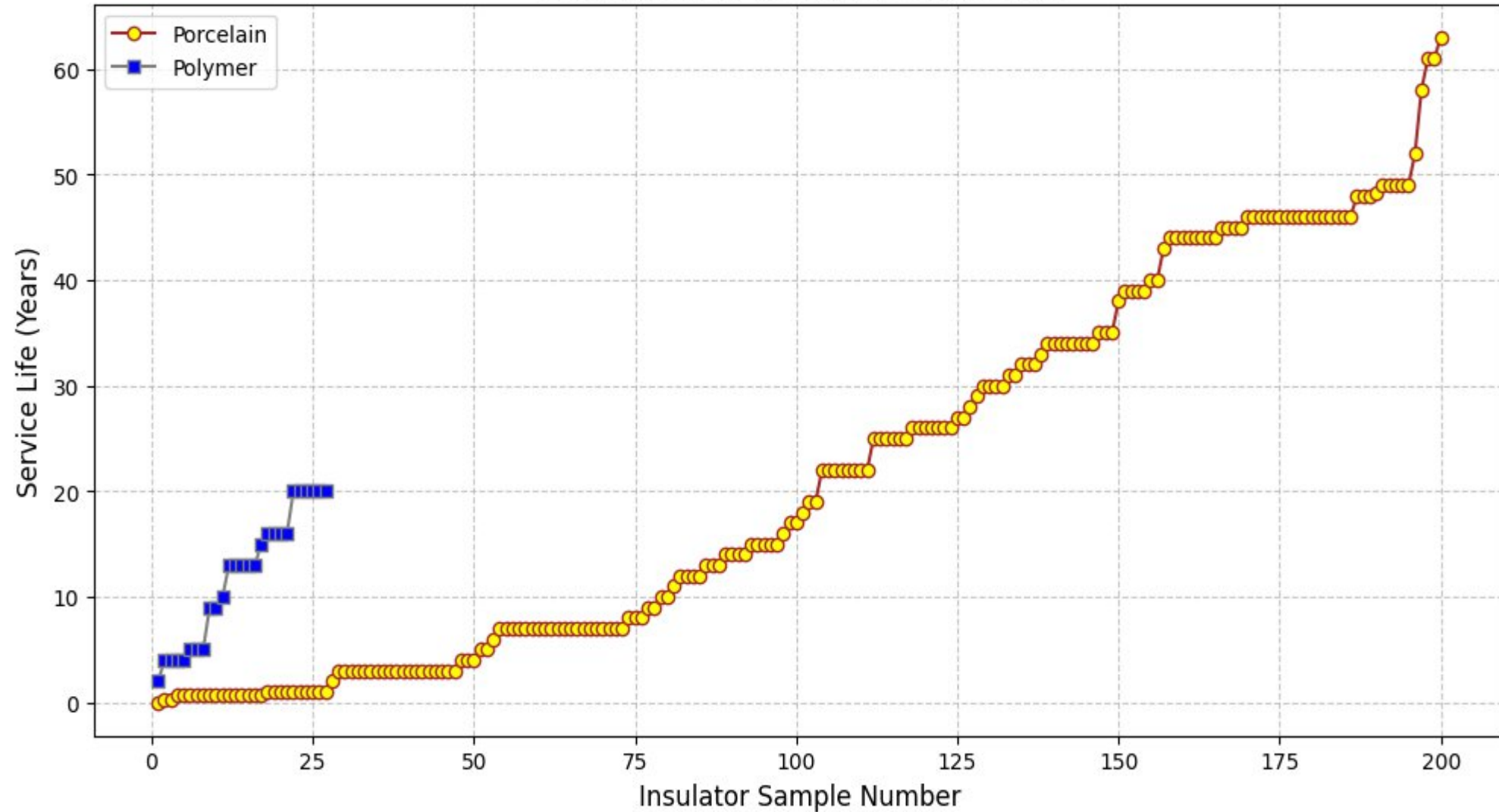
Polymer Insulators: Failures vs Batch Year





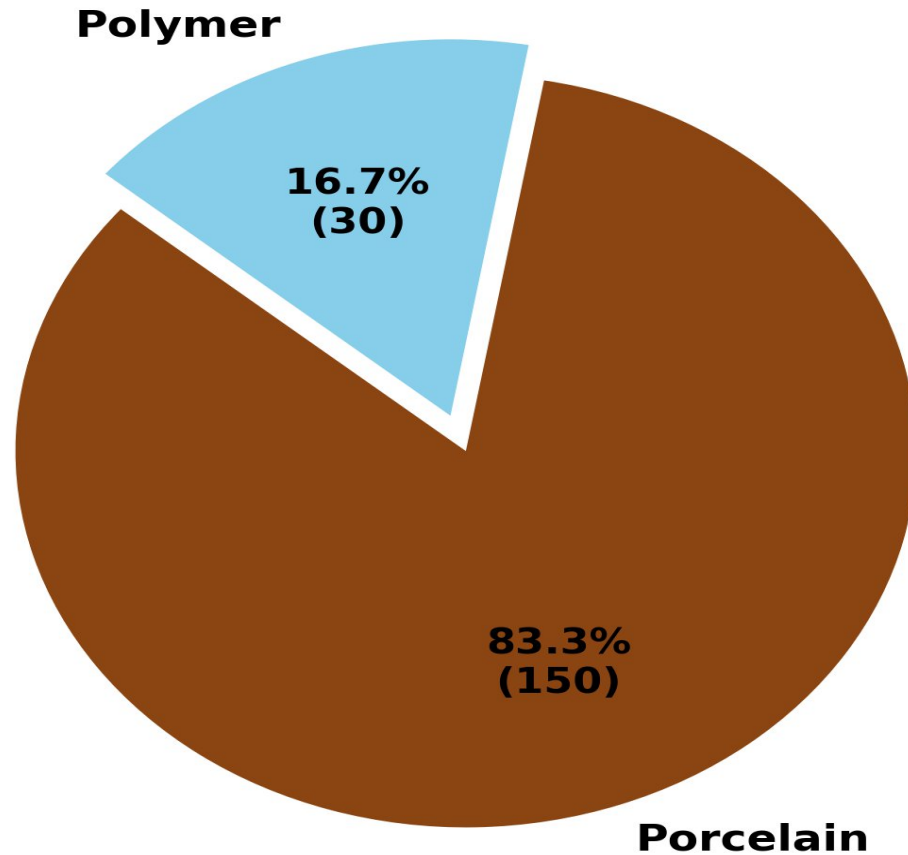
MSETCL Insulator Failures during 2025

MSETCL Asset - Service Life of Insulator Strings

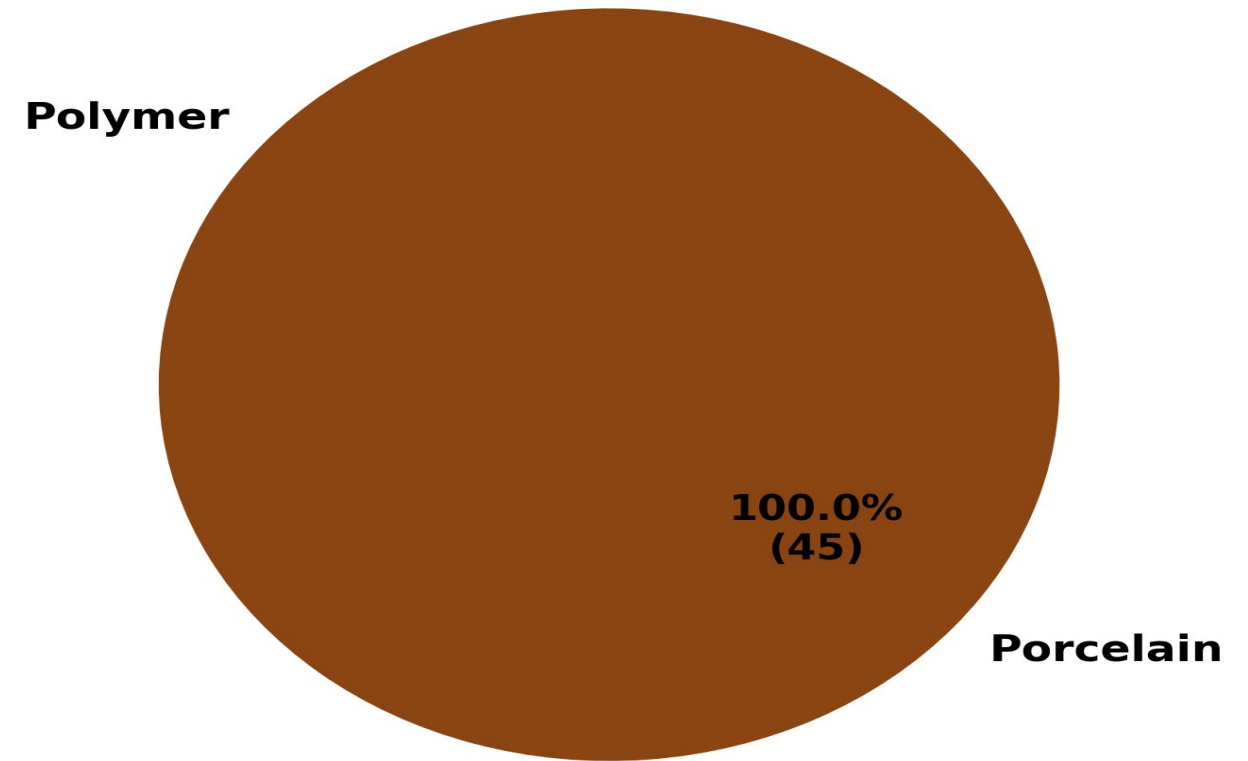


MSETCL Insulator Failures during 2025 – Failure Distribution

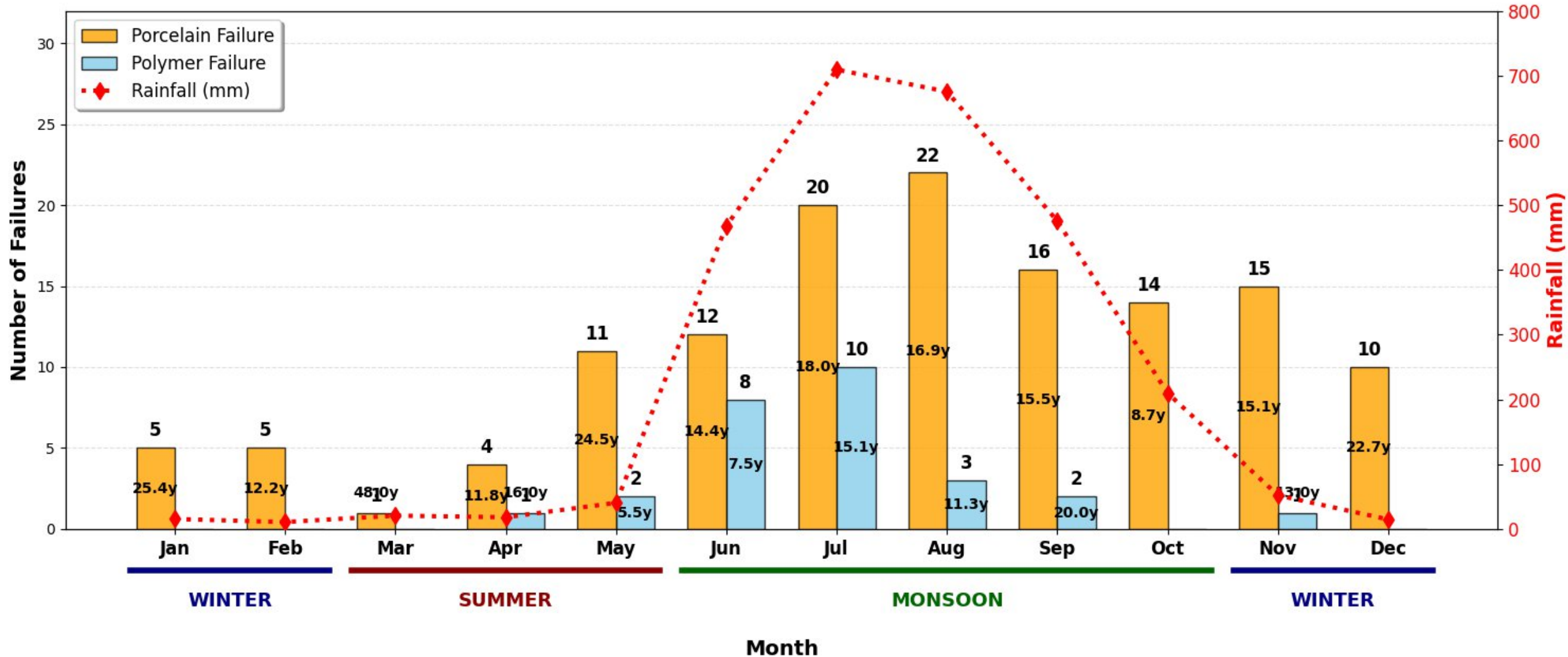
220 kV Failure Distribution



400 kV Failure Distribution



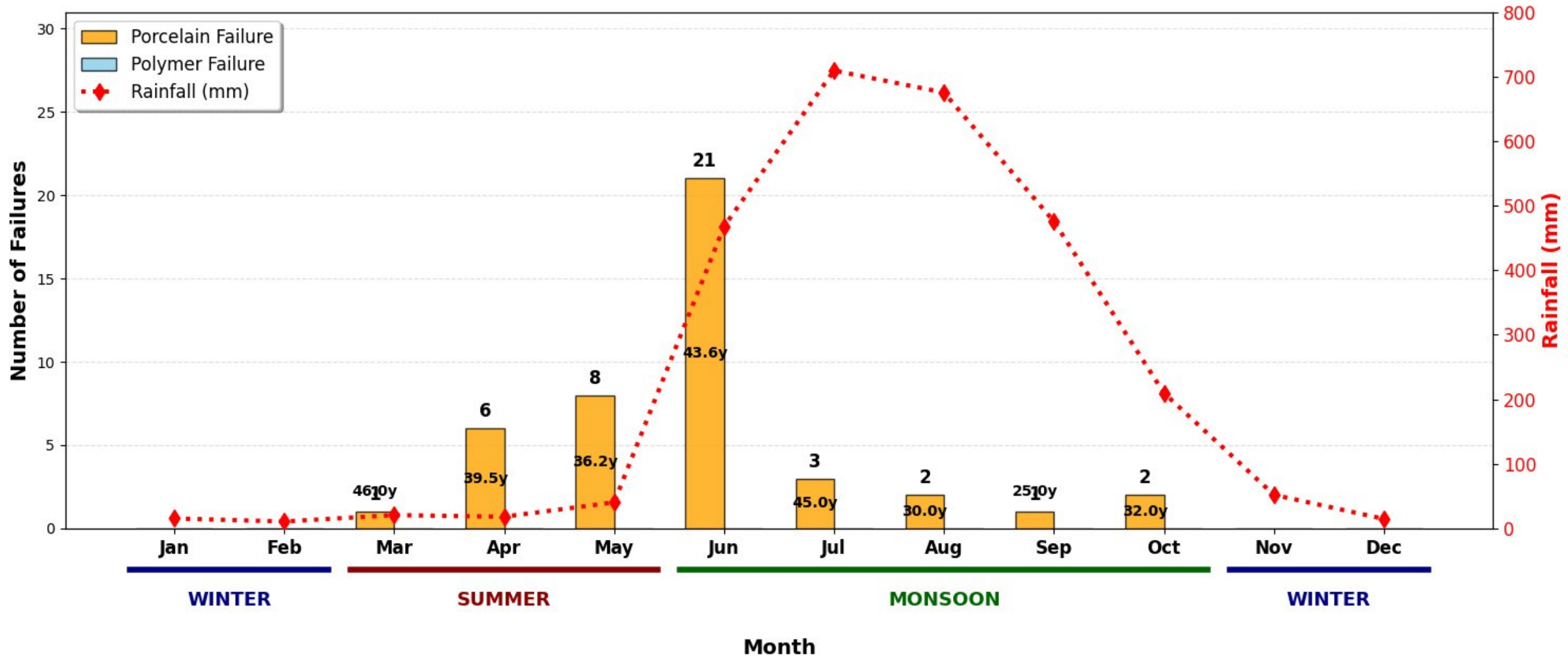
MSETCL Asset Failures - 220 kV Seasonal Variation





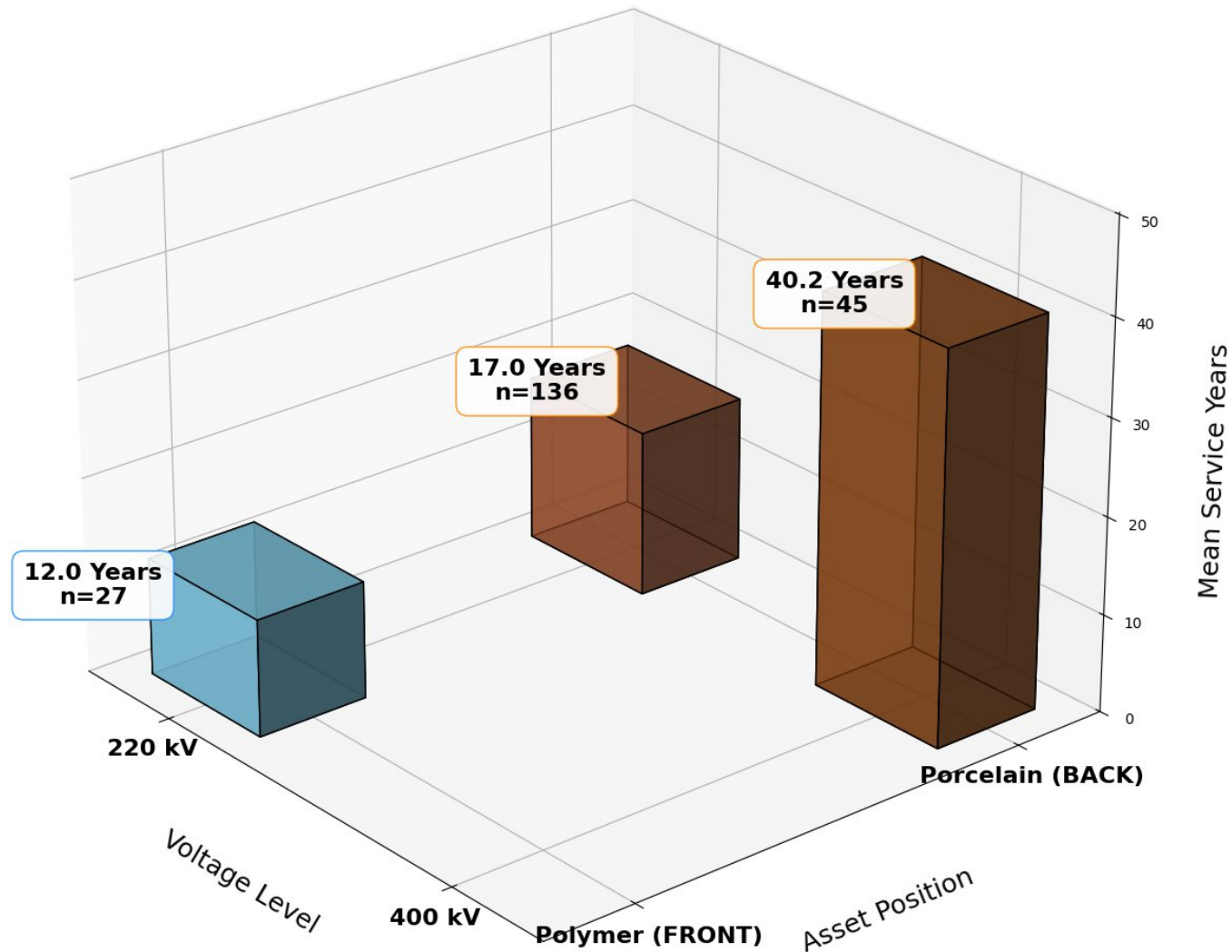
Insulator Failure Analysis

MSETCL Asset Failures - 400 kV Seasonal Variation



Insulator Failure Analysis

MSETCL Asset Failures Landscape (3D)

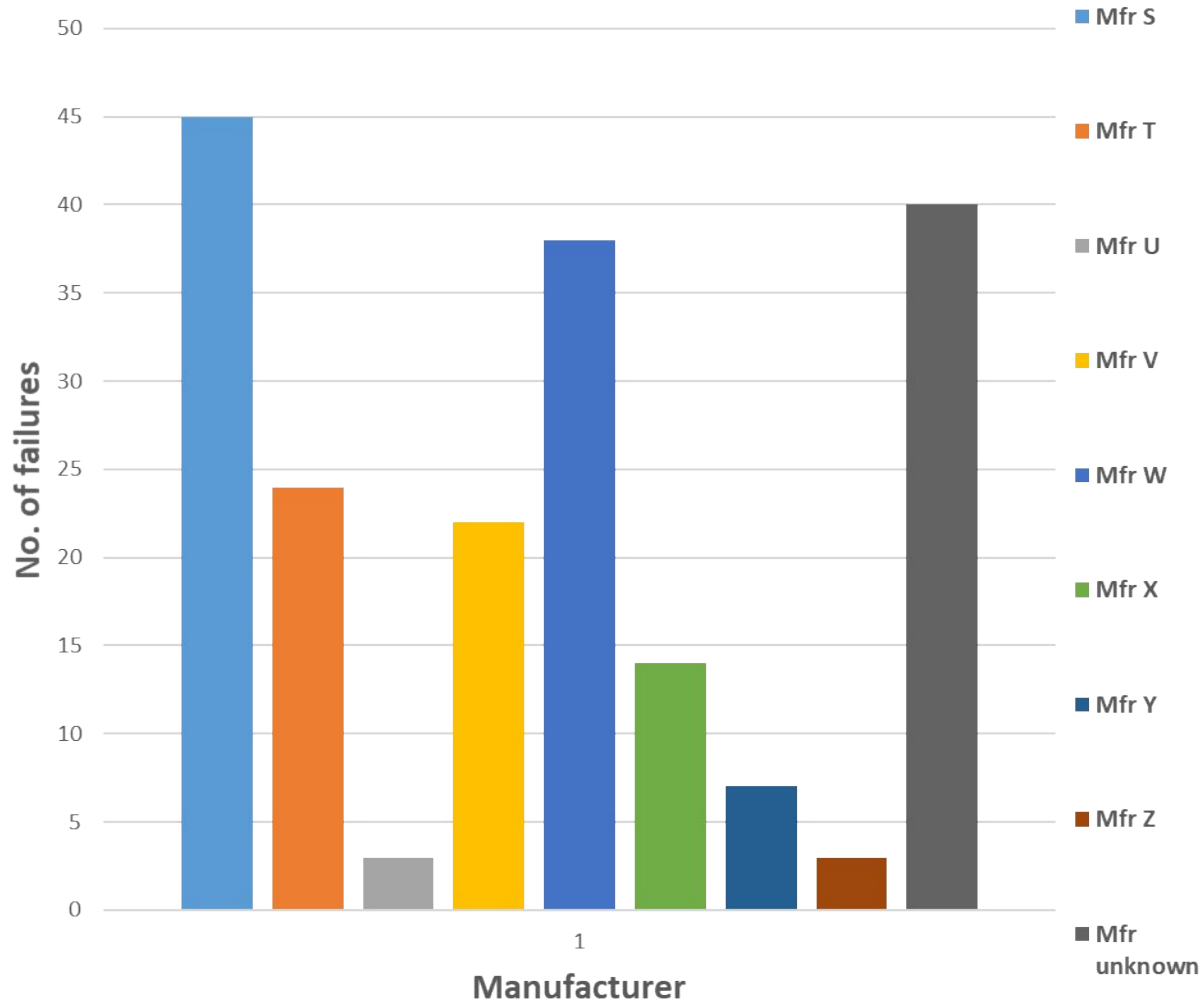




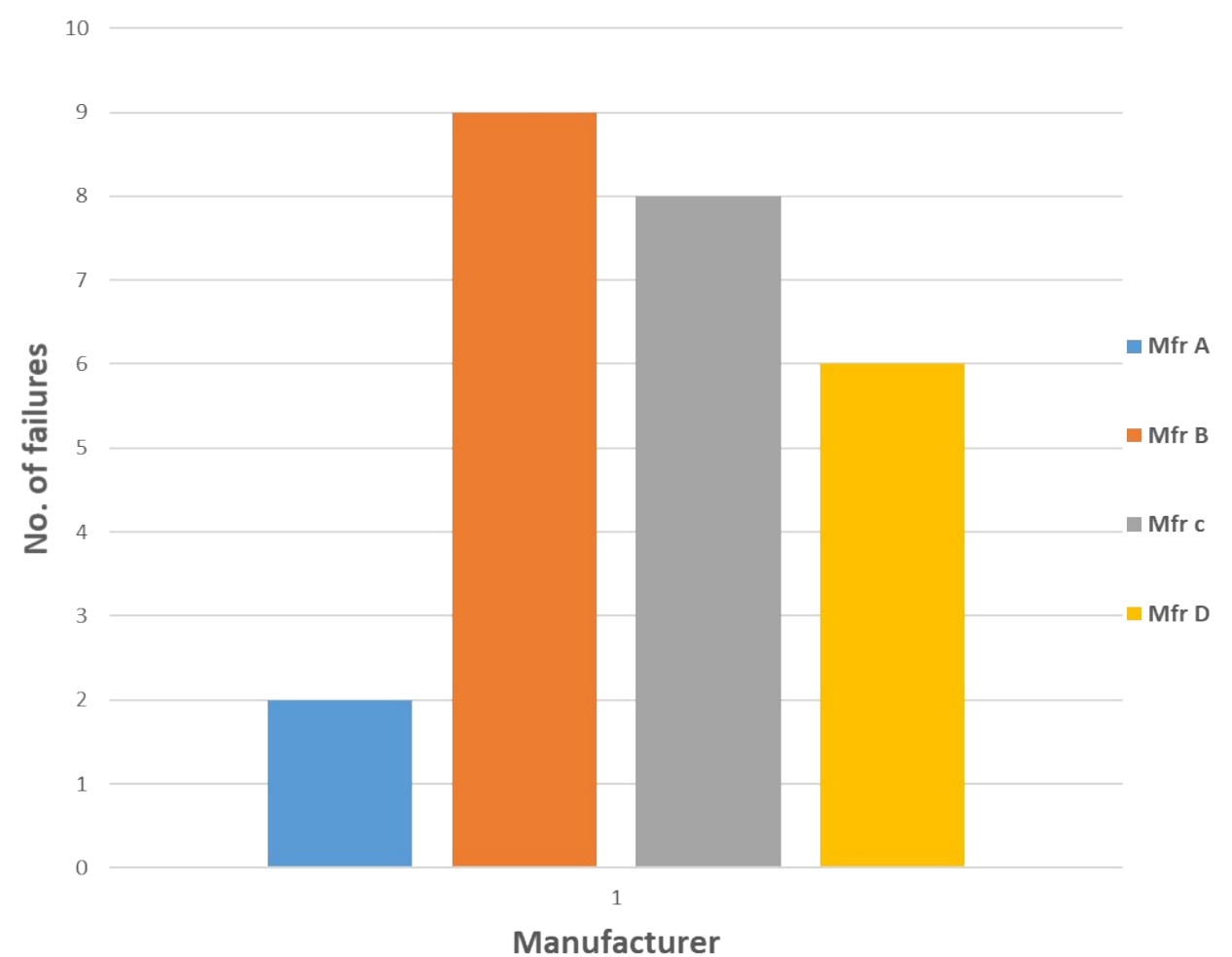
Insulator Failure Analysis

MSETCL Asset – Failures Manufacturer-wise

MSETCL porcelain failures - Manufacturer wise



MSETCL composite failures - Manufacturer wise



Key Observations

Feature	Porcelain Insulator	Polymeric (Composite) Insulator
Service Life	High: Consistently exceeds 20+ years in Indian terrain.	Lower: Subject to premature aging and material fatigue.
Reliability	Bathtub Curve: Long, stable "useful life" phase.	Accelerated Decay: Rapid deterioration from combined stresses.
Pollution Handling	Failure shall be linked to USCD vs. local pollution after 20 years.	Possible vulnerability to "Shed Bridging" during high monsoon humidity.
Phase Failure	High in Top/Bottom phases (Agricultural zones).	High in Top/Middle phases (General distribution).
Tension Strings	Superior: Minimal failures under high tensile load.	Critical: Higher failure risk due to stress.

Way Forward and Recommendations

■ **Porcelain Insulators:**

- Kindly do provide creepage distance and shed profile details (standard/deep/steep rib) at failed locations to quantify pollution withstand capability. This will enable data-driven optimization of insulator selection (MIL can support SPS measurements).

■ **Polymeric Insulators:**

- Pls do share dimensional and creepage details of failed units to assess CLRI performance under monsoon conditions. This will facilitate root-cause identification and design validation.

■ **Site Visit:**

- Conduct a joint inspection of selected failure locations to evaluate terrain- and phase-specific stress conditions. This will strengthen the technical basis of the failure analysis.

Way Forward and Recommendations

■ Hardware Fittings::

- Kindly do share dimensional details of corona rings, positing of corona and grading ring in field environments. This will enable assessment of electric field control and its impact on service life.

■ E-Field Analysis::

- In future, sharing of tower and conductor STEP drawings with the insulator supplier shall be encouraged. This will allow detailed electric field simulation and adequacy verification.

Thank You



Insulator Failure Analysis

Transmission Line Outages in 2025

IndiGrid & Adani Transmission Networks
68 Incidents Analyzed

Summary — 2025 Outages

68

Total Incidents
in 2025

85%

765kV Lines
(58 of 68)

73%

Adani Share
(50 of 68)

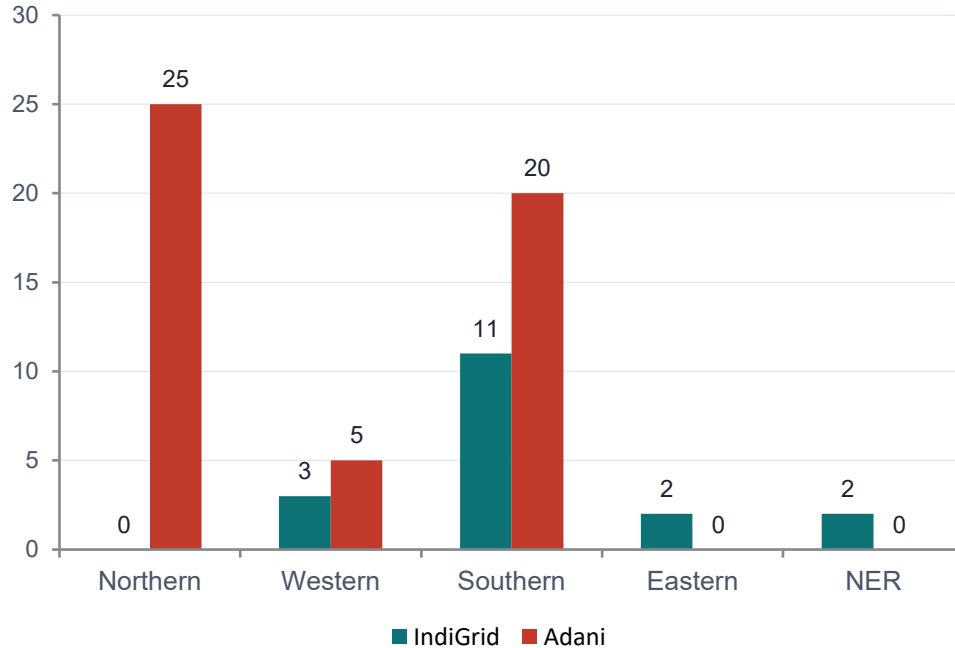
41%

Jul–Aug Peak
(27 incidents)

Key Findings

- Bikaner-Khetri (Adani) : 24 incidents — 8 planned + 16 forced outages, 673 insulators replaced on a single 765kV corridor
- WKTL Warangal cluster (Adani,) - 20 incidents — all Deccan insulators puncturing at just 2 years of age
- Raichur-Solapur (IndiGrid) — 6 events in 2025 alone vs 7 in prior 2 years combined; Spark-make insulators at 13–15 yr of life
- Monsoon / rainy season accounts for 76% of incidents (Mar–Sep); August is peak month at 15 incidents
- Deccan and Deccan Ent. insulators linked to 72% of 2025 failures (49 of 68) — systemic quality concern

Incident Distribution — Operator & Region

**18****IndiGrid**

SR: 11 | WR: 3 | ER: 2 | NER: 2

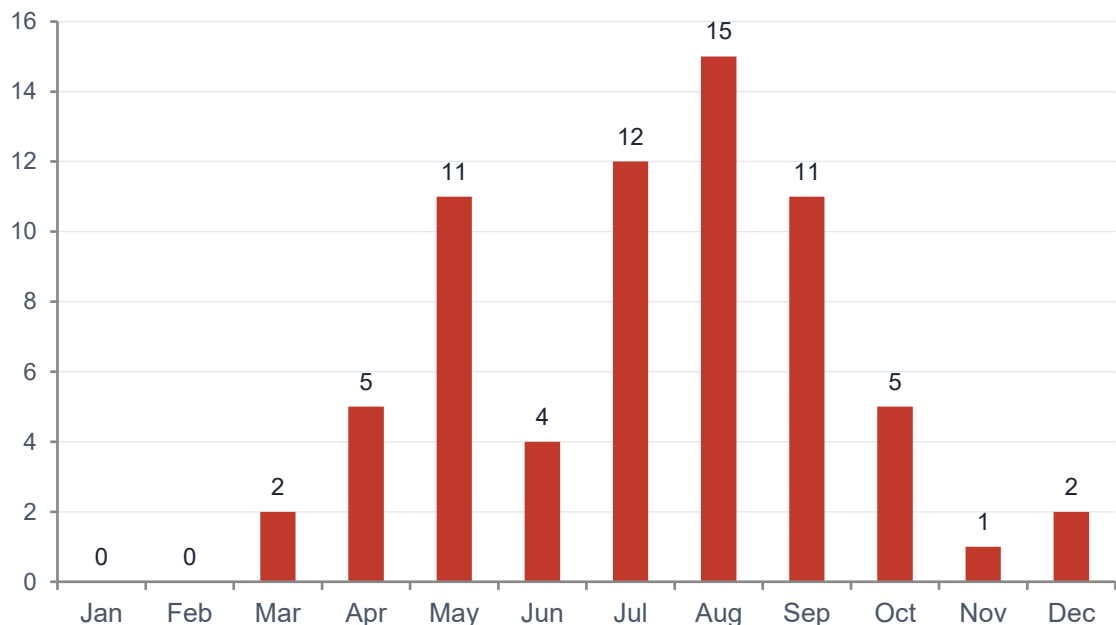
50**Adani**

NR: 25 | SR: 20 | WR: 5

Note: Adani NR 25 incidents include 8 planned outages for bulk insulator replacement on Bikaner-Khetri



Monthly Trend & Seasonal Pattern — 2025

**18****26%****Pre-Monsoon
(Mar–May)**

Rising trend as humidity increases

42**62%****Monsoon (Jun–
Sep)**Peak period — moisture ingress,
tracking, flashover**8****12%****Post-Monsoon
(Oct–Dec)**

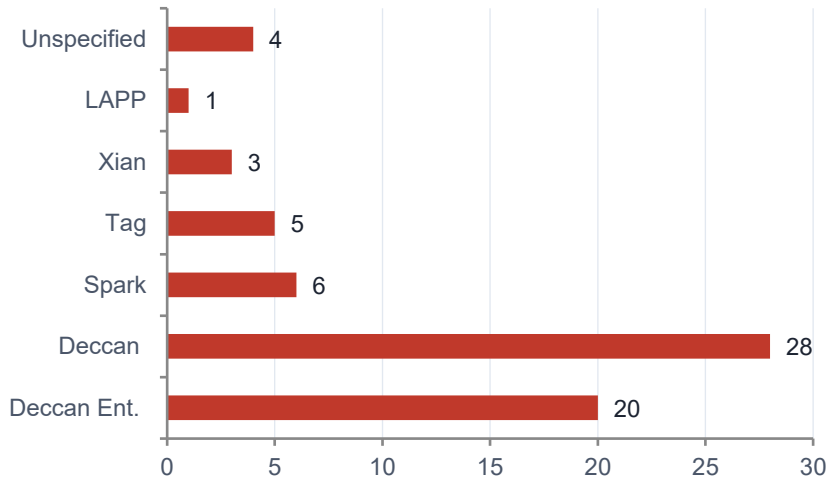
Decline but lingering moisture effects



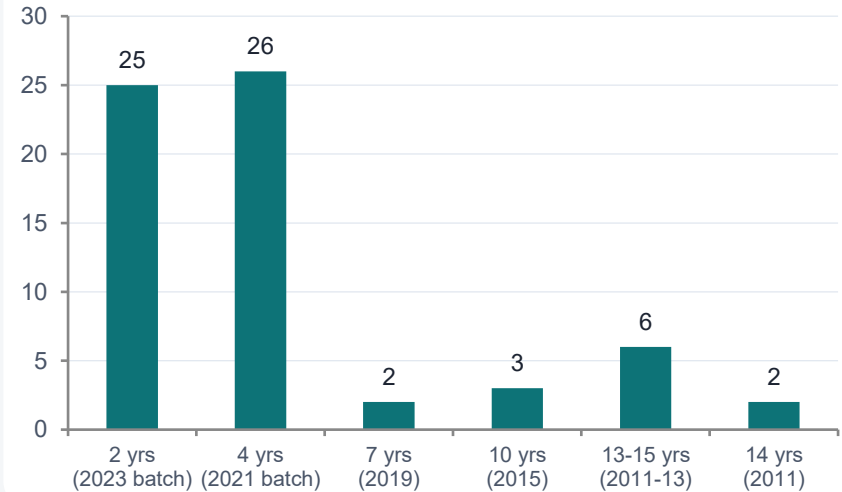
August 2025 was the single worst month with 15 incidents. The Jul–Sep window (38 events, 56%) infers that monsoon-driven moisture ingress and contamination are the primary environmental aggravators for composite insulator failure on EHV transmission lines.

Manufacturer & Insulator Age — 2025 Failures

Failures by Manufacturer (2025)



Failures by Insulator Age / Batch (2025)



Critical:

Deccan Enterprises and Deccan accounts for 72% of 2025 failures (49 of 68). Critically, the 2021 batch (Bikaner-Khetri, SM Nagar — 26 failures at 4 yrs) and 2023 batch (WKTL Warangal, Koppal — 25 failures at 2 yrs) together represent 75% of all 2025 incidents. These recent commissioning batches are exhibiting an alarming premature failure rate far below the expected 25–30 year composite insulator design life.



Line-wise Failure Summary — 2025

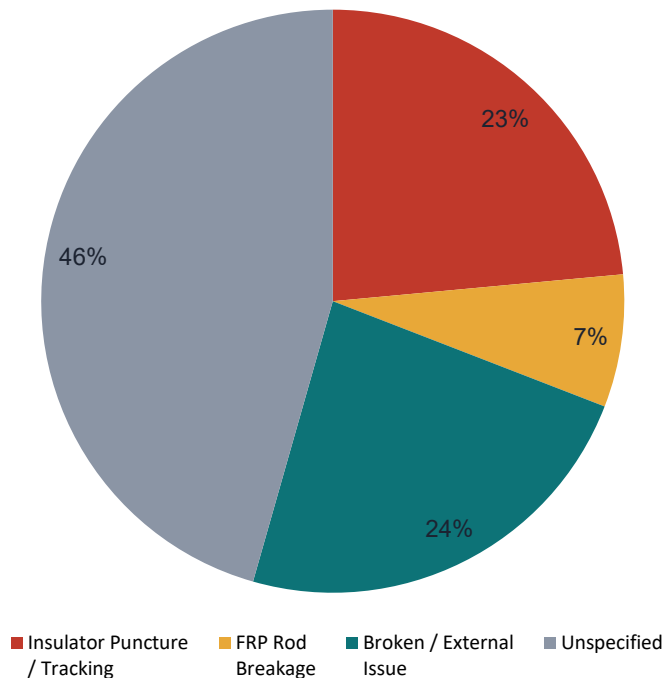
Line / Element	Operator	Region	kV	Count	Make	Age	Peak Months	Major Failure Mode
765kV Bikaner-Khetri Ckt-1	Adani	NR	765	12	Deccan	~4 yr	May–Oct	Broken insulator (673 replaced)
765kV Bikaner-Khetri Ckt-2	Adani	NR	765	12	Deccan	~4 yr	Jun–Dec	Broken insulator
765kV Raichur-Solapur	IndiGrid	WR-SR	765	6	Spark	13-15 yr	Mar–May	External issue / disk damage
765kV Warangal-Warora Ckt-2	Adani	WR-SR	765	6	Deccan Ent.	2 yr	Apr–Sep	Insulator puncture & tracking
765kV Warangal-Warora Ckt-1	Adani	WR-SR	765	5	Deccan Ent.	2 yr	Mar–Sep	Insulator puncture & tracking
765kV Maheshwaram-Warangal	Adani	SR	765	5	Deccan Ent.	2 yr	May–Sep	Insulator puncture & tracking
400kV Koppal-Nardera Ckt-1&2	IndiGrid	SR	400	5	Tag	2 yr	Jul–Sep	External issue
765kV Jabalpur-Bina / Dhule-Vadodara	IndiGrid	WR	765	3	Xian	10 yr	Jul–Aug	FRP rod broken (conductor side)
765kV Jharsuguda-Raipur	IndiGrid	ER	765	2	Deccan	7 yr	Apr, Dec	FRP rod broken
400kV Warangal-Warangal(New) / Chilakaluripeta	Adani	SR	400/765	4	Deccan Ent.	2 yr	Jul–Aug	Insulator puncture
400/765kV WR Lines (Kharghar / Padghe / Lonikhand)	Adani	WR	400/765	5	LAPP/Various	14 yr	May–Aug	Broken insulator (MSETCL/PGCIL towers)
400kV SM Nagar / Bus Reactor (NER)	IndiGrid	NER	400	2	Deccan	4 yr	May	Pilot insulator punctured

⚡ Failure Modes & Technical Analysis — 2025

Annexure-IV (Page 150 of 164)

Annexure-VII

2025 Failure Modes



Insulator Puncture / Tracking (24%)

Primary mode in WKTL Warangal & Raichur-Solapur. Contamination + moisture → partial discharge → carbonized tracking path → flashover.

FRP Rod Brittle Fracture (7%)

Xian-make (Jabalpur-Bina, Dhule-Vadodara) and Deccan 160kN (Jharsuguda-Raipur). Rod breaks.

Broken / External Issue (24%)

Bikaner-Khetri dominant. Attributed to external factors but likely includes undiagnosed manufacturing defects — 673 insulators replaced in bulk suggests systematic batch failure, not isolated events.

Unspecified (46%)

Major data gap — 31 of 68 incidents have no specific failure reason recorded. Analysis of recovered samples and improved reporting protocols are critical to close this gap.

Climate Correlation (2025)

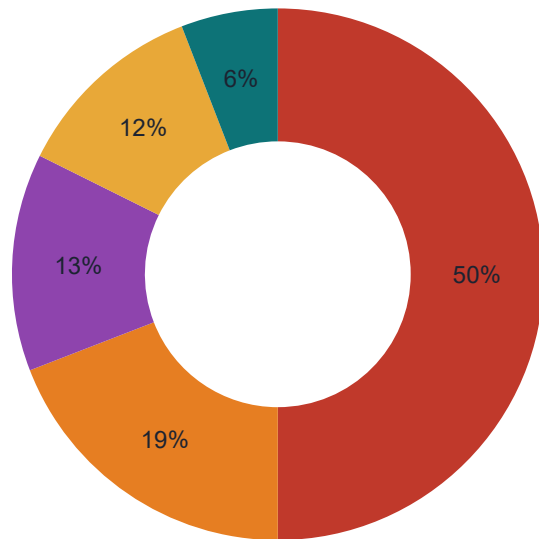
Monsoon/Rainy/Cloudy: 25 (37%) | Normal: 11 (16%) | Not reported: 32 (47%)

Rainy/cloudy climate explicitly cited in 25 events. Monsoon season (Jul-Sep) concentrates 56% of all incidents even where climate wasn't recorded, confirming humidity/moisture as the dominant environmental stressor.



Outage Classification & Remedial Response — 2025

2025 Outage Classification (n=68)



■ Forced ■ Insulator Tracking ■ Emergency ■ Planned ■ Other

56 **82%** **Unplanned Events**

Trip + Forced + Tracking + Emergency

8 **12%** **Planned Outages**

All on Bikaner-Khetri for bulk insulator replacement (673 nos.)

13 **19%** **Insulator Tracking**

All on WKTL Warangal lines

Thank You

Insulator Failure Analysis — 2025 Line Outages
IndiGrid & Adani Transmission | 68 Incidents



CEA 2nd meeting – 12-02-2026

Proactively Enhancing Reliability of Composite Insulators

Deccan submits the following summary highlighting additional tests, design improvements, and quality assurance practices being implemented beyond existing utility specifications and IEC requirements.

❑ Additional Tests during acceptance test

1. High voltage test on Composite insulators for Evaluation of Defects in FRP rods and Interfaces of composite insulators with IR camera.
2. Water diffusion test on complete unit
3. Acid resistance test (with 1M HNO₃)
4. Shear Test
5. Peel Test

❑ Additional Routine Manufacturing Tests

1. Peel Test at Room Temperature
2. Peel Test after 100 hours Boiling
3. NDT-based minimum sheath thickness verification and sheath thickness uniformity

❑ **Enhanced Incoming Raw Material Inspection – FRP Rods** (*Monthly 2 Lots-Based Selection*)

Every month, **FRP rod lots are randomly need to be selected by officials**, and the following **comprehensive factory tests** are carried out before lot acceptance:

- | | |
|---|--|
| 1. Visual Examination | 8. Specific Gravity Test |
| 2. Verification of Dimensions | 9. Glass Content Test |
| 3. Dye Penetration Test | 10. Water Absorption Test |
| 4. Brittle Fracture Resistance Test | 11. Tensile Strength Test |
| 5. Water Diffusion Test | 12. Flexural Strength Test |
| 6. Dry Power Frequency Test on FRP Rods | 13. Glass Transition Temperature (Tg) Test |
| 7. Hardness Test | 14. Boron Content Test |
| | 15. Void Content Test |

👉 This ensures **raw material robustness well before insulator manufacturing begins.**

❑ Design Improvements Implemented

1. Higher galvanization for coastal/polluted regions
2. Sheath thickness: 5 mm (NDT ensured), Shed root ≥ 6 mm, Shed tip ≥ 2.5 mm
3. Silicone rubber water absorption $< 0.25\%$
4. In-house FRP rods with $T_g \geq 140^\circ\text{C}$
5. Project-specific Electric Field Management (EFM)

❑ Conclusion

1. Enhanced tests beyond IEC & utility specifications
2. Supports IEC 61109:2025 based standardization
3. Focus on interface integrity & raw material robustness

Thank you



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Insulators & its purpose ...

Type of Insulators

Organic Materials :

- Silicon Rubber Insulators

Inorganic Materials

- Ceramic insulators

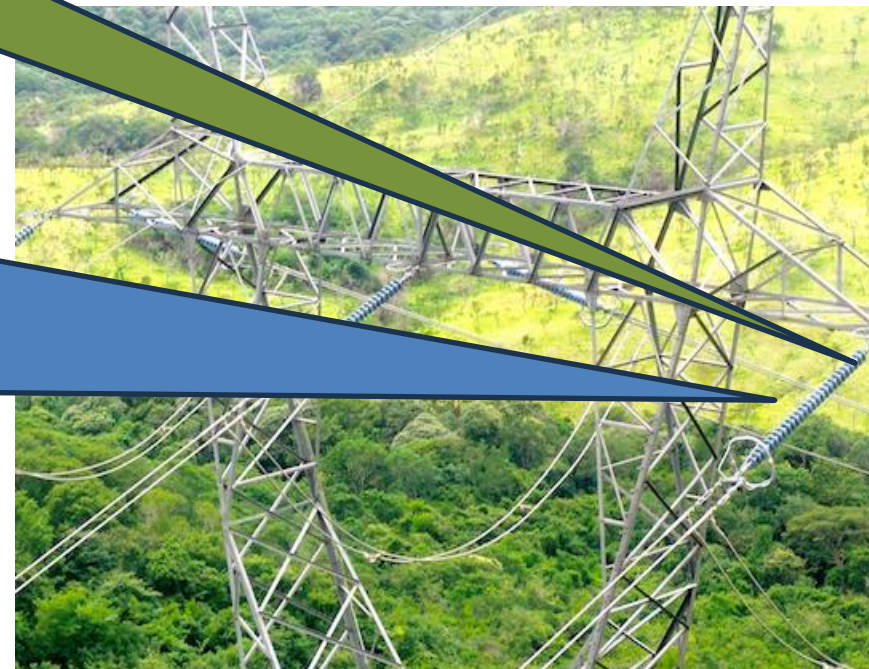
Hy-brid Materials

- RTV Coated Ceramic insulators

- Insulators provide **mechanical support** both in dead end and live end against wind load and line vibration.
- Insulators provide **electrical insulation and protection** against electrocution

Insulators are experienced with :

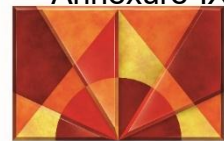
- THERMAL STRESS owing to change in temperature.
- ENVIRONMENTAL STRESS due to UV rays , Pollution , acid rain
- PHYSICAL STRESS due to contacts of bird / sand storms
- MECHANICAL STRESS due to various load





Maintenance, Reliability, and Predictability (basis of shared data)

- Ceramic insulators in use are mostly designed with 16mm/kV.
 - Service life of insulators are beyond 35 years in most cases.
 - Their ageing is gradual and predictable.
- CLRI used are mostly designed with 25-31mm/kV and ideally should exhibit better flashover performance.
 - Service life varying from 3-11 years and most failures happened within 3 years of operation.
 - Unpredictable failures and ageing observed.
- Diagnostic tools such as infrared (IR) / Thermal scanning have limitations and weak correlation with actual failure modes. Since April 2014 almost 2.09* lac ckt kms line has been constructed (>220kV). IR/Thermal scanning even atleast twice a year across variety of terrain is not only a humongous task but highly expensive – definitely a cost burden to the AM division. Its feasibility also need to be ascertained. (* Ref PIB, Delhi posted 22 Jan 2026)
- Traceability and failure analysis are well established for ceramic insulators, while similar systems for CLRI remain limited.



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Product Traceability at ABI ... Unique among industry



9875980018

2D Barcode

Motorola-
HHT ScannerInsulator
Before firingInsulator
After firing

Uniqueness about Bar Coding at ABI

- First time implemented in High Voltage Porcelain Insulator Industry.
- Improvement in WIP tracking, controlling Production Planning
- Elimination of approx. 700 manual entry and paperwork



Economic and Lifecycle Considerations

- CLRI offer lower initial cost and installation savings, their shorter and uncertain service life can lead to –
 - Multiple replacements during the life of a transmission asset
 - Increased outage, shutdown, and maintenance costs
 - Reduced line availability and higher system risk
- Ceramic insulators, despite higher upfront cost, typically provide lower total cost of ownership (TCO) due to long life, fewer replacements, and stable performance.

*If we **consider** a transmission line of 100km of 400kV transferring power of 500MW uses 120kN type insulator – it is seen that the replacement cost is 312 times more in case of CLRI over ceramic insulators.*

** Ref India foundation , issue April 2018*

Additional pain to the society for every replacements :

- Loss of agricultural crops & economic loss to the farmers
- Exposure to risk for gangman while working in the most difficult condition
- Risk of theft of conductor/ground wire (high valued items) during shutdown period
- Nevertheless – A weak grid and surged non-productive time leading to process inefficiencies at large



Global references ...

Country	Prevalent Insulator Technology
USA	Combination of Ceramic & CLRI
Bangladesh	Ceramic
Nepal	Ceramic is dominant while uses both
Srilanka	Ceramic is dominant while CLRI in distribution lines
Thailand	Ceramic
Malaysia	Ceramic
Indonesia	Ceramic is dominant , CLRI is distribution lines
Phillipines	Ceramic is dominant , CLRI has very limited usage
Vietnam	Ceramic & CLRI is used but recently shifting to ceramic
Saudi	Ceramic & CLRI is used but recently shifting to ceramic



*Presented By –
Chandan Banerjee
Regional Head – Aditya Birla Insulators*

Annexure-V (Page 1 of 4)

Composite Insulator Failures : Year 2025												
Sl. No	Region	Voltage Level	Line Name	Date of Failure	Make	Insulator Type	Batch Year	Loc. No.	Age (in years)	Season/Condition	Corrective Action	Failure Type
1	NR-2	765kV	765kV MEERUT-MOGA	11-May-2025	Olectra	Composite	2014	796	11	Summer	Replaced	Electrical
2	SR-2	400kV	400kV PAVAGADA-HIRIYUR-1	11-May-2025	Deccan	Composite	2018		7	Summer	Replaced	Electrical
3	ER-2	765kV	765kV MEDINIPUR-NEW JEERAT-2 (TE)	22-May-2025	Deccan	Composite	2018	4	7	Rainy	Replaced	Electrical
4	ER-1	765kV	765kV MEDINIPUR-NEW RANCHI-1 (TE)	24-May-2025	Deccan	Composite	2018	194	7	Rainy	Replaced	Electrical
5	ER-2	765kV	765kV MEDINIPUR-NEW JEERAT-2(TB)	25-May-2025	Deccan	Composite	2018	242	7	Rainy	Replaced	Electrical
6	SR-2	400kV	400kV MYSORE-HIRIYUR	11-Jun-2025	Deccan	Composite	2018	513	7	Rainy	Replaced	Electrical
7	ER-1	765kV	765kV MEDINIPUR-NEW RANCHI-2 (TE)	1-Jul-2025	Deccan	Composite	2019	54	6	Rainy	Replaced	Electrical
8	NR-3	400kV	400kV Balia-Sohawal-2	1-Jul-2025	Deccan	Composite	2018	372	7	Rainy	Replaced	Electrical
9	WR-2	220kV	220kV Vapi-Kharadpada (DNH)	4-Jul-2025	ABI	Composite	2019	41	6	Rainy	Replaced	Electrical
10	SR-2	400kV	400kV Narendra-Guttur (KPTCL)-2	4-Jul-2025	Deccan	Composite	2015	266	10	Rainy	Replaced	Electrical
11	ER-2	400kV	400kV Medinipur-Chanditala(WBSETCL)	5-Jul-2025	Deccan	Composite	2018	60	7	Rainy	Replaced	Electrical
12	NR-3	400kV	400kV Orai-Orai(UPPTCL)-1	5-Jul-2025	Deccan	Composite	2021	D-26	4	Rainy	Replaced	Electrical
13	WR-1	400kV	400kV Bhadrawati-Parli-1	7-Jul-2025	Deccan	Composite	2017	869	8	Rainy	Replaced	Electrical
14	SR-1	400kV	400kV Nellore PS-TPCIL-2	9-Jul-2025	Deccan	Composite	2018	67	7	Rainy	Replaced	Electrical
15	Odisha	400kV	400kV Dubiri (OPTCL)-Pandiabili-1	10-Jul-2025	Deccan	Composite	2019	665	6	Rainy	Replaced	Electrical
16	NR-1 G1	400kV	400kV MEERUT-MANDOLA-2	12-Jul-2025	Deccan	Composite	2020	24	5	Rainy	Replaced	Electrical
17	NR-2	765kV	765kV Meerut-Moga	16-Jul-2025	Olectra	Composite	2014	2	11	Rainy	Replaced	Electrical
18	NR-1	400kV	400kV BAMNOLI (DTL)-TUGHLAKABD-	17-Jul-2025	Deccan	Composite	2018	8	7	Rainy	Replaced	Electrical
19	NR-3	400kV	400kV Kanpur-Ballabgarh-1	18-Jul-2025	Deccan	Composite	2017	397	8	Rainy	Replaced	Electrical
20	ER-1	400kV	400kV Durgapur-Kahalgaon NTPC-2	18-Jul-2025	Deccan	Composite	2019	79	6	Rainy	Replaced	Electrical
21	ER-2	400kV	400kV New Jeerat-Subhashgram-1	19-Jul-2025	Deccan	Composite	2017	115	8	Rainy	Replaced	Electrical
22	NR-3	400kV	400kV Kanpur-Ballabgarh-3	22-Jul-2025	Deccan	Composite	2011	296	14	Rainy	Replaced	Electrical
23	Odisha	400kV	400kV Talcher(NTPC)-Rourkela-1	23-Jul-2025	Deccan	Composite	2019	260	6	Rainy	Replaced	Electrical
24	SR-2	400kV	400kV PUGALUR HVDC-THIRUVALAM	23-Jul-2025	Deccan	Composite	2019	415	6	Rainy	Replaced	Electrical
25	NR-3	400kV	400kV Kanpur-Ballabgarh-1	25-Jul-2025	Deccan	Composite	2012	374	13	Rainy	Replaced	Electrical
26	WR-2	400kV	400kV New Navsari GIS- Magarwada-1	26-Jul-2025	Deccan	Composite	2023	38/0	2	Rainy	Replaced	Electrical
27	SR-2	400kV	400kV Pugalur(HVDC)-Thiruvalem-2	27-Jul-2025	Deccan	Composite	2019	13	6	Rainy	Replaced	Electrical

Annexure-V (Page 2 of 4)

Sl. No	Region	Voltage Level	Line Name	Date of Failure	Make	Insulator Type	Batch Year	Loc. No.	Age (in years)	Season/Condition	Corrective Action	Failure Type
28	NR-3	400kV	400kV Motihari(DMTCL)-Gorakhpur-2	28-Jul-2025	Deccan	Composite	2018	890	7	Rainy	Replaced	Electrical
29	NR-1	400kV	400kV Hisar-Bhawadi-3	29-Jul-2025	Olectra	Composite	2012	660	13	Rainy	Replaced	Electrical
30	NR-3	400kV	400kV Auraiya-Agra-2	29-Jul-2025	Deccan	Composite	2016	67	9	Rainy	Replaced	Electrical
31	NR-2	765kV	765kV MEERUT-MOGA	31-Jul-2025	Olectra	Composite	2014	671	11	Rainy	Replaced	Electrical
32	WR-2	400kV	400kV MAGARWADA-BOISAR-1	3-Aug-2025	Deccan	Composite	2018	68	7	Rainy	Replaced	Electrical
33	ER-1	400kV	400kV BIHARSHARIF-MUZAFFARPUR	3-Aug-2025	Deccan	Composite	2019	137	6	Rainy	Replaced	Electrical
34	NR-3	400kV	400kV GORAKHPUR-GORAKHPUR (U	4-Aug-2025	Deccan	Composite	2021	65	4	Rainy	Replaced	Electrical
35	SR2	400kV	400kV PUGALUR-ARASUR-1	5-Aug-2025	Deccan	Composite	2019	114	6	Rainy	Replaced	Electrical
36	WR2	400kV	400kV CHITTORGARH-NEEMUCH-2 (T	6-Aug-2025	ABI	Composite	2022	217	3	Rainy	Replaced	Electrical
37	ER1	400kV	400kV MOTIHARI (DMTCL)-GORAKHP	7-Aug-2025	Deccan	Composite	2018	890	7	Rainy	Replaced	Electrical
38	SR2	400kV	400kV NNTPS (NLC)-ARIYALUR-2	7-Aug-2025	Deccan	Composite	2019	193	6	Rainy	Replaced	Electrical
39	SR1	765kV	765kV C'PETA-KADAPA GIS-2 (TBCB)	9-Aug-2025	Deccan	Composite	2018	527,673 & 542	7	Rainy	Replaced	Electrical
40	ER2	400kV	400kV NEW JEERAT-SUBHASHGRAM	10-Aug-2025	Deccan	Composite	2019	161	6	Rainy	Replaced	Electrical
41	SR2	400kV	400kV YELAHANKA GIS-TUMKUR-1	10-Aug-2025	Deccan	Composite	2018	62	7	Rainy	Replaced	Electrical
42	NR-3	400kV	400kV BALIA-SOHAWAL-1	10-Aug-2025	Deccan	Composite	2018	372	7	Rainy	Replaced	Electrical
43	SR2	400kV	400kV MYSORE-HIRIYUR	12-Aug-2025	Deccan	Composite	2018	180,290	7	Rainy	Replaced	Electrical
44	NR3	765kV	765kV BALIA-VARANASI	13-Aug-2025	Pheonix	Composite	2014	278	11	Rainy	Replaced	Electrical
45	NR3	400kV	400kV KANPUR-BALLABHGARH-3	14-Aug-2025	Deccan	Composite	2011	315	14	Rainy	Replaced	Electrical
46	NR3	765kV	765kV RAMPUR GIS-HAPUR (UPPTCL	15-Aug-2025	Deccan	Composite	2022	99	3	Rainy	Replaced	Electrical
47	ER2	400kV	400KV BERHAMPORE-BEHRAMARA (	15-Aug-2025	Deccan	Composite	2019	199	6	Rainy	Replaced	Electrical
48	NR3	765kV	765kV RAMPUR GIS-HAPUR (UPPTCL	16-Aug-2025	Deccan	Composite	2023	57,38	2	Rainy	Replaced	Electrical
49	WR2	400kV	400kV NEW NAVSARI GIS-MAGARWA	23-Aug-2025	Deccan	Composite	2023	38	2	Rainy	Replaced	Electrical
50	SR-1	400kV	Simhadri- Venmagiri-1	26-Aug-2025	Deccan	Composite	2018	417	7	Rainy	Replaced	Electrical
51	NR-3	400kV	Auriya- Agra-2	26-Aug-2025	Deccan	Composite	2016	193	9	Rainy	Replaced	Electrical
52	NR-3	400kV	Auriya- Agra-2	26-Aug-2025	Deccan	Composite	2016	187	9	Rainy	Replaced	Electrical
53	WR-2	220kV	Guna- Shivpuri	27-Aug-2025	ABI	Composite	2020	146	5	Rainy	Replaced	Electrical
54	SR-1	400kV	Nellore PS- TPCIL-2	27-Aug-2025	Deccan	Composite	2020	15	5	Rainy	Replaced	Electrical
55	SR-2	400kV	Kadapa- Tumkur-2	3-Sep-2025	Deccan	Composite	2018	613	7	Rainy	Replaced	Electrical

Annexure-V (Page 3 of 4)

Sl. No	Region	Voltage Level	Line Name	Date of Failure	Make	Insulator Type	Batch Year	Loc. No.	Age (in years)	Season/Condition	Corrective Action	Failure Type
56	WR-2	400kV	Magarwada- Navsari	5-Sep-2025	Deccan	Composite	2023	19	2	Rainy	Replaced	Electrical
57	WR-2	400kV	Magarwada- Navsari	8-Sep-2025	Deccan	Composite	2023	30B	2	Rainy	Replaced	Electrical
58	WR-2	220kV	Navasari- Navasari 2	8-Sep-2025	ABI	Composite	2022	146	3	Rainy	Replaced	Electrical
59	SR-2	400kV	Pavagada- Mysore	9-Sep-2025	Deccan	Composite	2018	471	7	Rainy	Replaced	Electrical
60	SR-1	765kV	C'Peta- Kadapa-1	11-Sep-2025	Deccan	Composite	2018	676A	7	Rainy	Replaced	Electrical
61	WR-1	400kV	Dhariwal- Parli	11-Sep-2025	Deccan	Composite	2017	898	8	Rainy	Replaced	Electrical
62	WR-1	765kV	Wardha- Aurangabad-3	15-Sep-2025	Deccan	Composite	2021	706	4	Rainy	Replaced	Electrical
63	ER-2	400kV	Rangpo- Binaguri-2	15-Sep-2025	Deccan	Composite	2018	11	7	Rainy	Replaced	Electrical
64	NR-3	765kV	Lucknow- Ballia	24-Sep-2025	Deccan	Composite	2021	246	4	Rainy	Replaced	Electrical
65	ER-2	400kV	Mednipur- Chanditala 2	27-Sep-2025	Deccan	Composite	2018	69	7	Rainy	Replaced	Electrical
66	SR-2	400kV	Pavagada- Hariyur-1	27-Sep-2025	Deccan	Composite	2018	211	7	Rainy	Replaced	Electrical
67	NR-1	765kV	Bhadla2-Sikar-2 Line-2	30-Sep-2025	Deccan	Composite	2023	94	2	Rainy	Replaced	Electrical
68	ER-2	400kV	New Jeerat- Subhashgram -1	5-Oct-2025	Deccan	Composite	2018	195	7	Post - Monsoon	Replaced	Electrical
69	NR-1	765kV	Ajmer- Phagi-2	7-Oct-2025	Deccan	Composite	2018	320	7	Post - Monsoon	Replaced	Electrical
70	SR-1	400kV	C'Peta- Narsaraopet-2	14-Oct-2025	Deccan	Composite	2018	82	7	Post - Monsoon	Replaced	Electrical
71	SR-2	400kV	Pugalur HVDC- Thrivalum 2	16-Oct-2025	Deccan	Composite	2019	148	6	Post - Monsoon	Replaced	Electrical
72	SR-2	400kV	Pavagada- Devanhalli-1	17-Oct-2025	Deccan	Composite	2018	14	7	Post - Monsoon	Replaced	Electrical
73	SR-2	400kV	Narendra- Gutur-2	21-Oct-2025	Deccan	Composite	2014	276	11	Post - Monsoon	Replaced	Electrical
74	ER-2	400kV	Rangpo- Binaguri-1	22-Oct-2025	Deccan	Composite	2019	292	6	Post - Monsoon	Replaced	Electrical
75	SR-1	400kV	Kadapa- Tumkur-1	23-Oct-2025	Deccan	Composite	2018	16	7	Post - Monsoon	Replaced	Electrical
76	SR-1	400kV	Kadapa- Tumkur-1	28-Oct-2025	Deccan	Composite	2018	22	7	Post - Monsoon	Replaced	Electrical
77	SR-1	400kV	Kadapa- Tumkur-2	28-Oct-2025	Deccan	Composite	2018	632	7	Post - Monsoon	Replaced	Electrical
78	NR-2	220kV	Sarna- Hiranagar	31-Oct-2025		Composite		99		Winter/Fogg	Replaced	Electrical
79	NR-3	400kV	Auraiya (NTPC)-Agra-2	31-Dec-2025	Deccan	Composite	2015	127	10	Winter/Fogg	Replaced	Electrical

Annexure-V (Page 4 of 4)

Porcelain Disc Insulator Failures : Year 2025											
Sl. No	Region	Voltage Level	Line Name	Date of Failure	Make	Insulator Type	Batch Year	Loc. No.	Age (in years)	Corrective Action	Failure Type
1	NR-1	765kV	Koteshwar - Meerut#1	01 January 2025	BHEL	Disc	1999	120	26	Replaced	Decapped
2	NR-3	765kV	Ballia- Bhiwadi- Pole-2	03 January 2025	BHEL	Disc	2007	516	18	Replaced	Decapped
3	NR-3	400kV	Sasaram- Allahabad	07 January 2025	BHEL	Disc	1989	531	36	Replaced	Decapped
4	NER	400kV	Ballipara- Bongaiqaon # 4	08 January 2025	BHEL	Disc	2011	262	14	Replaced	Decapped
5	NR-3	±500kV	Ballia- Bhiwadi- Pole-1	15 January 2025	BHEL	Disc	2009	292	16	Replaced	Decapped
6	SR-1	400kV	Raichur- Gooty #2	21 January 2025	BHEL	Disc	2006	64	19	Replaced	Decapped
7	SR-1	400kV	Raichur- Gooty #2	21 January 2025	BHEL	Disc	2006	89	19	Replaced	Decapped
8	SR-1	400kV	Raichur- Gooty #2	01 February 2025	BHEL	Disc	2006	93	19	Replaced	Decapped
9	SR-1	400kV	Gooty-Neelamangala(KPTCL)	15 February 2025	BHEL	Disc	2002	668,670,671,690	23	Replaced	Decapped
10	WR-1	400kV	Jharsuguda-Raigarh-1	22 February 2025	WSI	Disc	2001		24	Replaced	Decapped
11	NER	132kV	Gohpur (Assam-1)- Nirjuli	13 March 2025	BHEL	Disc	1989	77	36	Replaced	Decapped
12	SR-1	500kV	Talchar-Kolar Pole-1	15 March 2025	BHEL	Disc	2001	1405	24	Replaced	Decapped
13	SR-2	400kV	Tirunelveli- Kottayam (KSEB) # 2	26 March 2025	BHEL	Disc	2004	69	21	Replaced	Decapped
14	SR-1	765kV	Nizamabad- Maheshwaram # 2	15 May 2025	BHEL	Disc	2001	107	24	Replaced	Decapped
15	ER-1	400kV	Chaibasa- Rourkela- 1	15 June 2025	JSI	Disc	1988	166	37	Replaced	Decapped
16	NER	400kV	Kathalguri-Mariani-2	26 June 2025	BHEL	Disc	1993	120	32	Replaced	Decapped
17	NER	400kV	Kathalguri-Mariani-2	14 July 2025	BHEL	Disc	1993	80	32	Replaced	Decapped
18	NER	400kV	Kathalguri-Mariani-2	02 August 2025	BHEL	Disc	1993		32	Replaced	Decapped
19	ER-1	400kV	Banka- Biharsharif # 1	04 August 2025	BHEL	Disc	2007	466	18	Replaced	Decapped
20	SR-1	400kV	Gooty Pavaqada#1	05 August 2025	BHEL	Disc	1989	129	36	Replaced	Decapped
21	NER	400kV	Misa- New Miriani # 2	16 August 2025	BHEL	Disc	1993	916	32	Replaced	Decapped
22	ER-1	220kV	Ara-Naubatpur(BGCL)-1	30 September 2025	JSI	Disc	2002	43	23	Replaced	Decapped
23	SR-2	400kV	Tirunelveli- Thiruvananthapuram	09 November 2025	BHEL	Disc	2004	256	21	Replaced	Decapped
24	SR-2	400kV	Karaikudi-Madurai	19 November 2025	SIL	Disc	1989	275	36	Replaced	Decapped
25	SR-1	400kV	Nellore-Sriperumbudur-2	22 November 2025	JSI	Disc	2021	134	4	Replaced	Decapped
26	WR-1	400kV	Kolhapur GiS- Mapusa-2	25 November 2025	BHEL	Disc	2001	190	24	Replaced	Decapped
27	ER-1	765kV	Gaya- Ballia	13 December 2025	BHEL	Disc	2011	329	14	Replaced	Decapped
28	NR-3	±500kV	Ballia-Bhiwadi Pole-2	16 December 2025	BHEL	Disc	2009	641	16	Replaced	Decapped
29	NR-3	765kV	Fatehpur- Agra # 1	16 December 2025	BHEL	Disc	2010	287	15	Replaced	Decapped
30	ER-1	400kV	Daltonganj- Sasaram #2	18 December 2025	BHEL	Disc	2011	79	14	Replaced	Decapped
31	NR-2	400kV	Kala Amb- Abdullapur # 2	18 December 2025	ABI	Disc	2012	412	13	Replaced	Decapped
32	ER-1	765kV	Gaya - Ballia	19 December 2025	BHEL	Disc	2011	406	14	Replaced	Decapped
33	SR-2	400kV	Kola- Mylasandra (KPTL)	25 December 2025	WSI	Disc	1986	602	39	Replaced	Decapped
34	SR-2	400kV	Kola- Mylasandra (KPTL)	28 December 2025	WSI	Disc	1989	603	36	Replaced	Decapped

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Sr. No.	Voltage Class	Finance Year	Name of Line	Length (KM)	Date of Commissioning	TRIPPING DATE	Month of Failed	Month of Incident	Year of Incident	Duration from date of Comm.	Duration Slab	TRIPPING TIME	Restoration DATE	Restoration Time	Outage Hrs. litram	Reason of Breakdown	PHASE	TYPE OF INSULATOR	MAKE	MFG	SOIL STRATA	TERRAIN CATEGORY	Arching Horn	TYPE OF TOWER	DIVISION	CIRCLE	Observation of Failed Insulator
1399	132KV	2024-25	AGRA - MAKDON	31.534	01-Mar-21	1-Jan-25	Jan, 2025	Jan	2025	3.84	0-5 Years	07.04	1-Jan-25	12.04	05.00	B/D DUE TO INSULATOR FAILURE AT LOC NO.8/TOP PHASE PORCELAIN JSI INDIA INSULATOR.	Bottom	Porcelain	JSI India	1974	Black Cotton	Agriculture	Installed	Suspension	Rafam	Indore	
1400	132KV	2024-25	BUJAWAR - HATTA	76.391	29-Sep-06	6-Jan-25	Jan, 2025	Jan	2025	18.28	15-20 Years	05.35	6-Jan-25	12.35	07.00	B/D due to Middle Phase Insulator Failed at loc. No. 180	Make	Porcelain	BCPL India	2012	Black Cotton	Agriculture	Installed	Suspension	Damoh	Gwalior	
1401	132KV	2024-25	DAMOH [132] - HATTA TAP (Diamond Cement)	55.958	16-Oct-81	17-Jan-25	Jan, 2025	Jan	2025	43.28	40-45 Years	06.49	17-Jan-25	11.54	05.05	B/D DUE TO INSULATOR FAILURE AT LOC NO.9/TOP PHASE PORCELAIN BHEL INDIA INSULATOR.	Top	Porcelain	BHEL India	1999	Black Cotton	Agriculture	Installed	Suspension	Damoh	Gwalior	
1402	132KV	2024-25	DEWAS [220 KV] - CHAPDA II	41.4	21-Dec-14	20-Jan-25	Jan, 2025	Jan	2025	10.09	10-15 Years	05.15	20-Jan-25	11.13	05.58	B/D DUE TO INSULATOR FAILURE AT LOC NO.21/BOTTOM PHASE POLYMER ABI INDIA INSULATOR	Bottom	Polymer	ABI India	2011	Black Cotton	Agriculture	Installed	Suspension	Indore	Indore	Punctured Silicon Rubber shed at End-fitting
1403	132KV	2024-25	PICHORE-SHIPURI [132 KV]	75.166	03-Sep-83	2-Jan-25	Jan, 2025	Jan	2025	41.36	40-45 Years	03.20	2-Jan-25	08.45	05.25	B/D DUE TO INSULATOR FAILURE AT LOC NO.196/TOP PHASE PORCELAIN SJ INDIA INSULATOR	Top	Porcelain	SJ India	1982	Black Cotton	Agriculture	Installed	Suspension	Gwalior	Gwalior	
1404	132KV	2024-25	SHAHUPURA-SHRINGAR	45.013	01-Aug-10	1-Jan-25	Jan, 2025	Jan	2025	14.43	10-15 Years	09.10	1-Jan-25	15.42	06.32	B/D due to loc. No. 165 P-B two other loc. Suspected to create in near future B/d at loc. No. 200 P-B & 205 P-B (Porcelain Insulator).	Make	Porcelain	JSI India	1974	Black Cotton	Agriculture	Installed	Suspension	Jabalpur	Jabalpur	
1405	132KV	2024-25	SHAJAPUR [220 KV] - BERCHEHA II	20.48	08-Apr-15	2-Jan-25	Jan, 2025	Jan	2025	9.75	5-10 Years	01.16	2-Jan-25	09.16	08.00	B/D DUE TO INSULATOR FAILURE AT LOC NO.10/TOP PHASE, DECIMER DECOSIL INDIA INSULATOR.	Top	Polymer	DECOSIL	2015	Black Cotton	Agriculture	Installed	Suspension	Ujjain	Bhopal	Punctured Silicon Rubber shed at End-fitting
1406	132KV	2024-25	SHAJAPUR-GAMESHA [CHANDGARH]-I	29.53	31-Mar-15	1-Jan-25	Jan, 2025	Jan	2025	9.76	5-10 Years	23.01	2-Jan-25	11.27	12.26	B/D DUE TO INSULATOR FAILURE AT LOC NO.15/TOP PHASE POLYMER PHOENIX INDIA INSULATOR.	Top	Polymer	PHOENIX India	2014	Black Cotton	Agriculture	Installed	Tension	Ujjain	Bhopal	Punctured Silicon Rubber shed at End-fitting
1407	132KV	2024-25	SHULALPUR [220 KV] - ARNIYAKALAN-I	28.343	30-May-04	2-Jan-25	Jan, 2025	Jan	2025	20.61	20-25 Years	19.20	3-Jan-25	02.33	07.13	B/D DUE TO INSULATOR FAILURE AT LOC NO.7/TOP PHASE PORCELAIN JSI INDIA INSULATOR	Top	Porcelain	BHEL India	2003	Black Cotton	Agriculture	Installed	Suspension	Ujjain	Bhopal	
1408	132KV	2024-25	TRIMARGARH [220 KV] - BUDHERA I	32.218	11-Nov-14	2-Jan-25	Jan, 2025	Jan	2025	10.15	10-15 Years	10.12	2-Jan-25	16.44	06.32	B/D DUE TO INSULATOR FAILURE AT LOC NO.20/ MIDDLE PHASE PORCELAIN JSI INDIA INSULATOR.	Make	Porcelain	IP India	2015	Lal Muram	Agriculture	Installed	Tension	Damoh	Gwalior	
1409	132KV	2024-25	TRIMARGARH [220 KV] - BUDHERA II	32.218	13-Feb-18	28-Jan-25	Jan, 2025	Jan	2025	6.96	5-10 Years	05.45	28-Jan-25	09.54	04.09	B/D DUE TO POLYMER INSULATOR FLASHOVER FOUND AT LOC NO.58/TOP PHASE POLYMER MAKE PHOENIX 2014.	Top	Polymer	PHOENIX India	2014	Black Cotton	Agriculture	Installed	Suspension	Damoh	Gwalior	Exposure of core owing to shed movement
1410	132KV	2024-25	UJJAIN [220 KV] - MAKDON	104.182	01-Mar-21	1-Jan-25	Jan, 2025	Jan	2025	3.84	0-5 Years	00.35	1-Jan-25	10.21	09.46	B/D DUE TO INSULATOR FAILURE AT LOC NO.19/TOP PHASE (I.L.O SECTION) PORCELAIN INSULATOR.	Bottom	Porcelain	IEC India	1996	Black Cotton	Agriculture	Installed	Suspension	Rafam	Indore	
1411	220KV	2024-25	BADNAGAR [220 KV] - RATLAM-II	41.63	11-Nov-19	1-Jan-25	Jan, 2025	Jan	2025	5.15	5-10 Years	07.42	1-Jan-25	12.14	04.32	B/D DUE TO INSULATOR FAILURE AT LOC NO.298/MIDDLE PHASE, PORCELAIN BHEL INDIA INSULATOR.	Make	Porcelain	BHEL India	2001	Black Cotton	Agriculture	Installed	Suspension	Rafam	Indore	
1412	220KV	2024-25	BINA 400KV-I, GUWA	129.367	30-Sep-03	1-Jan-25	Jan, 2025	Jan	2025	34.27	20-25 Years	06.32	1-Jan-25	12.04	05.32	B/D due to insulator failure at Loc. No. 155. M due to heavy foggs.	Make	Porcelain	BHEL India	2021	Black Cotton	Agriculture	Installed	Suspension	Bina	Gwalior	
1413	220KV	2024-25	MANDSOUR 400KV-1, NIPANYA (Meruti shakti I)	46.458	07-Aug-20	2-Jan-25	Jan, 2025	Jan	2025	4.41	0-5 Years	03.20	2-Jan-25	08.45	05.25	B/D DUE TO INSULATOR FAILURE AT LOC NO.196/TOP PHASE PORCELAIN SJ INDIA INSULATOR	Top	Polymer	Not Visible	Not Visible	Black Cotton	Agriculture	Installed	Suspension	Rafam	Indore	
1414	220KV	2024-25	AJRAJAPURA - MALANPUR	146.463	17-Nov-93	3-Jan-25	Jan, 2025	Jan	2025	31.15	30-35 Years	09.52	3-Jan-25	18.17	12.20	Breakdown due to insulator failure at Loc. No. 81.1 T Due to heavy foggs.	Top	Porcelain	BHEL India	1989	Normal	Agriculture	Installed	Suspension	Gwalior	Gwalior	
1415	132KV	2025-26	DAMOH [132]-HATTA TAP (Diamond Cement)	55.958	16-Oct-81	23-Feb-25	Feb, 2025	Feb	2025	43.39	40-45 Years	12.35	23-Feb-25	17.02	04.27	Breakdown due to insulator string failed at loc. No. 01 B	Bottom	Porcelain	NGK Japan	1963	Lal Muram	Plain	Installed	Tension	Damoh	Gwalior	
1416	132KV	2024-25	JACRA-MANDSAUR	57.52	25-Jan-82	2-Feb-25	Feb, 2025	Feb	2025	43.05	40-45 Years	04.28	2-Feb-25	11.38	07.10	B/D due to DISC INSULATOR FLASHOVER AT LOC NO.45/TOP PHASE PORCELAIN BIKANER INSULATOR INDIA INSULATOR	Top	Porcelain	BCPL India	Ja-05	Black Cotton	Agriculture	Installed	Suspension	Rafam	Indore	
1417	132KV	2024-25	JACRA-MANDSAUR	57.52	25-Jan-82	2-Feb-25	Feb, 2025	Feb	2025	43.05	40-45 Years	20.23	3-Feb-25	02.55	06.32	Breakdown due to INSULATOR FAILURE AT LOC NO.41/TOP PHASE PORCELAIN BHEL INDIA INSULATOR	Top	Porcelain	BHEL India	Jun-05	Black Cotton	Agriculture	Installed	Suspension	Rafam	Indore	
1418	220KV	2024-25	AJRAJAPURA - MALANPUR	146.463	17-Nov-93	19-Feb-25	Feb, 2025	Feb	2025	31.28	30-35 Years	02.21	19-Feb-25	15.01	12.40	B/D DUE TO INSULATOR FAILURE AT LOC NO.66/TOP PHASE PORCELAIN SJ INDIA INSULATOR	Top	Porcelain	JSI India	1992	Normal	Agriculture	Installed	Suspension	Gwalior	Gwalior	
1419	220KV	2024-25	BINA [PGCL]-I, SHIPURI	169.485	02-Oct-11	24-Feb-25	Feb, 2025	Feb	2025	13.41	10-15 Years	02.52	24-Feb-25	11.16	08.24	Breakdown due to insulator failed at loc. No. 237 / M	Make	Porcelain	IP India	2005	Black Cotton	Agriculture	Installed	Suspension	Bina	Gwalior	
1420	220KV	2024-25	INDORE 400 KV] - BADNAGAR	89.1	03-Dec-04	1-Feb-25	Feb, 2025	Feb	2025	20.18	20-25 Years	04.28	1-Feb-25	12.19	07.51	B/D DUE TO INSULATOR FAILURE AT LOC NO.184/TOP PHASE PORCELAIN INSULATOR	Top	Porcelain	ICE	Jul-05	Black Cotton	Agriculture	Installed	Suspension	Rafam	Indore	
1421	220KV	2024-25	INDORE 400 KV] - BADNAGAR	89.1	03-Dec-04	10-Feb-25	Feb, 2025	Feb	2025	20.2	20-25 Years	10.35	10-Feb-25	17.46	07.11	B/D DUE TO INSULATOR FAILURE AT LOC NO.184/TOP PHASE PORCELAIN INSULATOR	Top	Porcelain	ICE	Jul-05	Black Cotton	Agriculture	Installed	Suspension	Rafam	Indore	
1422	132KV	2024-25	GWALIOR [220KV-II] - DABRA	37.496	29-Aug-19	11-Mar-25	March, 2025	Mar	2025	5.54	5-10 Years	13.56	11-Mar-25	21.00	07.04	B/D DUE TO INSULATOR FAILURE AT TENSION LOC NO.13/TOP PHASE PORCELAIN BHEL INDIA INSULATOR	Top	Porcelain	BHEL India	1989	Normal	Plain	Installed	Tension	Gwalior	Gwalior	
1423	132KV	2024-25	PICHORE-BASAI RTS I	31.125	01-Oct-88	25-Mar-25	March, 2025	Mar	2025	36.5	30-35 Years	13.09	25-Mar-25	19.48	06.39	B/D DUE TO INSULATOR FAILURE AT LOC NO.34/TOP PHASE, PORCELAIN MAKE OF INSULATOR NOT VISIBLE	Top	Porcelain	LPL INDIA	1987	Normal	Agriculture	Installed	Tension	Bina	Gwalior	
1424	400KV	2024-25	ISP-NAUGDA	187.318	28-Jun-92	13-Mar-25	March, 2025	Mar	2025	32.73	30-40 Years	19.41	14-Mar-25	03.01	07.20	B/D DUE TO DISC INSULATOR FAILED AT LOC NO.223/TOP PHASE, PORCELAIN MAKE OF INSULATOR NOT VISIBLE	Top	Porcelain	SJ India	1989	Black Cotton	Agriculture	Installed	Suspension	Ujjain	Bhopal	
1425	220KV	2025-26	SAGAR 400 KV]- MAKRONIA RTS - II	7.758	05-Feb-93	3-Apr-25	April, 2025	Apr	2025	31.18	30-35 Years	06.11	3-Apr-25	10.31	04.20	Breakdown due to insulator string failed at loc. No. 04 T & 05 T	Top	Porcelain	IEC India	2008	Normal	Agriculture	Installed	Suspension	Damoh	Gwalior	
1426	132KV	2025-26	DEWAS MSP - RAUKHEDI	18.1	22-Jan-83	1-Apr-25	April, 2025	Apr	2025	42.22	40-45 Years	05.47	3-Apr-25	06.20	00.33	Tripping due to DISC INSULATOR FOUND FLASH OVER AT LOC NO.24 IN TOP PHASE.	Top	Porcelain	IP India	2005	Normal	Agriculture	Installed	Suspension	Indore	Gwalior	
1427	220KV	2025-26	AMARKANTAK - SIDHI	210.74	05-Dec-08	24-May-25	May, 2025	May	2025	16.65	15-20 Years	07.52	24-May-25	20.46	12.54	Tripping due to Fault Found Disc Flash Over At Loc. No. 145 V y ph	Bottom	Porcelain	BCPL India	2003	Black Cotton	Agriculture	Installed	Suspension	Saiba	Jabalpur	
1428	220KV	2025-26	HANDIA - BARIWAHA - I	107.047	05-Dec-06	4-May-25	May, 2025	May	2025	28.43	25-30 Years	18.17	5-May-25	10.55	15.38	Breakdown due to Fault Found Disc Insulator scattered.	Make	Porcelain	SJ India	Not Visible	Stony Soil	Forest	Installed	Suspension	Itarsi	Bhopal	
1429	220KV	2025-26	ITARSI 220 KV]- BARWAHA	191.324	27-Nov-08	4-May-25	May, 2025	May	2025	66.47	15-60 Years	19.18	5-May-25	11.27	10.58	Breakdown due to Insulator failure (disc insulator scattered).	Bottom	Porcelain	NOT JAPAN	1964	Stony Soil	Forest	Installed	Suspension	Itarsi	Bhopal	
1430	220KV	2025-26	OMKARESWAR HEP - KHANDWA 400 KV]	97.7	01-Apr-08	5-May-25	May, 2025	May	2025	17.1	15-20 Years	19.32	6-May-25	07.48	12.16	B/D DUE TO LIGHTNING, DISC INSULATOR STRING FAILED AT LOC NO. 65/ TOP PHASE	Top	Porcelain	BHEL India	2003	Black Cotton	Agriculture	Installed	Suspension	Barwaaha	Indore	
1431	220KV	2025-26	MANJURANA - KALMESWAR (UP TO MP BORDER)	18.523	21-Nov-13	28-May-25	May, 2025	May	2025	11.52	10-15 Years	16.14	29-May-25	07.10	14.56	B/D DUE TO INSULATOR FAILURE AT LOC NO.322/TOP PHASE PORCELAIN NOT VISIBLE INSULATOR	Make	Porcelain	MTC	1972	Stony Soil	Forest	Installed	Tension	Seoni	Jabalpur	
1432	220KV	2025-26	PITHAMPUR [SEC II] - RAJGARH(D)-PGCL	78.642	06-Dec-95	24-May-25	May, 2025	May	2025	29.48	25-30 Years	13.46	24-May-25	23.43	09.57	B/D DUE TO INSULATOR FAILURE AT LOC NO.8/TOP PHASE PORCELAIN JSI INDIA INSULATOR	Top	Porcelain	JSI India	2007	Black Cotton	Agriculture	Installed	Suspension	Indore	Indore	
1433	132KV	2025-26	ASHTA [220 KV] - ARNIYAKALAN I	19.641	30-May-05	4-May-25	May, 2025	May	2025	19.94	15-20 Years	18.23	5-May-25	13.07	18.44	B/D due to lightning, Disc insulator string failed at Tension loc. no. 13/TOP phase	Top	Porcelain	BHEL India	2003	Normal	Agriculture	Installed	Tension	Bhopal	Bhopal	
1434	132KV	2025-26	BADNAGAR [220 KV] - GAUTAMPURA I	23.23	26-May-04	5-May-25	May, 2025	May	2025	20.96	20-25 Years	21.16	6-May-25	14.18	17.02	B/D DUE TO LIGHTNING, DISC INSULATOR STRING FAILED AT LOC NO. 12/ MIDDLE PHASE	Make	Porcelain	BHEL India	2003	Black Cotton	Agriculture	Installed	Tension	Bhopal	Bhopal	
1435	132KV	2025-26	CHHEDOGAON [132 KV]- BHIKANGAON (DP LINE)	25.11	25-Apr-73	19-May-25	May, 2025	May	2025	52.1	60-65 Years	21.47	20-May-25	03.43	05.56	B/D DUE TO INSULATOR FAILURE AT LOC NO.59/TOP PHASE PORCELAIN JSI INDIA INSULATOR	Top	Porcelain	Made in China	1964	Hard Rock	Plain	Installed	Suspension	Barwaaha	Indore	
1436	132KV	2025-26	CHHINDWARA [132 KV] - UMRETH	29.928	18-Feb-16	27-May-25	May, 2025	May	2025	9.28	5-10 Years	21.28	28-May-25	01.10	03.42	B/D DUE TO INSULATOR FAILURE AT LOC NO.51/BOTTOM PHASE PORCELAIN JSI INDIA INSULATOR	Bottom	Porcelain	JSI India	1976	Normal	Plain	Installed	Suspension	Seoni	Jabalpur	
1437	132KV	2025-26	RAJGARH (D) - PETLAWAD	53.28	27-Mar-10	24-May-25	May, 2025	May	2025	15.17	15-20 Years	15.22	24-May-25	20.15	04.53	B/D DUE TO INSULATOR FAILURE AT LOC NO.124/TOP PHASE POLYMER SPARKIL INDIA INSULATOR	Top	Polymer	SPARKIL	Not Visible	Lal Muram	Agriculture	Installed	Suspension	Indore	Indore	Punctured Silicon Rubber shed along moulding line
1438	132KV	2025-26	RATLAM RTS - I	3	13-Apr-87	22-May-25	May, 2025	May	2025	38.13	35-40 Years	21.41	23-May-25	00.22	02.41	B/D DUE TO INSULATOR FAILURE AT LOC NO.8/TOP PHASE PORCELAIN JSI INDIA INSULATOR	Top	Porcelain	JSI India	1983	Black Cotton	Agriculture	Installed	Suspension	Rafam	Indore	
1439	220KV	2025-26	BETUL 220 KV]- CHICHOLI - I	26.55	3/30/2011	17-May-25	May, 2025	May	2025	14.14	10-15 Years	15.16	17-May-25	19.39	03.41	At loc. No. 84 Top Disc Insulator scattered due to lightning.	Top	Porcelain	W/S India	2008	Lal Muram	Plain	Installed	Suspension	Itarsi	Bhopal	
1440	132KV	2025-26	INDORE 400 KV]- BADNAGAR	89.1	03-Dec-04	14-Jun-25	June, 2025	Jun	2025	20.54	20-25 Years	18.40	15-Jun-25	01.12	06.32	B/D DUE TO INSULATOR FAILURE AT LOC NO.145/TOP PHASE PORCELAIN MAKE OF INSULATOR NOT VISIBLE	Top	Porcelain	AN-YUAN	2008	Black Cotton	Agriculture	Installed	Suspension	Indore	Indore	
1441	220KV	2025-26	ITARSI [PGCL] - BUDHANI [220 KV] -I	29.942	09-Feb-22	23-Jun-25	June, 2025	Jun	2025	3.37	0-4 Years	11.02	23-Jun-25	22.15	11.13	B/D DUE TO POLYMER INSULATOR FAILED AT 41 V PHASE MAKE DECCAN HYDRABAD 2021	Make	Polymer	DECCAN	2021	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	Punctured Silicon Rubber shed along moulding line
1442	220KV	2025-26	ITARSI [PGCL] - BUDHANI [220 KV] -I	29.942	09-Feb-22	3-Aug-25																					

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1464	132KV	2025-26	CHHEOGAON [132 KV]-BHIKANGAON (OP LINE)	25.11	25-Apr-73	29-Jul-25	July_2025	Jul	2025	52.3	50-55 Years	08/28	29-Jul-25	13/18	04/50	B/D DUE TO INSULATOR FAILURE AT LOC NO.79/MIDDLE PHASE.POLYMER ABH INDIA INSULATOR	Top	Porcelain	DECCAN	2021	Black Cotton	Agriculture	Installed	Tension	Barwaha	Indore	
1465	132KV	2025-26	CHHEOGAON [220KV]-SAORI	31.054	31-Jul-18	23-Jul-25	July_2025	Jul	2025	6.98	5-10 Years	23/52	24-Jul-25	06/55	07/03	B/D DUE TO INSULATOR FAILURE AT LOC NO.83/ TOP PHASE.POLYMER ABH INDIA INSULATOR	Made	Polymer	ABH India	2017	Hard Rock	Hill	Installed	Suspension	Seoni	Jabalpur	
1466	132KV	2025-26	CHHORE II [220 KV] -DEPALPUR [220 KV-I]	31.97	30-Dec-09	27-Aug-25	Aug_2025	Aug	2025	15.67	15-20 Years	16/05	27-Aug-25	22/04	05/59	B/D DUE TO LIGHTNING INSULATOR FAILURE AT LOC NO.86 & 96/TOP PHASE.PORCELAIN BIKANER INSULATOR INDIA INSULATOR	Top	Porcelain	ABH India	2017	Lat Marlam	Agriculture	Installed	Suspension	Indore	Indore	
1467	132KV	2025-26	JULWANIA [400 KV] - SENDHAWA [132 KV-I]	26.68	10-Jul-21	31-Jul-25	July_2025	Jul	2025	4.06	0-5 Years	04/07	31-Jul-25	07/42	03/35	B/D DUE TO INSULATOR FAILURE AT LOC NO.91/TOP PHASE.PORCELAIN BHEL INDIA INSULATOR	Top	Porcelain	W/S India	2010	Black Cotton	Agriculture	Installed	Suspension	Barwaha	Indore	
1468	132KV	2025-26	JULWANIA [400 KV] - SENDHAWA [220 KV-II]	37.043	10-Jul-21	28-Sep-25	Sept_2025	Sep	2025	4.22	0-5 Years	12/02	28-Sep-25	17/46	05/44	B/D DUE TO INSULATOR FAILURE AT LOC NO.108/MIDDLE PHASE (LOC NO. 108 TO PORTION) POLYMER ABH INDIA INSULATOR	Made	Polymer	ABH India	2018	Normal	Plain	Installed	Tension	Barwaha	Indore	Punctured Silicon Rubber shed at End-fitting
1469	132KV	2025-26	JULWANIA [220 KV] -TALAKPURA	21.002	20-Jan-16	13-Jun-25	June_2025	Jun	2025	9.4	5-10 Years	19/55	13-Jun-25	23/51	03/56	B/D DUE TO INSULATOR FAILURE AT LOC NO.217/TOP/MIDDLE/BOTTOM PHASE.PORCELAIN BHEL INDIA INSULATOR	Made	Polymer	BHEL India	2018	Normal	Agriculture	Installed	Tension	Barwaha	Indore	
1470	132KV	2025-26	KANWANI C I	13.35	30-Mar-19	29-Jul-25	July_2025	Jul	2025	6.34	5-10 Years	12/04	29-Jul-25	20/13	08/09	B/D DUE TO POLYMER INSULATOR FAILURE AT LOC NO.27/BOTTOM PHASE.POLYMER ABH INDIA INSULATOR	Bottom	Polymer	ABH India	2018	Black Cotton	Agriculture	Installed	Suspension	Indore	Indore	Punctured Silicon Rubber shed along insulating line
1471	132KV	2025-26	KATNI [400 KV] - (132KV) - SUEMNABAD CH - I	32.17	24-Oct-13	24-Sep-25	Sept_2025	Sep	2025	11.93	10-15 Years	22/00	25-Sep-25	03/54	05/54	B/D DUE TO INSULATOR FAILURE AT LOC NO.284/BOTTOM PHASE.PORCELAIN NGK JAPAN INSULATOR	Bottom	Porcelain	ABH India	2018	Black Cotton	Agriculture	Installed	Tension	Damoh	Gwalior	
1472	132KV	2025-26	KATNI [400 KV] - (132KV) - SUEMNABAD CH - II	32.17	24-Oct-13	24-Sep-25	Sept_2025	Sep	2025	11.93	10-15 Years	22/00	25-Sep-25	03/54	05/54	Breakdown due to Insulator Failure at loc. No. 284.	Bottom	Porcelain	NGK Japan	1961	Black Cotton	Agriculture	Installed	Suspension	Damoh	Gwalior	
1473	132KV	2025-26	KHARGONE - TALAKPURA	24.284	20-Dec-16	12-Jun-25	June_2025	Jun	2025	8.48	5-10 Years	19/10	13-Jun-25	03/02	07/52	B/D DUE TO INSULATOR FAILURE AT LOC NO.57/TOP/MIDDLE/BOTTOM PHASE.PORCELAIN SL INDIA INSULATOR	Bottom	Porcelain	NGK Japan	1961	Black Cotton	Agriculture	Installed	Suspension	Barwaha	Indore	
1474	132KV	2025-26	KHURLA - KHMILASA	20.943	28-Nov-19	14-Aug-25	Aug_2025	Aug	2025	5.72	5-10 Years	09/47	14-Aug-25	11/31	01/45	B/D DUE TO INSULATOR FAILURE AT LOC NO.42/TOP PHASE.POLYMER OTHER MAKE OF INSULATOR INSULATOR	Top, Middle, Bottom	Porcelain	SL India	1971	Black Cotton	Agriculture	Installed	Suspension	Bina	Gwalior	
1475	132KV	2025-26	MANDLA MANERI	77.59	05-Jul-23	15-Sep-25	Sept_2025	Sep	2025	2.2	0-5 Years	09/05	16-Sep-25	00/17	15/12	breakdown of line due to flash over polymer insulator at loc. no. 54, 57, 59 (Loc.No. 54)	Top	Polymer	GKEXPL	2024	Black Cotton	Agriculture	Installed	Suspension	Jabalpur	Jabalpur	
	132KV			77.59	05-Jul-23	15-Sep-25	Sept_2025	Sep	2025	2.2	0-5 Years		16-Sep-25			breakdown of line due to flash over polymer insulator at loc. no. 54, 57, 59 (Loc.No. 54)	Top	Polymer	GKEXPL	2024	Black Cotton	Agriculture	Installed	Suspension	Jabalpur	Jabalpur	
	132KV			77.59	05-Jul-23	15-Sep-25	Sept_2025	Sep	2025	2.2	0-5 Years		16-Sep-25			breakdown of line due to flash over polymer insulator at loc. no. 54, 57, 59 (Loc.No. 59)	Top	Polymer	GKEXPL	2024	Black Cotton	Agriculture	Installed	Suspension	Jabalpur	Jabalpur	
1476	132KV	2025-26	MANDSAUR - MALHARGARH	24.68	27-Dec-03	26-Jul-25	July_2025	Jul	2025	21.59	20-25 Years	10/33	26-Jul-25	12/48	02/15	B/D DUE TO INSULATOR FAILURE AT LOC NO.135/TOP PHASE.PORCELAIN ABH INDIA INSULATOR	Top	Polymer	DECCAN	2022	Black Cotton	Agriculture	Installed	Suspension	Ratlam	Indore	
1477	132KV	2025-26	MANDSAUR - BUDHA	39.279	12-Aug-21	7-Sep-25	Sept_2025	Sep	2025	4.07	0-5 Years	15/49	7-Sep-25	19/47	03/58	B/D DUE TO INSULATOR FAILURE AT LOC NO.88/BOTTOM PHASE.POLYMER ABH INDIA INSULATOR	Bottom	Polymer	ABH India	2019	Normal	Plain	Installed	Suspension	Ratlam	Indore	Punctured Silicon Rubber shed at End-fitting
1478	132KV	2025-26	MORENA [220 KV]-BANMORE -II	15.333	19-Feb-17	27-Sep-25	Sept_2025	Sep	2025	8.61	5-10 Years	13/02	27-Sep-25	18/27	05/25	B/D DUE TO INSULATOR FAILURE AT LOC NO.180/TOP PHASE.PORCELAIN BHEL INDIA INSULATOR	Top	Polymer	ABH India	2019	Black Cotton	Agriculture	Installed	Suspension	Gwalior	Gwalior	
1479	132KV	2025-26	MUGALYACHHAP [220 KV]-SEHORE	25.424	28-Jun-18	30-Jul-25	July_2025	Jul	2025	7.09	5-10 Years	05/49	30-Jul-25	14/41	08/52	Tripping due to INSULATOR FAILURE AT LOC NO.19/MIDDLE PHASE.POLYMER DECCOSIL INSULATOR	Middle	Polymer	Decosil	2015	Normal	Plain	Installed	Tension	Bhopal	Bhopal	
1480	132KV	2025-26	NAGDA [220 KV] - A LOT	37.447	25-Nov-91	28-Sep-25	Sept_2025	Sep	2025	33.87	30-35 Years	04/54	28-Sep-25	08/28	03/34	B/D DUE TO INSULATOR FAILURE AT LOC NO.30/TOP PHASE.PORCELAIN SL INDIA INSULATOR	Middle	Polymer	DECOSIL	2021	Normal	Agriculture	Installed	Suspension	Ujjain	Bhopal	
1481	132KV	2025-26	NIMRANI [220 KV] -JATAPURA PALASIA I	18.915	08-Nov-21	2-Aug-25	Aug_2025	Aug	2025	3.373	0-5 Years	10/52	2-Aug-25	17/41	06/32	Outage due to B/D due to INSULATOR FAILURE AT LOC NO.51/TOP PHASE.POLYMER DECCOSIL INSULATOR	Top	Porcelain	SL India	1989	Black Cotton	Agriculture	Installed	Suspension	Barwaha	Indore	
1482	132KV	2025-26	NIMRANI [220 KV] -JATAPURA PALASIA II	18.915	08-Nov-21	29-Jun-25	June_2025	Jun	2025	3.84	0-5 Years	16/18	30-Jun-25	02/46	10/28	B/D DUE TO INSULATOR FAILURE AT LOC NO.35/MIDDLE PHASE.POLYMER DECCOSIL INSULATOR	Top	Polymer	DECOSIL	Not Visible	Black Cotton	Agriculture	Installed	Suspension	Barwaha	Indore	Internal breakdown caused by tracking up the corehousing interface
1483	132KV	2025-26	NIMRANI [220 KV] -JATAPURA PALASIA I	18.915	08-Nov-21	8-Aug-25	Aug_2025	Aug	2025	3.75	0-5 Years	14/27	8-Aug-25	18/23	03/56	Outage due to Breakdown DUE TO INSULATOR FAILURE AT LOC NO.50/MIDDLE PHASE.POLYMER DECCOSIL INSULATOR	Middle	Polymer	DECOSIL	Not Visible	Black Cotton	Agriculture	Installed	Suspension	Barwaha	Indore	
1484	132KV	2025-26	PANAGAR [220 KV] -KATNI [132 KV]	80.99	17-Jan-04	20-Sep-25	Sept_2025	Sep	2025	21.69	20-25 Years	12/51	20-Sep-25	18/80	05/49	Breakdown due to Disc Insulator string failed at loc. No. 284	Made	Porcelain	DECOSIL	Not Visible	Black Cotton	Agriculture	Installed	Suspension	Damoh	Gwalior	
1485	132KV	2025-26	PICHORE-SHIRPUR [132 KV]	75.166	03-Sep-83	22-Jun-25	June_2025	Jun	2025	41.83	40-45 Years	06/26	22-Jun-25	17/42	11/16	B/D due to Disc string failed at Loc. No. 225 Tension Top, Middle & Loc. No. 225 Middle Phase (Loc. No. 225)	Top	Porcelain	NGK Japan	1961	Black Cotton	Agriculture	Installed	Suspension	Bina	Gwalior	
	132KV			75.166	03-Sep-83	22-Jun-25	June_2025	Jun	2025	41.83	40-45 Years		22-Jun-25			B/D due to Disc string failed at Loc. No. 228 Tension Top, Middle & Loc. No. 225 Middle Phase (Loc. No. 228)	Top	Porcelain	NGK Japan	1961	Black Cotton	Agriculture	Installed	Tension	Bina	Gwalior	
1486	132KV	2025-26	PITHAMPUR SEC3 [220 KV] - SEZ	8.86	10-Sep-16	31-Aug-25	Aug_2025	Aug	2025	8.98	5-10 Years	19/57	1-Sep-25	03/30	07/33	B/D DUE TO INSULATOR FAILURE AT LOC NO.238/TOP PHASE.POLYMER SRI INDIA INSULATOR	Bottom	Polymer	SRI India	2023	Story Soil	Forest	Installed	Tension	Indore	Indore	Exposure of core wiring to shed movement
1487	132KV	2025-26	PITHAMPUR SEC3 [220 KV] - SEZ	8.86	10-Sep-16	7-Sep-25	Sept_2025	Sep	2025	9	5-10 Years	18/22	8-Sep-25	02/56	08/34	Tripping due to INSULATOR FAILURE AT LOC NO.22/MIDDLE PHASE.POLYMER INSULATOR	Made	Polymer	SRI India	2023	Story Soil	Hill	Installed	Tension	Indore	Indore	Punctured Silicon Rubber shed at End-fitting & Splitting of shed.
1488	132KV	2025-26	RAISEN - GARIGANJ	59.509	06-Jun-18	29-Jul-25	July_2025	Jul	2025	7.15	5-10 Years	20/51	30-Jul-25	12/51	16/00	B/D DUE TO POLYMER INSULATOR FAILURE AT LOC NO.27/ MIDDLE PHASE	Made	Polymer	DECOSIL	Not Visible	Story Soil	Hill	Installed	Tension	Bhopal	Bhopal	Punctured Silicon Rubber shed at End-fitting
1489	132KV	2025-26	RAJGARH [B]-RAGOHGARH	74	18-Feb-11	28-Jul-25	July_2025	Jul	2025	14.45	10-15 Years	09/04	30-Jul-25	16/12	07/08	B/D DUE TO INSULATOR FAILURE AT LOC NO.222/TOP PHASE.PORCELAIN INSULATOR	Made	Polymer	DECOSIL	Not Visible	Normal	Agriculture	Installed	Suspension	Bina	Gwalior	
1490	132KV	2025-26	RAJGARH [B]- KHULNER	27.928	30-Jul-18	29-Jul-25	July_2025	Jul	2025	7	5-10 Years	14/07	30-Jul-25	13/38	23/31	B/D DUE TO POLYMER INSULATOR FAILURE AT LOC NO.53/TOP AND TENSION LOC. NO. 95/ MIDDLE PHASE (Loc. No. 53)	Top	Polymer	DECOSIL	Not Visible	Black Cotton	Forest	Installed	Suspension	Indore	Indore	Punctured Silicon Rubber shed at End-fitting
	132KV	2025-26	RAJGARH [B]- KHULNER	27.928	30-Jul-18	29-Jul-25	July_2025	Jul	2025	7	5-10 Years		30-Jul-25			B/D DUE TO POLYMER INSULATOR FAILURE AT LOC NO.53/TOP AND TENSION LOC. NO. 95/ MIDDLE PHASE (Loc. No. 53)	Top	Polymer	DECOSIL	Not Visible	Black Cotton	Forest	Installed	Suspension	Indore	Indore	Punctured Silicon Rubber shed at End-fitting
1491	132KV	2025-26	RAJGARH [B]- MAGADANGARH	65.282	08-Jul-09	28-Jul-25	July_2025	Jul	2025	16.07	15-20 Years	09/04	28-Jul-25	17/22	08/18	B/D DUE TO INSULATOR FAILURE AT LOC NO.58/TOP/BOTTOM PHASE	Top	Polymer	ABH India	Not Visible	Black Cotton	Agriculture	Installed	Suspension	Bina	Gwalior	
1492	132KV	2025-26	RAMLAM-DONGARITAL	14.59	01-Dec-15	24-Aug-25	Aug_2025	Aug	2025	9.74	5-10 Years	21/16	25-Aug-25	13/49	16/33	B/D DUE TO INSULATOR FAILURE AT LOC NO.442/TOP PHASE.PORCELAIN JSI INDIA INSULATOR	Top, Bottom	Porcelain	BCPL India	2011	Black Cotton	Agriculture	Installed	Suspension	Sahta	Jabalpur	
1493	132KV	2025-26	RATULAM [220 KV] - JAORA II	33.78	14-Apr-87	18-Aug-25	Aug_2025	Aug	2025	38.37	35-40 Years	16/40	18-Aug-25	20/00	02/20	Tripping due to tripping due to INSULATOR FAILURE AT LOC NO.66/TOP/BOTTOM PHASE.PORCELAIN JSI INDIA INSULATOR	Top	Porcelain	JSI India	Not Visible	Black Cotton	Agriculture	Installed	Suspension	Ratlam	Indore	
1494	132KV	2025-26	SAGAR-GARHA KOTA	30.792	27-Feb-04	20-Aug-25	Aug_2025	Aug	2025	21.49	20-25 Years	12/37	20-Aug-25	18/54	06/17	Outage due to Breakdown due to insulator failure at loc no 129B, 136T, 138T/MB, 139B, 140T & 142B (Loc. No. 129B)	Top, Bottom	Porcelain	JSI India	1982	Black Cotton	Agriculture	Installed	Tension	Damoh	Gwalior	
1495	132KV	2025-26	SEONI [132 KV] -LALBARRA	52.809	23-Jan-16	13-Sep-25	Sept_2025	Sep	2025	9.65	5-10 Years	06/58	13-Sep-25	17/14	10/16	B/D due to Breakdown Due to insulator failure at loc no 129B, 136T, 138T/MB, 139B, 140T & 142B (Loc. No. 129B)	Bottom	Porcelain	NGK Japan	1963	Black Cotton	Forest	Installed	Suspension	Seoni	Jabalpur	
	132KV			52.809	23-Jan-16	13-Sep-25	Sept_2025	Sep	2025	9.65	5-10 Years		13-Sep-25			Breakdown Due to insulator failure at loc no 129B, 136T, 138T/MB, 139B, 140T & 142B (Loc. No. 136T)	Top	Porcelain	NGK Japan	1963	Black Cotton	Forest	Installed	Suspension	Seoni	Jabalpur	
	132KV			52.809	23-Jan-16	13-Sep-25	Sept_2025	Sep	2025	9.65	5-10 Years		13-Sep-25			Breakdown Due to insulator failure at loc no 129B, 136T, 138T/MB, 139B, 140T & 142B (Loc. No. 138T/MB)	Top, Middle, Bottom	Porcelain	NGK Japan	1963	Black Cotton	Forest	Installed	Suspension	Seoni	Jabalpur	
	132KV			52.809	23-Jan-16	13-Sep-25	Sept_2025	Sep	2025	9.65	5-10 Years		13-Sep-25			Breakdown Due to insulator failure at loc no 129B, 136T, 138T/MB, 139B, 140T & 142B (Loc. No. 139B)	Bottom	Porcelain	NGK Japan	1963	Black Cotton	Forest	Installed	Suspension	Seoni	Jabalpur	
	132KV			52.809	23-Jan-16	13-Sep-25	Sept_2025	Sep	2025	9.65	5-10 Years		13-Sep-25			Breakdown Due to insulator failure at loc no 129B, 136T, 138T/MB, 139B, 140T & 142B (Loc. No. 140T)	Bottom	Porcelain	NGK Japan	1963	Black Cotton	Forest	Installed	Suspension	Seoni	Jabalpur	
	132KV			52.809	23-Jan-16	13-Sep-25	Sept_2025	Sep	2025	9.65	5-10 Years		13-Sep-25			Breakdown Due to insulator failure at loc no 129B, 136T, 138T/MB, 139B, 140T & 142B (Loc. No. 142B)	Bottom	Porcelain	NGK Japan	1963	Black Cotton	Forest	Installed	Suspension	Seoni	Jabalpur	
1496	132KV	2025-26	SEONI [132 KV] - KATANGI	99.986	29-Aug-16	19-Aug-25	Aug_2025	Aug	2025	9.95	5-10 Years	22/58	20-Aug-25	13/08	14/10	B/D due to INSULATOR FAILURE AT LOC NO.93/BOTTOM PHASE.POLYMER PHOENIX INDIA INSULATOR	Top, Middle, Bottom	Porcelain	JSI India	1989	Black Cotton	Agriculture	Installed	Suspension	Seoni	Jabalpur	
1497	132KV	2025-26	SEONI [132 KV] - KATANGI	99.986	29-Aug-16	13-Sep-25	Sept_2025	Sep	2025	9.05	5-10 Years	06/58	13-Sep-25	17/14	10/16	breakdown of line DUE TO INSULATOR FAILURE AT LOC NO.129, 136, 138, 139, 140 & 142/ TOP/MIDDLE/BOTTOM PHASE, PORCELAIN INSULATOR (Loc. No. 129B)	Bottom	Porcelain	NGK Japan	1963	Black Cotton	Agriculture	Installed	Suspension	Seoni	Jabalpur	
	132KV			99.986	29-Aug-16	13-Sep-25	Sept_2025	Sep	2025	9.05	5-10 Years		13-Sep-25			breakdown of line DUE TO INSULATOR FAILURE AT LOC NO.129, 136, 138, 139, 140 & 142/ TOP/MIDDLE/BOTTOM PHASE, PORCELAIN INSULATOR (Loc. No. 136T)	Bottom	Porcelain	NGK Japan	1963	Black Cotton	Agriculture					

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1812	220KV	2025-26	BETUL (220 KV) - GUDGAON-I	46.771	12-Jun-19	13-Sep-25	Sept_2025	Sept_2025	6.26	5-10 Years	17-27	14-Sep-25	10.31	17.04	BD / AI loc. 158 & 38 Polymer Insulator failed). (Loc. No. 158)	Top	Porcelain	BHEL India	2000	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	
1813	220KV	2025-26	BETUL (220 KV) - GUDGAON-I	46.771	12-Jun-19	13-Sep-25	Sept_2025	Sept_2025	6.26	5-10 Years		14-Sep-25		09.55	BD / AI loc. 158 & 38 Polymer Insulator failed). (Loc. No. 38)	Top	Porcelain	BHEL India	2000	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	
1814	220KV	2025-26	BINA (400KV) - DATA	183.023	23-Jan-16	28-Sep-25	Sept_2025	Sept_2025	9.69	5-10 Years	18.10	28-Sep-25	02.05		B/D DUE TO INSULATOR FAILURE AT LOC NO.62 MIDDLE PHASE PORCELAIN JSI INDIA INSULATOR.	Top	Polymer	ABI India	2018	Black Cotton	Agriculture	Installed	Suspension	Bina	Gwalior	
1814	400KV	2025-26	RAJGARH - SSP -I	113.677	20-Mar-08	7-Aug-25	Aug_2025	Aug_2025	17.39	15-20 Years	01.50	7-Aug-25	16.04	14.14	PHASE PORCELAIN BHEL INDIA INSULATOR	Middle	Porcelain	JSI India	1992	Stony Soil	Hill	Installed	Suspension	Indore	Indore	
1815	400KV	2025-26	RAJGARH - SSP -II	113.902	20-Mar-08	17-Jun-25	June_2025	June_2025	17.25	15-20 Years	09.17	17-Jun-25	22.36	13.19	B/D DUE TO INSULATOR FAILURE AT LOC NO / 475 MIDDLE PHASE PORCELAIN BHEL INDIA INSULATOR	Middle	Porcelain	BHEL India	2002	Lai Muram	Agriculture	Installed	Suspension	Indore	Indore	
1816	400KV	2025-26	RAJGARH - SSP -II	113.902	20-Mar-08	6-Aug-25	Aug_2025	Aug_2025	17.39	15-20 Years	03.22	6-Aug-25	16.07	12.45	B/D DUE TO INSULATOR FAILURE AT LOC NO.4697TOP PHASE PORCELAIN BHEL INDIA INSULATOR	Middle	Porcelain	BHEL India	2002	Lai Muram	Agriculture	Installed	Suspension	Indore	Indore	
1817	400KV	2025-26	RAJGARH - SSP -II	113.902	20-Mar-08	17-Aug-25	Aug_2025	Aug_2025	17.42	15-20 Years	17.06	18-Aug-25	20.26	03.20	B/D due to INSULATOR FAILURE WAS FOUND AT LOCATION NO. 135 AND THIS LOCATION FALLS UNDER GUJARAT STATE	Top	Porcelain	BHEL India	2002	Lai Muram	Agriculture	Installed	Suspension	Indore	Indore	
1818	400KV	2025-26	RAJGARH - SSP -II	113.902	20-Mar-08	20-Sep-25	Sept_2025	Sept_2025	17.52	15-20 Years	23.50	21-Sep-25	16.33	16.43	B/D DUE TO INSULATOR FAILURE AT LOC NO.479/BOTTOM PHASE PORCELAIN BHEL INDIA INSULATOR	Bottom	Porcelain	BHEL India	2002	Lai Muram	Agriculture	Installed	Suspension	Indore	Indore	
1820	132KV	2025-26	ITARSI - BUDHNI	41.048	16-Jun-22	1-Jul-25	July_2025	July_2025	3.04	0-5 Years	13.35	1-Jul-25	17.41	04.06	AI loc. No. 18 FRP ROD of polymer insulator PUNTURE DUE TO INSULATOR FAILURE.	Top	Polymer	DECCAN	2021	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	Punctured Silicon Rubber shed along moulding line
1821	220KV	2025-26	BETUL (220 KV) - GUDGAON-I	46.77	12-Jun-19	4-Jul-25	July_2025	July_2025	6.07	5-10 Years	21.25	5-Jul-25	06.20	08.55	AI loc. No. 134 Bottom phase disc insulator failure due to lightning	Bottom	Polymer	ABI INDIA	2018	Black Cotton	Agriculture	Installed	Tension	Itarsi	Bhopal	
1822	132KV	2025-26	PIPARIYA(220 KV) - SEMRHAHACHAN I	39.362	29-Dec-20	6-Jul-25	July_2025	July_2025	4.52	0-5 Years	11.35	6-Jul-25	03.47	04.12	AI loc. No. 43 FRP ROD of polymer insulator PUNTURE DUE TO INSULATOR FAILURE.	Bottom	Polymer	DECCAN	2020	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	Punctured Silicon Rubber shed along moulding line
1823	220KV	2025-26	PIPARIYA (220KV) - NARSINGHPUR	100.09	5-Dec-77	29-Jul-25	July_2025	July_2025	47.68	45-50 Years	20.40	29-Jul-25	12.15	15.35	at loc. No. 487488 top phase disc insulator scattered due to lightning (Loc. No. 487)	Top	Porcelain	SIL INDIA	1962	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	
	220KV	2025-26	PIPARIYA (220KV) - NARSINGHPUR	100.09	5-Dec-77	29-Jul-25	July_2025	July_2025	47.68	45-50 Years		29-Jul-25			at loc. No. 487488 top phase disc insulator scattered due to lightning (Loc. No. 488)	Top	Porcelain	SIL INDIA	1962	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	
1824	220KV	2025-26	PIPARIYA - CHICHLI	57.5	1-Jan-66	29-Jul-25	July_2025	July_2025	59.61	55-60 Years	20.40	29-Jul-25	14.13	17.33	at loc. No. 487 top phase insulator scattered due to lightning.	Top	Porcelain	SIL INDIA	1962	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	
1825	220KV	2025-26	BETUL (132KV) - PANDHURNA	85.96	10-Jul-20	16-Aug-25	Aug_2025	Aug_2025	5.1	5-10 Years	17.31	17-Aug-25	01.00	07.25	AI loc. 471LO POLYMER INSULATOR FAILURE DUE TO LIGHTENING	Middle	Polymer	ABI INDIA	2018	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	
1826	132KV	2025-26	ITARSI - BUDHNI	41.049	16-Jun-22	8-Sep-25	Sept_2025	Sept_2025	3.23	0-5 Years	21.02	9-Sep-25	01.29	04.27	AI loc. 18 Bottom phase double suspension polymer string FRP Rod found rupture	Bottom	Polymer	DECCAN	Not Visible	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	Punctured Silicon Rubber shed at End-fitting
1827	220KV	2025-26	BETUL (220 KV) - GUDGAON-II	46.77	12-Jun-19	21-Sep-25	Sept_2025	Sept_2025	6.28	5-10 Years	13.22	21-Sep-25	22.22	09.01	AI loc. No. 138 Top ph Polymer Insulator Punctured	Top	Polymer	ABI INDIA	2018	Black Cotton	Agriculture	Installed	Tension	Itarsi	Bhopal	
1828	220KV	2025-26	BETUL (220 KV) - GUDGAON-II	46.77	12-Jun-19	27-Sep-25	Sept_2025	Sept_2025	6.3	5-10 Years	07.56	27-Sep-25	12.36	04.02	AI loc. No. 12 Bottom ph Polymer Insulator Punctured	Bottom	Polymer	ABI INDIA	2015	Black Cotton	Agriculture	Installed	Tension	Itarsi	Bhopal	
1829	132KV	2025-26	GUDGAON (220 KV) - GUDGAON (132 KV) LOC - II	7.71	20-Jun-19	28-Sep-25	Sept_2025	Sept_2025	6.28	5-10 Years	11.33	28-Sep-25	17.16	05.43	AI loc. No. 146 Middle ph Polymer Insulator Punctured	Middle	Polymer	Not visible	Not Visible	Black Cotton	Agriculture	Installed	Tension	Itarsi	Bhopal	
1830	220KV	2025-26	BETUL (220 KV) - GUDGAON-I	46.771	12-Jun-19	30-Oct-25	Oct_2025	Oct_2025	6.39	5-10 Years	12.27	30-Oct-25	19.02	06.35	Due to lightning AI loc. No. 155 Bottom ph Polymer Insulator Punctured	Bottom	Polymer	ABI INDIA	2018	Black cotton	Agriculture	Installed	Tension	Itarsi	Bhopal	Punctured Silicon Rubber shed at End-fitting
1831	132KV	2025-26	132 KV ITARSI- SEMRHAHACHAN I	33.933	29-Jul-03	4-Jan-25	Jan_2025	Jan_2025	21.49	20-25 Years	01.50	4-Jan-25	08.19	06.29	AI loc. No. 88 Top ph Insulator Failure	Top	Porcelain	JSI India	1977	Black Cotton	Agriculture	Installed	Suspension	Itarsi	Bhopal	Punctured Silicon Rubber shed at End-fitting
1832	132KV	2024-25	TRAKAMGARH (220 KV) - BUDHERA II	32.218	13-Feb-18	4-Jul-25	Jul_2025	Jul_2025	7.36	5-10 Years					Loc. No. 80 / Top Phase	Top	Polymer	JSI		Black Cotton	Agriculture	Installed	Suspension	Damoh	Gwalior	Punctured Silicon Rubber shed at End-fitting
1833	132KV	2025-26	Bina-Ashoknagar SIC line	101.543	26-Oct-86	11-Oct-25	Oct_2025	Oct_2025	38.99	35-40 Years					Loc. No. 102 / Top Phase	Top	Polymer	Not visible	Not visible	Black Cotton	Agriculture	Installed	Tension	Damoh	Gwalior	Punctured Silicon Rubber shed along moulding line
1834	220KV	2025-26	Bina-Ganjbasoda line (LLO Portion)	68.448	06-May-23	23-Nov-25	Nov_2025	Nov_2025	2.55	0-5 Years					Loc. No. 39 / Top Phase	Top	Polymer	SRI India	2024	Black Cotton	Agriculture	Installed	Tension	Bhopal	Gwalior	Exposure of core owing to shed movement
1835	132KV	2025-26	Shivpuri-Karahal line	74.298	14-Nov-22	18-Dec-25	Dec_2025	Dec_2025	3.1	0-5 Years					Loc. No. 82 / Top Phase	Top	Polymer	ABI India	2019	Black Cotton	Agriculture	Installed	Suspension	Gwalior	Gwalior	Exposure of core owing to shed movement

Detailed insulator failure data (220 kV, 400 kV & 765 kV)
Amravati Zone

Sr. No.	Name of Zone	Name of the line	Voltage level of the line	Date of Insulator Failure	Reason for insulator failure	Year of commissioning of Insulator	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite)	Make of the Insulator	Prevailing climatic conditions at the time of failure	Remedial action taken	Maintenance practices adopted
1	Amravati	220kV Wardha-Yavatmal (PGCIL) Line	220kV	27.05.2025	De-caping At Loc No.136 R-Ph	28.12.1982	43	Porcelain	ABI India	Normal wether	Inulator String replaced with new one	Routine Monkey patrolling & PID testing carried out
2	Amravati	220 KV Pusad - Deoli PG Line	220KV	26.06.2025	Decapping of R-ph insulator string at location 366.	21.09.1976	49	Porcelain	ABI India	Rainy Season Heavy rain,lightening ,thunderstorm	Decapped String replaced and normalcy restored	Routine Monkey patrolling & PID testing carried out
3	Amravati	220 KV Yavatmal-Pusad Line	220KV	25.07.2025	Decaping of B Phase insulator string at Loc No. 360 Due to Monkey Fault	21.09.1976	49	Porcelain	ABI India	Rainy Season	Decapped String replaced and normalcy restored	Routine Monkey patrolling & PID testing carried out
4	Amravati	220kV Deoli-Pusad Ckt-I	220kV	15.08.2025	De-capping 223 R - Phase & Y-Phase.	21.09.1976	49	Porcelain	ABI India	Rainy Season Heavy rain,lightening ,thunderstorm	Inulator String replaced with new one	Routine Monkey patrolling & PID testing carried out
5	Amravati	220kV Yavatmal-Pusad Line	220kV	15.08.2025	De-caping loc no. 223 B-Phase	21.09.1976	49	Porcelain	ABI India	Rainy Season Heavy rain,lightening ,thunderstorm	Inulator String replaced with new one	Routine Monkey patrolling & PID testing carried out
6	Amravati	220 KV Pusad - Deoli PG Line	220KV	26.09.2025	Decapping of R-ph insulator string at location 366.	21.09.1976	49	Porcelain	ABI India	Rainy Season Heavy rain,lightening ,thunderstorm	Decapped String replaced and normalcy restored	Routine Monkey patrolling & PID testing carried out
7	Amravati	220kV Amravati-Karanja Line	220kV	17.05.2025	Decapping	1973	52	Porcelain	ABI India	Weather was rainy, cloudy, lightning and stormy	Decapped Flashover disc/Insulator string is replaced successfully	PID, Tower footing Resistance measurement, Line Signature Test as per MSETCL Norms
8	Amravati	220kV Amravati-Badnera Line	220kV	28.08.2025	Decapping	1993	32	Porcelain	ABI India	Weather was rainy, cloudy, lightning and stormy	Decapped Flashover disc/Insulator string is replaced successfully	PID, Tower footing Resistance measurement, Line Signature Test as per MSETCL Norms
9	Amravati	400kV Akola-Khadka	400kV	25.03.2025	String brokened	1979	46	Porecelain	BHEL	Cloudy	String replaced and PID carried out for complete line	Arial patrolling, PID, cold washing if required.
10	Amravati	400kV Akola-Khadka	400kV	13.04.2025	String brokened	1979	46	Porecelain	BHEL	Clear	String replaced and PID carried out for complete line	Arial patrolling, PID, cold washing if required.

Detailed insulator failure data (220 kV, 400 kV & 765 kV)**CSN Zone**

Sr.No.	Name of Zone	Name of the line	Voltage level of the line	Date of Insulator Failure	Reason for insulator failure	Year of commissioning of Insulator	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite)	Make of the Insulator	Prevailing climatic conditions at the time of failure	Remedial action taken	Maintenance practices adopted
1	CSN	220KV Parii-PGCIL ckt2	220KV	10.12.2025	Flashover	25.09.1977	48 years 3month	porcelain	Not Available	climate condition is sunny	faulty string replace	1)ground patrolling 2)monkey patrolling
2	CSN	220 KV Osmanabad-Solapur(Bale) Line	220 KV	Mar-25	Disc Insulator Flashover	24.10.1977	48	Porcelain	Not Available	Cloudy	Flashover Disc Insulator at loc.no.52 (Bph) was replaced with new one during outage on dt.02.03.2025	Monkey Patrolling & Ground Patrolling Method
3	CSN	220 KV Osmanabad-PGCIL (Shepwadi) Line	220 KV	May-25	Observed in PID Testing Report (Critical)	18.01.2019	6	Porcelain	Not Available	Cloudy	As per PID Test Results, Critical Disc Insulators at loc.no.204 (Rph) was replaced during outage on dt.02.06.2025	Monkey Patrolling and PID Testing Method
4	CSN	220 KV Osmanabad-Tuljapur Line	220 KV	Aug-25	Decapping of Disc Insulator	24.10.1977	48	Porcelain	Not Available	Cloudy	Decapping of Disc Insulator at loc.no.83 (Yph) was replaced with new one during outage on dt.11.08.2025 (Tripping)	Monkey Patrolling & Ground Patrolling Method
5	CSN	220 KV Narangwadi-Solapur (PGCIL) Line Ckt-1	220 KV	Aug-25	Disc Insulator Flashover	26.06.2021	4	Porcelain	Not Available	Cloudy	Flashover Disc Insulator at loc.no.6 (Rph) was replaced with new one during outage on dt.25.08.2025	Monkey Patrolling & Ground Patrolling Method
6	CSN	220 KV Murud-Tuljapur Line	220 KV	Aug-25	Disc Insulator Flashover	22.11.2011	14	Porcelain	Not Available	Cloudy	Flashover Disc Insulator at loc.no.113 (Rph) was replaced with new one during outage on dt.26.08.2025	Monkey Patrolling & Ground Patrolling Method
7	CSN	220 KV Osmnabad-Paranda Line	220 KV	Apr-25	Disc Insulator Flashover	15.03.2012	13	Porcelain	Not Available	Windy	Flashover Disc Insulator at loc.no.07 (Rph) was replaced with new one during outage on dt.09.04.2025 (Emergency)	Monkey Patrolling & Ground Patrolling Method
8	CSN	220 KV Tuljapur-Lamboti Line	220 KV	Sep-25	Disc Insulator Flashover	18.03.2016	9	Porcelain	Not Available	Clear	Flashover Disc Insulator at loc.no.97 (Bph) was replaced with new one during outage on dt.11.09.2025	Monkey Patrolling & Ground Patrolling Method
9	CSN	220 KV Osmnabad-Paranda Line	220 KV	Oct-25	Disc Insulator Flashover	15.03.2012	13	Porcelain	Not Available	Clear	Flashover Disc Insulator at loc.no.33 (Rph), 32 (Rph) and 42 (Rph) was replaced with new one during outage on dt.07.10.2025 & 31.10.2025	Monkey Patrolling & Ground Patrolling Method
10	CSN	220kv Parii ckt-1	220 KV	Apr-25	Disc Insulator Flashover	2001	25	Porcelain	Not Available	Cloudy	Replaced with new one during outage	Monkey Patrolling & Ground Patrolling Method
11	CSN	220kv Parii ckt-2	220 KV	Jun-25	Disc Insulator Flashover	2001	25	Porcelain	Not Available	Cloudy	Replaced with new one during outage	Monkey Patrolling & Ground Patrolling Method
12	CSN	220 KV PUSAD - HINGOLI LINE	220 Kv	25.02.2025	Flash Over	10.02.2011	14 Year	Porcelain	Not Available	Weather normal	faulty string found are replaced by taking outage	Monkey patrolling
13	CSN	220 KV GHATODI - NANDED LINE	220 Kv	26.02.2025	Flash Over	22.12.2014	10 Year	Porcelain	Not Available	Weather normal	faulty string found are replaced by taking outage	Monkey patrolling
14	CSN	220 KV GHATODI - HINGOLI LINE	220 Kv	28.02.2025	Flash Over	22.12.2014	10 Year	Porcelain	Not Available	Weather normal	faulty string found are replaced by taking outage	Monkey patrolling
15	CSN	220 KV PUSAD-HINGOLI LINE	220 KV	12.06.2025	heavily raining and lightnenning	10.02.2011	14 Year	Porcelain	JSI INDIA 70KN N9-04	Raining and lightnenning	PID of the line is done. More then 3 disc of string found weak. As per instructions of PID team faulty string replaced by taking outage	Monkey patrolling

Detailed insulator failure data (220 kV, 400 kV & 765 kV)

CSN Zone

Sr.N o.	Name of Zone	Name of the line	Voltage level of the line	Date of Insulator Failure	Reason for insulator failure	Year of commissioning of Insulator	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite)	Make of the Insulator	Prevailing climatic conditions at the time of failure	Remedial action taken	Maintenance practices adopted
16	CSN	220 KV PUSAD-HINGOLI LINE	220 Kv	06.08.2025	Flash Over	10.02.2021	13 Year	Porcelain	Not Available	Weather normal	faulty string found are replaced by taking outage	Monkey patrolling
17	CSN	220 KV GIRWALI - KURUNDA GIS	220 Kv	11.08.2025	Flash Over	28.03.2021	03 Year	Porcelain	Not Available	Weather normal	faulty string found are replaced by taking outage	Monkey patrolling
18	CSN	220 KV GIRWALI - KURUNDA GIS	220 Kv	12.11.2025	Flash Over	28.03.2021	03 Year	Porcelain	Not Available	Weather normal	faulty string found are replaced by taking outage	Monkey patrolling
19	CSN	220 KV GHATODI-HINGOLI LINE	220 Kv	28.12.2025	Flash Over	17.02.2017	08 Year	Porcelain	Not Available	Weather normal	faulty string found are replaced by taking outage	Monkey patrolling
20	CSN	220 KV HINGOLI - KURUNDA GIS	220 Kv	29.12.2025	Flash Over	28.03.2021	03 Year	Porcelain	Not Available	Weather normal	faulty string found are replaced by taking outage	Monkey patrolling
21	CSN	220 KV GHATODI-NANDED	220 Kv	30.12.2025	Broken disc	22.12.2014	14 Year	Porcelain	Not Available	Weather normal	faulty string found are replaced by taking outage	Monkey patrolling
22	CSN	220 KV Parbhani-waghala	220 KV	24.11.2025	Flash Over	Not Available	Not Available	PORCELAIN	Not Available	Weather normal	Disc replaced on Dt. 12/12/2025	Monkey patrolling
23	CSN	220 KV Parbhani-waghala	220 KV	22.11.2025	Flash Over	Not Available	Not Available	PORCELAIN	Not Available	Weather normal	Disc replaced on Dt.13/12/2025	Monkey patrolling
24	CSN	220 KV parbhani-ntps	220 KV	10.11.2025	Flash Over	Not Available	Not Available	PORCELAIN	Not Available	Weather normal	Disc replaced on Dt.22/12/2025	Monkey patrolling
25	CSN	220KV Girwali-Kurunda	220 KV	17.11.2025	Flash Over	Not Available	Not Available	PORCELAIN	Not Available	Weather normal	Disc replaced on Dt.24/12/2025	Monkey patrolling
26	CSN	220KV Girwali-Kurunda	220 KV	17.11.2025	Flash Over	Not Available	Not Available	PORCELAIN	Not Available	Weather normal	Disc replaced on Dt. 02/01/2026	Monkey patrolling
27	CSN	220 KV Parbhani-waghala	220 KV	24-11-2025	Broken disc	Not Available	Not Available	PORCELAIN	Not Available	Weather normal	Disc replaced on Dt.12/12/2025	Monkey patrolling
28	CSN	220 KV Parbhani-waghala	220 KV	24-11-2025	Broken disc	Not Available	Not Available	PORCELAIN	Not Available	Weather normal	Disc replaced on Dt.12/12/2025	Monkey patrolling
29	CSN	220 KV Parbhani-waghala	220 KV	08-12-2025	Broken disc	Not Available	Not Available	PORCELAIN	Not Available	Weather normal	Disc replaced on Dt.13/12/2025	Monkey patrolling
30				22-11-2025								
31	CSN	220kV Thaptitanda - Amrapur	220kV	26.12.2023	Flashover	02.07.2022	2022	Porcelain	IEC	Winter	NA	Monkey patrolling
32	CSN	220kV Thaptitanda - Amrapur	220kV	6.01.2025	Flashover	02.07.2022	2022	Porcelain	IEC	Winter	NA	Monkey patrolling
33	CSN	220kV Thaptitanda - Amrapur	220kV	11.06.2025	Flashover	02.07.2022	2022	Porcelain	IEC	Rainy	NA	Monkey Petrolling
34	CSN	220kV Thaptitanda - Amrapur	220kV	13.06.2025	Flashover	02.07.2022	2022	Porcelain	IEC	Rainy	NA	Monkey Petrolling
35	CSN	220kV Thaptitanda - Amrapur	220kV	20.06.2025	Flashover	02.07.2022	2022	Porcelain	IEC	Rainy	NA	Monkey Petrolling
36	CSN	220kV Thaptitanda - Amrapur	220kV	30.06.2025	Flashover	02.07.2022	2022	Porcelain	IEC	Rainy	NA	Monkey patrolling
37	CSN	220kV Thaptitanda - Amrapur	220kV	6.07.2025	Flashover	02.07.2022	2022	Porcelain	IEC	Rainy	NA	Monkey patrolling
38	CSN	220kV Thaptitanda - Amrapur	220kV	20.07.2025	Flashover	02.07.2022	2022	Porcelain	IEC	Rainy	NA	Monkey patrolling
39	CSN	220kV Thaptitanda - Amrapur	220kV	01.10.2025	Flashover	02.07.2022	2022	Porcelain	IEC	Winter	NA	Monkey patrolling
40	CSN	132kV Vaijapur - Panchganaga	132kV	08.11.2025	Flashover	02.12.2025	2025	Porcelain	IEC	Winter	NA	Monkey patrolling
41	CSN	132kV Vaijapur - Panchganaga	132kV	13.11.2025	Flashover	02.12.2025	2025	Porcelain	IEC	Winter	NA	Monkey patrolling
42	CSN	132kV Vaijapur - Panchganaga	132kV	25.11.2025	Flashover	02.12.2025	2025	Porcelain	IEC	Winter	NA	Monkey patrolling
43	CSN	132kV Vaijapur - Panchganaga	132kV	25.11.2025	Flashover	02.12.2025	2025	Porcelain	IEC	Winter	NA	Monkey patrolling
44	CSN	220kV Nagewadi-Partur Ckt-II, loc. No. 37, Rphase	220kV	13.10.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Rainy	Disc replaced on dt.17.10.2025	Monkey patrolling
45	CSN	220kV Nagewadi-Partur Ckt-II loc. No. 14, Rphase	220kV	13.10.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Rainy	Disc replaced on dt.17.10.2025	Monkey patrolling
46	CSN	220kV Nagewadi-Partur Ckt-I, loc. No. 112, Rphase	220kV	27.10.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Clear	Disc replaced on dt.18.11.2025	Monkey patrolling
47	CSN	220kV Nagewadi-Partur Ckt-II, loc. No. 25, Rphase	220kV	17.11.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Clear	Disc replaced on dt.17.11.2025	Monkey patrolling
48	CSN	220kV Nagewadi-Partur Ckt-I, loc. No. 25, Rphase	220kV	17.11.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Clear	Disc replaced on dt.18.11.2025	Monkey patrolling
49	CSN	220kV Nagewadi-Partur Ckt-I, loc. No. 25, Rphase	220kV	17.11.2025	Disc Broken	27.09.2018	7 years	Porcelain	BPCL-BKN	Clear	Disc replaced on dt.18.11.2025	Monkey Patrolling
50	CSN	220kV Nagewadi-Partur Ckt-I, loc. No. 17, Rphase	220kV	13.10.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Rainy	Disc replaced on dt.18.11.2025	Monkey patrolling
51	CSN	220kV Nagewadi-Partur Ckt-II, loc. No. 39, Rphase	220kV	16.09.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Heavy rain	Disc replaced on dt.18.11.2025	Monkey patrolling
52	CSN	220kV Nagewadi-Partur Ckt-II, loc. No. 6, Rphase	220kV	13.10.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Rainy	Disc replaced	Monkey patrolling
53	CSN	220kV Nagewadi-Partur Ckt-II, loc. No. 39, Rphase	220kV	16.09.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Heavy rain	Disc replaced on dt.17.11.2025	Monkey patrolling
53	CSN	220kV Nagewadi-Partur Ckt-II, loc. No. 39, Yphase	220kV	16.09.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Heavy rain	Disc replaced on dt.17.11.2025	Monkey patrolling
54	CSN	220kV Nagewadi-Partur Ckt-II, loc. No. 19, Bphase	220kV	13.10.2025	Disc Broken	27.09.2018	7 years	Porcelain	BPCL-BKN	Rainy	Disc replaced on dt.17.11.2025	Monkey patrolling

Detailed insulator failure data (220 kV, 400 kV & 765 kV)**CSN Zone**

Sr.No.	Name of Zone	Name of the line	Voltage level of the line	Date of Insulator Failure	Reason for insulator failure	Year of commissioning of Insulator	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite)	Make of the Insulator	Prevailing climatic conditions at the time of failure	Remedial action taken	Maintenance practices adopted
55	CSN	220kV Nagewadi-Partur Ckt-II,loc. No. 73, Rphase	220kV	14.10.2025	Disc flashover	27.09.2018	7 years	Porcelain	BPCL-BKN	Rainy	Disc replaced on dt.17.10.2025	Monkey patrolling
56	CSN	Nagewadi - Tata power solar,loc. No. 69, Rphase	220kV	45850	Bird Waste	27.09.2018	7 years	Porcelain	BPCL-BKN	Heavy rain	String Replaced	Monkey patrolling
57	CSN	Thapti- Jalna ckt I,loc. No. 118, Rphase	220kV	45865	Bird Waste	37881	7 years	Porcelain	BPCL-BKN	Rainy	String Replaced	Monkey patrolling
58	CSN	Thapti- Jalna ckt I,loc. No. 166, Rphase	220kV	45864	Bird Waste	37881	22 years	Porcelain	BPCL-BKN	Heavy rain	String Replaced	Monkey patrolling
59	CSN	Thapti- Jalna ckt I,loc. No. 166, Bphase	220kV	45864	Bird Waste	37881	22 years	Porcelain	BPCL-BKN	Heavy rain	String Replaced	Monkey patrolling
60	CSN	Thapti- Jalna ckt II,loc. No. 184, Rphase	220kV	45867	Bird Waste	37881	22 years	Porcelain	BPCL-BKN	Rainy	String Replaced	Monkey patrolling
61	CSN	Thapti- Jalna ckt II,loc. No. 185, Bphase	220kV	45867	Bird Waste	37881	22 years	Porcelain	BPCL-BKN	Rainy	String Replaced	Monkey patrolling
62	CSN	Thapti - Nagewadi,loc. No. 41, Rphase	220kV	45902	Bird Waste	43370	22 years	Porcelain	BPCL-BKN	Winter	String Replaced	Monkey patrolling
63	CSN	Thapti - Nagewad , Loc. No. 24, Rphase	220kV	45967	Found faulty in PID	43370	7 years	Porcelain	BPCL-BKN	Winter	String Replaced	Monkey patrolling
64	CSN	Thapti - Nagewadi,Loc. No. 70, R phase	220kV	45931	Found faulty in PID	43370	7 years	Porcelain	BPCL-BKN	Winter	String Replaced	Monkey patrolling

Detailed insulator failure data (220 kV, 400 kV & 765 kV)												
Karad Zone												
Sr. No.	Name of Zone	Name of the line	Voltage level of the line	Date of Insulator Failure	Reason for insulator failure	Year of commissioning of Insulator	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite)	Make of the Insulator	Prevailing climatic conditions at the time of failure	Remedial action taken	Maintenance practices adopted
1	Karad	Niwali-pawas	220kv	02.02.2025	Decapping	2006	19	porcelain disc	BHEL	foggy/dusty	replaced	cold washing
2	Karad	220KV NIWALI - PAWAS LINE	220 KV	02-02-2025	Decapping at lo no 61 (LILO)	Data not available	Data not available	Porcelain	NJK	Rain and thunderstorm	insulator string replaced	Cold washing
3	KARAD	220KV Halkarni Mahala xmi Line	220KV	24.04.2025	Flashover	2008-09	16	Polymer	Not Available	Clear	Scheme is in progress of replacement of Polymer	1)Insulator cleaning work 2) PID testing carried out 3) TFR Measurement done
4	Karad	220 KV LOTEPA ARSHU RAM-DASTURI LINE	220 KV	19-05-2025	Insulator string flashover	Data not available	Data not available	Porcelain	ABI	Rain and thunderstorm	insulator string replaced & proposal sent for replacement of disc insulator by long rod insulator	Cold washing & Chemical washing, PID Testing
5	Karad	220 KV PEDHAMBONI LINE	220 KV	21-05-2025	Tower Loc No 162 Bottom Phase	Data not available	Data not available	Porcelain	ABI	Rain and thunderstorm	insulator string replaced & proposal sent for replacement of disc insulator by long rod insulator	Cold washing & PID Testing
6	KARAD	220KV Talandage Sawant wadi	220KV	20.05.2025	Decapping	2003	22	Disc	Bhel	Rainy	Aerial Patrolling done,	1)Insulator cleaning work 2) PID testing carried out 3) TFR Measurement done
7	KARAD	220KV Talandage Sawant wadi	220KV	29.06.2025	Flashover	2010	15	Polymer	Not Available	Rainy	Polymer Replacement is in process	1)Insulator cleaning work 2) PID testing carried out 3) TFR Measurement done
8	Karad	220KV NERAL E - PEDAMBE	220 KV	07-07-2025	insulator string - Decapping due to ball rod rusting	Data not available	Data not available	Polymer	NJK	Rain and thunderstorm	insulator string replaced & proposal sent for replacement of disc insulator by long rod insulator	Cold washing
9	KARAD	220KV Halkarni Mahala xmi Line	220KV	07.07.2025	Flashover	2008-09	16	Polymer	Not Available	Clear	Scheme is in progress of replacement of Polymer	1)Insulator cleaning work 2) PID testing carried out 3) TFR Measurement done
10	KARAD	220KV Halkarni Mahala xmi Line	220KV	08.07.2025	Flashover	2008-09	16	Polymer	Not Available	Clear	Scheme is in progress of replacement of Polymer	1)Insulator cleaning work 2) PID testing carried out 3) TFR Measurement done

11	KARAD	220KV Halkarni Mahala xmi Line	220KV	08.07.2025	Flashover	2008-09	16	Polymer	Not Available	Clear	Scheme is in progress of replacement of Polymer	1)Insulator cleaning work 2) PID testing carried out 3) TFR Measurement done
12	Karad	220KV NERAL E - PEDAM BE	220 KV	26-07-2025	insulator string - Decapping due to ball rod rusting	Data not available	Data not available	Polymer	ABI	Rain and thunderstorm	insulator string replaced & proposal sent for replacement of disc insulator by long rod insulator	Cold washing
13	KARAD	220kv Miraj- Ichalkar anji-II	220kv	31.07.2025	Decapping	1996	29	Disc Insulator	Not Available	Heavy rainy & foggy climate	Replaced decapped insulator string	1)Insulator cleaning work 2) PID testing carried out 3) TFR Measurement done
14	Karad	220 KV ADLAB S - PEDAM BE	220 KV	17-08-2025	loc 83 bottom ph insulator string decapp	Data not available	Data not available	Porcelain	ABI	Rain and thunderstorm	insulator string replaced & proposal sent for replacement of disc insulator by long rod insulator	Cold washing & Chemical washing, PID Testing
15	Karad	220KV NERAL E - POPHA LI	220 KV	30-08-2025	at loc no 17 bottom phase- flashover	Data not available	Data not available	Polymer	ABI	Rain and thunderstorm	insulator string replaced & proposal sent for replacement of disc insulator by long rod insulator	Cold washing
16	karad	pawas- kharepa tan	220kv	21.10.2025	decapping	1995	31	porcelain disc	BHEL	thundering/ lightning	replaced	maintaning earth wire
17	Karad	221 KV KALAM BANI TSS- PEDAM BE	220 KV	23-10-2025	insulator string - Decapping due to ball rod rusting	Data not available	Data not available	Porcelain	NJK	Rain and thunderstorm	insulator string replaced & proposal sent for replacement of disc insulator by long rod insulator	Cold washing & Chemical washing, PID Testing
18	Karad	400KV Karad - Solapur (PG)	400KV	14.05.2025	Decapping	1987	38	Porcelain	JSI	Strong wind & Lightning	Faulty Insulator Replaced and Periodic PID testing & Cold washing carried out on insulator Strings	Cod washing & Periodic PID Testing of insulator
19	Karad	220KV Vira- Miraj	220KV	06.01.2025	Y Ph String Decapped due to Flash Over at Loc 126 STN Tower	1999	25	Porcelain	NA	Normal	Flahover string replaced by agency	1)Timely PID work completed 2)Cold washing completed in Year 2025 3)Wedge connector work carried out in year 2025

Detailed insulator failure data (220 kV, 400 kV & 765 kV)												
Nagpur Zone												
Sr. No.	Name of Zone	Name of the line	Voltage level of the line	Date of Insulator Failure	Reason for insulator failure	Year of commissioning of Insulator	In-service years of the Insulators before failure	Type of Insulator (Porcelain / Composite)	Make of the Insulator	Prevailing climatic conditions at the time of failure	Remedial action taken	Maintenance practices adopted
1	Nagpur	220 KV BHANDARA-BHANDARA RLY TSS 1	220 KV	01.11.2025	It may be the cause due to the industrial dust of M/S Sunflag Steel Ltd.	05.10.1991	34YEAR 2MONTH	PORCELAIN	NA	Climate is Clear	Proposed for the PID test of line.	YEARLY MONKEY AND GROUND PATROLLING.
2	Nagpur	220KV New Khaperkheda-Kanhan ckt	220KV	A/R operated on 12.08.2025	Flashover observed	1997	28	Porcelain	BHEL	Rainy season thundering climate	emergency outage on dtd:-15.08.2025	Drone Patrolling & Monkey patrolling
3	Nagpur	220 KV KHAPERKHEDA-BUTIBORI-3	220 kV	15.08.2025	Insulator Burst	2014	12	Porcelain	BHEL	Heavy Rain & Lightening	Replaced	TFR taken
4	Nagpur	220 kV Khaperkheda Butibori-1	220 kV	19.09.2025	Insulator Burst	2014	12	Porcelain	BHEL	Heavy Rain & Lightening	Replaced	TFR taken
5	Nagpur	220 KV KHAPERKHEDA-BUTIBORI-3	220 kV	07.11.2025	Insulator Burst	2014	12	Porcelain	AB India	Heavy Fog	Replaced	TFR taken
6	Nagpur	220 kV Wardha-New Dhamangao	220 KV	17.12.2025	Rph Sub station Gantry Insulator string Burst due to fog	1991	34	Porcelain	ABI INDIA	Foggy weather condition	Replace by New	PID , Monkey Patrolling
7	Nagpur	220 kV Wardha - PGCIL (Deoli)	220 kV	10.12.2025	Rph Sub station Gantry Insulator string Burst due to fog	1991	34	Porcelain	ABI INDIA	Foggy weather condition	Replace by New	PID , Monkey Patrolling
8	Nagpur	220 kV PGCIL (Deoli)-Badnera	220kV	08.12.2025	Flashover Insulator string at Loc No 97 Rph	1991	34	Porcelain	WSI	Lightning	Replace by New	PID , Monkey Patrolling
9	Nagpur	220 kV Wardha - PGCIL (Deoli)	220 kV	08.09.2025	Flashover Insulator string at Loc No 21 Yph	1991	34	Porcelain	WSI	Lightning	Replace by New	PID , Monkey Patrolling
10	Nagpur	220 kV Bhugao-Purti	220 KV	05.11.2025	Rph Insulator string burst (De-capping) at Loc No 271	1998	27	Porcelain	WSI	Thunderstorm	Replaced by New	PID, Monkey Patrolling
11	Nagpur	Bhugaon- Warora ckt-II	220kV	23.01.2025	LIGHTENING	2018	7yrs	porcelain	NA	thermderstorm	disc change on date:- 15.04.2025	PID, Monkey Patrolling
12	Nagpur	Wardha - Yewatmal ckt	220kV	04.02.2025	LIGHTENING	2017	8 yrs.	porcelain	NA	thermderstorm	disc change on date:- 30.05.2025	PID, Monkey Patrolling
13	Nagpur	220 KV CHANDRAPUR 2-BALLARSHAH	220 kV	27.05.2025	Decapping of the R Phase insulator string at Location No. 27	30.12.2020	5 years	Porcelain	NA	Heavy Lightening	Tower earthing checked	PID, Monkey Patrolling
14	Nagpur	500KV Chandrapur - Padghe HVDC Pole-I (loc no. 358)	500KV	27.05.2025	Flashover on disc insulator	1999	26	Porcelain	NGK Japan	Rainy	Replacement of disc insulator	Cold line washing & Monkey patrolling for diagnostic
15	Nagpur	500KV Chandrapur - Padghe HVDC Pole-I (loc no. 395)	500KV	28.05.2025	Flashover on disc insulator	1999	26	Porcelain	NGK Japan	Rainy	Replacement of disc insulator	Cold line washing & Monkey patrolling for diagnostic
16	Nagpur	500KV Chandrapur - Padghe HVDC Pole-I (loc no. 396)	500KV	28.05.2025	Flashover on disc insulator	1999	26	Porcelain	NGK Japan	Rainy	Replacement of disc insulator	Cold line washing & Monkey patrolling for diagnostic
17	Nagpur	500KV Chandrapur - Padghe HVDC Pole-I (loc no. 402)	500KV	28.05.2025	Flashover on disc insulator	1999	26	Porcelain	NGK Japan	Rainy	Replacement of disc insulator	Cold line washing & Monkey patrolling for diagnostic
18	Nagpur	500KV Chandrapur - Padghe HVDC Pole-I (loc no. 409)	500KV	28.05.2025	Flashover on disc insulator	1999	26	Porcelain	NGK Japan	Rainy	Replacement of disc insulator	Cold line washing & Monkey patrolling for diagnostic

Detailed insulator failure data (220 kV, 400 kV & 765 kV)												
NASHIK ZONE												
Sr. No.	Name of Zone	Name of the line	Voltage level of the line	Date of Insulator Failure	Reason for insulator failure	Year of commissioning of Insulator	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite)	Make of the Insulator	Prevailing climatic conditions at the time of failure	Remedial action taken	Maintenance practices adopted
1	Nashik	400kV Babhaleshwar-Padghe-2	400kV	15.05.2025	lightening Strok D-Caping loc.no.98(Y)	17.10.1980	45 Year	porcelain Disc	BHEL	Unseasonable rain & Strom	Replace By Porcelain Insulator	PID Test, and cold washing
2	Nashik	400kV Babhaleshwar-Dhule-2	400kV	16.05.2025	String Replaced D-Caping loc.no.116 (B).	18.11.1995	30 year	porcelain Disc	ABIN	Unseasonable rain & Strom	Replace By Porcelain Insulator	PID Test, and cold washing
3	Nashik	400kV Babhaleshwar-Padghe-1	400kV	25.07.2025	String Replaced D-Caping loc.no.135(Y Phase)	17.10.1980	45 Year	porcelain Disc	BHEL	Heayvi Fog & Rain	Replace By Long Rod Porcelain Insulator	PID Test, and cold washing
4	Nashik	400kV Babhaleshwar-Padghe-2	400kV	25.07.2025	String Replaced D-Caping loc.no.146 (Y).	17.10.1980	45 Year	porcelain Disc	BHEL	Heayvi Fog & Rain	Replace By Long Rod Porcelain Insulator	PID Test, and cold washing
5	Nashik	400kV Babhaleshwar-Padghe-2	400kV	25.07.2025	String Replaced D-Caping loc.no.115 Rph	17.10.1980	45 Year	porcelain Disc	BHEL	Heayvi Fog & Rain	Replace By Long Rod Porcelain Insulator	PID Test, and cold washing
6	Nashik	400kV Babhaleshwar-Dhule -2	400kV	18.08.2025	12 Rph decapping Due to Rain	18.11.1995	30 year	porcelain Disc	ABIN	Heayvi Fog & Rain	Replace By Long Rod Porcelain Insulator	PID Test, and cold washing
7	Nashik	220kV Babhaleshwar - Ahilyanagar Circuit 1	220kV	28-01-2025	Bird Pitting	1990	34 Years	Porcelain	AB India	Foggy	Additional Bird Guards Provided	Cleaning of Insulators
8	Nashik	220kV Babhaleshwar - Ahilyanagar Circuit 2	220kV	18-08-2025	Bird Pitting	1993	32 Years	Porcelain	AB India	Foggy & Near to river Bank	Additional Bird Guards Provided	Cleaning of Insulators
9	Nashik	220kV Babhaleshwar - Ahilyanagar Circuit 1	220kV	05-09-2025	Transient Fault	1990	34 Years	Porcelain	AB India	Rainy	Replaced	Cleaning of Insulators
10	Nashik	220kV Babhaleshwar - Ahilyanagar Circuit 1	220kV	11-09-2025	Bird Pitting	1990	34 Years	Porcelain	AB India	Foggy & Near to river Bank	Replaced	Cleaning of Insulators
11	Nashik	220kV Babhaleshwar - Ahilyanagar Circuit 1	220kV	17-09-2025	Bird Pitting	2025	04 Days	Porcelain	AB India	Foggy & Near to river Bank	Additional Bird Guards Provided	Cleaning of Insulators
12	Nashik	220kV Babhaleshwar - Ahilyanagar Circuit 2	220kV	05-11-2025	Bird Pitting	2025	79 Days	Porcelain	AB India	Foggy & Near to river Bank	Additional Bird Guards Provided	Cleaning of Insulators
13	Nashik	220kV Babhaleshwar - Ahilyanagar Circuit 1	220kV	19-11-2025	Bird Pitting	2025	35 Years	Porcelain	AB India	Foggy & Near to river Bank	Additional Bird Guards Provided	Cleaning of Insulators
14	Nashik	220kV Babhaleshwar - Ahilyanagar Circuit 1	220kV	26-7-2025	Flashover	1993	35 Years	porcelain	AB India	Normal	Replaced	monkey & ground patrolling, Thermoscaning,
15	Nashik	220kV GCR Babhaleshwar Ckt-II	220kV	16.08.2025	Old insulator Decapping	1968	48	Porcelain	NGK	Partially rainy	Replaced by Porcelain longrod	Maximum old disc insulators are already replaced with longrod.
16	Nashik	220kV Malegaon-Sayne	220kV	18.04.2025	Old Disc insulator Decapping	2017	8	Porcelain	BHEL	Partially rainy	Replaced by Polymer longrod	Replaced by Longrod or AF Disc
17	Nashik	220kV Malegaon-Satana	220kV	21.07.2025	Old Disc insulator Decapping	2011	15	Porcelain	BHEL	NORMAL	Replaced by Polymer longrod	Replaced by Longrod or AF Disc
18	Nashik	220kV Malegaon-Satana	220kV	12.08.2025	Old Disc insulator Decapping	2011	15	Porcelain	BHEL	NORMAL	Replaced by Porcelain longrod	Replaced by Longrod or AF Disc
19	Nashik	220kV Malegaon-Satana	220kV	13.11.2025	Old Disc insulator Decapping	2011	15	Porcelain	BHEL	NORMAL	Replaced by Porcelain longrod	Replaced by Longrod or AF Disc
20	Nashik	220kV Malegaon-Satana	220kV	14.11.2025	Old Disc insulator Decapping	2011	15	Porcelain	BHEL	NORMAL	Replaced by Porcelain longrod	Replaced by Longrod or AF Disc
21	Nashik	400 kV Khadka - Aurangabad Ckt	400 kV	05.05.2025	Broken due to heavy Lightning	1999	26 Years	Porcelain	NA	Rainy condition	Replaced by Long Rod Insulator String	Monkey Petrolling done.
22	Nashik	400 kV Dhule - SSNNL Ckt 1	400 kV	12.06.2025	Decapping	1995	30 Years	Porcelain	JSI India Ltd	Raining & foggy	Replaced by Long Rod Insulator String	Monkey patrolling of all Location done.
23	Nashik	400 kV Dhule - SSNNL Ckt 1	400 kV	16.08.2025	Broken due to heavy Lightning	1995	30 Years	Porcelain	JSI India Ltd	Raining & foggy	Replaced by Long Rod Insulator String	Monkey patrolling of all Location done.
24	Nashik	220 kV Dhule - Dondaicha	220 kV	17.08.2025	Broken due to heavy Lightning	1998	27 Years	Porcelain	NA	Rainy condition	Replaced by Long Rod Insulator String	Regular Patrolling Done byt LMSD Dhule Gang
25	Nashik	220 kV Khadka - Kekatnimbhora Ckt	220 kV	16.09.2025	Decapping	1999	26 Years	Porcelain	NA	Rainy condition	Replaced by Long Rod Insulator String	Regular Patrolling Done but LMSD Dhule Gang
26	Nashik	220 kV Amalner-Dondaicha	220 kV	23.10.2025	Decapping	2007	18 Years	Porcelain	BHEL	Normal	Replaced by Long Rod Insulator String	Monkey Petrolling done. Cold Washing Done after occurrence

Detailed insulator failure data (220 kV, 400 kV & 765 kV)												
Pune Zone												
Sr.No	Name of Zone	Name of the line	Voltage level of the line	Date of Insulator Failure	Reason for insulator failure	Year of commissioning of Insulator	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite)	Make of the Insulator	Prevailing climatic conditions at the time of failure	Remedial action taken	Maintenance practices adopted
1	Pune	220kV Theur-magarpatta line	220 kV	18.11.2025	Flashover	s	Approx 16 years	Porcelain	BHEL	Fog	Insulator string replaced	Cold line & chemical cleaning,Monkey patrolling
2	Pune	220kV Theur-Phursungi-2 line	220 kV	15.11.2025	Decapping	15.06.2016	Approx 9 years	Porcelain	VML	clear	Insulator string replaced	Cold line & chemical cleaning,Monkey patrolling
3	Pune	220kV Jejuri-Phursungi 3 line	220 kV	27.10.2025	Flashover	10.06.2025	4 month	Porcelain longrod	Modern insulator	Fog	Insulator string replaced	Cold line & chemical cleaning,Monkey patrolling
4	Pune	220kV Sahara Bombay Dyeing	220kV	22.01.2025	Flashover	1967	58 Yrs	Discs type porcelain	NGK	Fog	String replaced	Chemical or cold washing of insulators is done regularly to avoid insulator failure due to flashover. Also weak discs detected in PID testing are replaced
5	Pune	220kV Talegaon (Ambi) - GM	220kV	27.07.2025	Flashover	2008	17 Yrs	Discs type porcelain	WS	Rainy	String replaced by disc insulator string	
6	Pune	220KV Urse-Talegaon Ckt-1	220kV	09.08.2025	Flashover	2008	17 Yrs	Discs type porcelain	WS	Rainy	String replaced by disc insulator string	
7	Pune	220kV Urse Chinchwad line	220kV	21.08.2025	Flashover	2015	10 Yrs	Polymer	NGK LOCKE	Rainy	String replaced by disc insulator string	
8	Pune	220kV Pirangut Kandalgaon	220kV	08.12.2025	Flashover	2006	19 Yrs	Discs type porcelain	WS	Fog	String replaced	Chemical or cold washing of insulators is done regularly to avoid insulator failure due to flashover.
9	Pune	220kV Alephata-Babhaleshwar line	220kV	11.12.2025	Decapping	1993	Approx 32 years	Porcelain	BHEL	sunny	insulator replaced	
10	Pune	400kV Lonikand2-Karjat ckt 2	400kV	03.04.2025	Decapping	18.03.1991	25 Yrs	Porcelain	BHEL	windy and stormy weather	Replaced the decapped string at loc 444 B ph by LMSD Lonikand	Replacement of old disc insulator strings with anti fog long rod insulators is in progress
11	Pune	400kV Karjat Girawali ckt 2	400kV	07.09.2025	Flashover	18.03.1991	25 Yrs	Porcelain	BHEL	Normal	R ph flashovered string replaced at loc:159 by LMSD Lamboti	
12	Pune	400 kV Lonikand-1-Talegaon(PGCIL) line	400 kV	25.06.2025; 05.04.2025;	Decapping	17.02.1990	35 Yrs	Discs type porcelain	BHEL	Clear	Replaced with discs type insulator strings	PID, periodic washing; prepared scheme for use of Porcelain Long Rod Insulator
13	Pune Zone	400kV Lamboti-PG(Solapur)	400kV	15.05.2025	Flashover/Decapping	2003	22 Years	Porcelain	BHEL INDIA	Thunder storm	Cold Line washing carried out & PID testing	1. Cold Line washing carried out 2.PID testing defect attended 3.TFR higher earthing values & Missing earthing attended
14	Pune Zone	400kV Lamboti-PG(Solapur)	400kV	28.06.2025	Flashover/Decapping	2003	22 Years	Porcelain	BHEL INDIA	Normal	Cold Line washing carried out & PID testing	1. Cold Line washing carried out 2.PID testing defect attended 3.TFR higher earthing values & Missing earthing attended

15	Pune	220 kV Karjat-Shirshuphal	220 kV	05.09.2025	insulator flashover observed	23.08.2024	1 year	Porcelain	NA	Thunderstorm	Flashovered insulator string replaced	PID testing , Insulator cleaning ,monkey patrolling
16	Pune	400kV Jejuri - 220kV Lonand CKT-II	220kV	24.11.2025	Due to dense Fog	24.01.1992	33	Porcelain	NA	Cold Weather Condition & Dense Fog	String Replacement done	PID, Cold Line Washing ,
17	Pune	220 KV Bale-Dharashiv	220 KV	14-05-2025	String Flashover	1985	40	Porcelain	Insulators Electrical Company, Bhopal	Rainy, humidity	1 Insulator String replaced 2) PID testing 3) TFR	1)Cold line Cleaning of Insulators. 2)Replacement of Insulator Strings. 3)PID testing.
18	Pune	220 KV Bale-PG 2 Multicircuit	220 KV	06-06-2025	String Flashover	2025	1	Porcelain	Insulators Electrical Company, Bhopal	Heatwaves/Monsoon	1)Insulator String replaced 2) PID testing 3) TFR	1)Cold line Cleaning of Insulators. 2)Replacement of Insulator Strings. 3)PID testing.
19	Pune	220 KV Bale-Dharashiv	220 KV	22-07-2025	Disc found broken	1985	40	Porcelain	Insulators Electrical Company, Bhopal	Heavy winds	1)Insulator String replaced 2) PID testing 3) TFR	1)Cold line Cleaning of Insulators. 2)Replacement of Insulator Strings. 3)PID testing.
20	Pune	220 KV Bale-PG 1 Multicircuit	220 KV	26-08-2025	String Flashover	2025	1	Porcelain	Insulators Electrical Company, Bhopal	Humid weather	1)Insulator String replaced 2) PID testing 3) TFR	1)Cold line Cleaning of Insulators. 2)Replacement of Insulator Strings. 3)PID testing.
21	Pune	220 KV Bale-PG 2 Multicircuit	220 KV	10-09-2025	Disc found broken	2025	1	Porcelain	Insulators Electrical Company, Bhopal	Thunder Storms	1)Insulator String replaced 2) PID testing 3) TFR	1)Cold line Cleaning of Insulators. 2)Replacement of Insulator Strings. 3)PID testing.
22	Pune	220 KV Bale-PG 2 Multicircuit	220 KV	24-10-2025	String Flashover	2025	1	Porcelain	Insulators Electrical Company, Bhopal	Thunder Storms & rainy weather	1)Insulator String replaced 2) PID testing 3) TFR	1)Cold line Cleaning of Insulators. 2)Replacement of Insulator Strings. 3)PID testing.

Detailed insulator failure data (220 kV, 400 kV & 765 kV)												
Vashi Zone												
Sr. No.	Name of Zone/ Circle	Name of the line	Voltage level of the line	Date of Insulator Failure	Reason for insulator failure	Year of commissioning of Insulator	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite)	Make of the Insulator	Prevailing climatic conditions at the time of failure	Remedial action taken	Maintenance practices adopted
1	Vashi/ Kalwa	220kV Kalwa-Trombay Line	220kV	16.06.2025	Quality Issue/ Manufacturing Defect	2020-21	5 Years	Composite	Shri.Radha industries Make	Rainy & Humid	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
2	Vashi/ Kalwa	220kV Mulund-Trombay Line	220kV	18.06.2025	Quality Issue/ Manufacturing Defect	2020-21	5 Years	Composite	Shri.Radha industries Make	Rainy & Humid	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
3	Vashi/ Kalwa	220kV Mulund-Trombay Line	220kV	19.06.2025	Quality Issue/ Manufacturing Defect	2020-21	5 Years	Composite	Shri.Radha industries Make	Rainy & Humid	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
4	Vashi/ Kalwa	220KV Padgha-Temghar line 1	220kV	27.06.2025	Quality Issue/ Manufacturing Defect	2021-22	4 Years	Composite	Shri.Radha industries Make	Rainy & Humid	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
5	Vashi/ Kalwa	220KV Padgha-Temghar line 2	220kV	23.07.2025	Quality Issue/ Manufacturing Defect	2021-22	4 Years	Composite	Shri.Radha industries Make	Rainy & Humid	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
6	Vashi/ Kalwa	220kV Kalwa-Trombay Line	220kV	24.08.2025	Quality Issue/ Manufacturing Defect	2021-22	4 Years	Composite	Shri.Radha industries Make	Rainy & Humid	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
7	Vashi/ Kalwa	220kV AKP-Nashik Line	220kV	20.09.2025	Decapping	2021-22	4 Years	Porcelain	IEC	Rainy & Humid	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
8	Vashi/ Kalwa	220kV Padgha-Nalasopara-Vasai Tap line	220kV	07.05.2025	Poor quality/ Manufacturing Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Normal	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.

9	Vashi/ Kalwa	220kv kamba - Vasai line	220kV	06.06.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Normal	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
10	Vashi/ Kalwa	220kV Padgha- Nalasopara- Vasai Tap line	220kV	29.06.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
11	Vashi/ Kalwa	220kv Kamba - Vasai line	220kV	06.07.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
12	Vashi/ Kalwa	220kV Padgha- Nalasopara- Vasai Tap line	220kV	06.07.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
13	Vashi/ Kalwa	220kv Padgha- Nalasopara Vasai (tap) line	220kV	13.07.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
14	Vashi/ Kalwa	220kv Padgha - Nalasopara line	220kV	17.07.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
15	Vashi/ Kalwa	220kV Kamba- Vasai Line	220kV	05.08.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
16	Vashi/ Kalwa	220kV Kamba- Vasai Line	220kV	14.08.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
17	Vashi/ Kalwa	220kV Kamba- Vasai Line	220kV	14.08.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.

18	Vashi/ Kalwa	220kV Kamba- Vasai Line	220kV	29.08.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
19	Vashi/ Kalwa	220kV Kamba- Vasai Line	220kV	29.08.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
20	Vashi/ Kalwa	220kV Kamba- Vasai Line	220kV	30.08.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
21	Vashi/ Kalwa	220kV Kamba- Vasai Line	220kV	04.09.2025	Poor quality/ Manufacturin g Defect	07.09.2024	8 to 9 Months	Porcelain	Insulators & Electricals company, Mandideep M.P.(IEC)	Rainy	Insulators Replaced with new one	Visual inspection during ground patrolling quarterly basis and MonkeyPatrolling by climbing on tower yearly basis. Also, Cleaning of insulators is carried out in heavily polluted and dust prone area.
22	Vashi/ Panvel	220kV Uran - Sez line	220kV	07.04.2025	Insulation degradation	2024	1 Years	Porcelain	Modern	Normal sunny weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
23	Vashi/ Panvel	220kV Bombay Dyeing - Sahara Line trip outage	220kV	07.05.2025	Insulation degradation	2020	5 Years	Porcelain	Modern	Normal sunny weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
24	Vashi/ Panvel	220 kV Apta PGCIL -2	220kV	21.05.2025	Insulation degradation	2016	9 Years	Composite	Gold stone	Rainy Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
25	Vashi/ Panvel	220kV Apta Uran 4	220kV	22.05.2025	Insulation degradation	2021	4 Years	Porcelain	Modern	Rainy Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
26	Vashi/ Panvel	220kV Apta Uran 2 Line	220kV	24.05.2025	Insulation degradation	2023	2 Years	Composite	Gold stone	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
27	Vashi/ Panvel	220kV Apta- Uran 1 line	220kV	04.06.2025	Insulation degradation	2021	4 Years	Composite	Gold stone	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
28	Vashi/ Panvel	220 kV Apta ACCIL line	220kV	07.06.2025	Insulation degradation	2018	7 Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
29	Vashi/ Panvel	100 kV Apta jite Line	100kV	13.06.2025	Insulation degradation	2024	1 Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
30	Vashi/ Panvel	100kV Apta- Bhokarpada- Khopoli line	100kV	13.06.2025	Insulation degradation	2018	7 Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
31	Vashi/ Panvel	220 kV Apta- Uran 2-line	220kV	18.06.2025	Insulation degradation	2016	9 Years	Composite	Gold stone	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
32	Vashi/ Panvel	100kV Apta MUSCo 1 Line	100kV	24.06.2025	Insulation degradation	2014	11 Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
33	Vashi/ Panvel	220kV Kharghar - Khandeshw ar 1 line	220kV	27.06.2025	Insulation degradation	2012	13 Years	Composite	Gold stone	Rainy & Lightening Weather	Replaced by new one	cold line washing insulator celaing and bird guard
34	Vashi/ Panvel	220kV Uran ONGC line	220kV	02.07.2025	Insulation degradation	2012	13 Years	Composite	Gold stone	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
35	Vashi/ Panvel	220kV ONGC- JNPT line	220kV	03.07.2025	Insulation degradation	2012	13 Years	Composite	Gold stone	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation

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36	Vashi/ Panvel	220 kV bombay dyeing sahara line	220kV	12.07.2025	Insulation degradation	2022	3 Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
37	Vashi/ Panvel	100 kV Bhushan steel line no.2	100kV	20.07.2025	Insulation degradation	2010	15 Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
38	Vashi/ Panvel	220kV ONGC- JNPT link line	220kV	21.07.2025	Insulation degradation	2012	13 Years	Composite	Gold stone	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
39	Vashi/ Panvel	100 kV tss - thal	100kV	22.07.2025	Insulation degradation	2024	1 Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
40	Vashi/ Panvel	220kV Waghivali - Kharghar 2 Line	220kV	02.08.2025	Insulation degradation	2022	3Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
41	Vashi/ Panvel	100kV Jite Thal Gail Tap Line	100kV	12.10.2025	Insulation degradation	2014	12 Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
42	Vashi/ Panvel	100kV Apta TSS Line	100kV	04.11.2025	Insulation degradation	2024	1 Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
43	Vashi/ Panvel	100kV Apta Jite Line	100kV	05.11.2025	Insulation degradation	2023	2 Years	Porcelain	Modern	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
44	Vashi/ Panvel	220 kV Addlab - Pedambe line	220kV	10.11.2025	Insulation degradation	2012	13 Years	Composite	Gold stone	Rainy & Lightening Weather	Replaced by new one	cold line washing, insulator cleaning and bird guard installation
45	Vashi/ Panvel	Pedambe- Adlab Line	220 kV	14.05.2025	Decapping	NA	61 Years	Porcelain	Disc	Rain fall season	Insulator replaced	cold line washing, insulator cleaning and bird guard installation
46	Vashi/ Panvel	Mangaon Tss- Mhasala Line	100 kV	14.06.2025	Decapping	NA	3 Years	Porcelain	Disc	Rain fall season	Insulator replaced	cold line washing, insulator cleaning and bird guard installation
47	Vashi/ Panvel	Koyna- Kgaon Line	220 kV	18.06.2025	Decapping	NA	63 Years	Porcelain	Disc	Rain fall season	Insulator replaced	cold line washing, insulator cleaning and bird guard installation
48	Vashi/ Panvel	Nagothane- ACCIL Line	220 kV	20.07.2025	Decapping	NA	61 Years	Porcelain	Disc	Rain fall season	Insulator replaced	cold line washing, insulator cleaning and bird guard installation
49	Vashi/ Panvel	220kV Baggaon- Ghatghar line	220kV	01.07.2025	Flashover	2005	20 Years	Composite	NGK	Rainy	After Monkey Patrolling, faulty insulator replaced	cold line washing, insulator cleaning and bird guard installation
50	Vashi/ Panvel	220kV Washala- Ghatghar line	220kV	08.07.2025	Flashover	2005	20 Years	Composite	NGK	Rainy	After Monkey Patrolling, faulty insulator replaced	cold line washing, insulator cleaning and bird guard installation
51	Vashi/ Panvel	220kV Jindal- Ghatghar line	220kV	28.07.2025	Flashover	2005	20 Years	Composite	NGK	Rainy	After Monkey Patrolling, faulty insulator replaced	cold line washing, insulator cleaning and bird guard installation
52	Vashi/ Panvel	220kV Jindal- Ghatghar line	220kV	01.08.2025	Flashover	2005	20	Composite	NGK	Rainy	After Monkey Patrolling, faulty insulator replaced	cold line washing, insulator cleaning and bird guard installation
53	Vashi/ Panvel	220kV Nashik GCR- Ghatghar line	220kV	02.09.2025	Flashover	2005	20 Year	Composite	NGK	Rainy	After Monkey Patrolling, faulty insulator replaced	cold line washing, insulator cleaning and bird guard installation
54	Vashi/ Panvel	220kV Baggaon- Ghatghar line	220kV	15.09.2025	Flashover	2005	20 Year	Composite	NGK	Rainy	After Monkey Patrolling, faulty insulator replaced	cold line washing, insulator cleaning and bird guard installation
55	Vashi/ Panvel	220 kV Padgha - Pal	220 kV	24.05.2025	Flashover	06.04.1994	31 Years	Porcelain	BHEL	heavy rain & lightning	Flashover insulator string replaced with New	cold line washing, insulator cleaning and bird guard installation
56	Vashi/ Panvel		220 kV	04.07.2025	Flashover			Porcelain	BHEL	heavy rain & lightning	Flashover insulator string replaced with New	cold line washing, insulator cleaning and bird guard installation
57	Vashi/ Panvel	Nagothane- Padgha 1 Line	400 KV	01.10.2025	Decapping	NA	25 Years	Porcelain	Disc	Rain fall season	Insulator replaced	cold line washing, insulator cleaning and bird guard installation

58	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400kV	18-04-2025	Flashhover	1979	39 Years	Porcelain	120KN-ABI, 160KN- BHEL	Hot and dry climatic conditions	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
59	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400kV	05-10-2025	Flashhover	1979	39 Years	Porcelain	120KN-ABI, 160KN- BHEL	Hot and dry climatic conditions	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
60	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400kV	06-05-2025	Flashhover	1979	39 Years	Porcelain	120KN-ABI, 160KN- BHEL	cloudy, hot and humid, with intermittent strong winds	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
61	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 2	400kV	13-04-2025	Flashhover	1979	39 Years	Porcelain	120KN-ABI, 160KN- BHEL	Hot and dry climatic conditions	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
62	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 2	400 kV	20.04.2025	PID faulty report of luster 2023- 24	1981	44 Years	Porcelain	JSL INDIA	Hot and Dry Climatic Condition	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
63	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 2	400 kV	20.04.2025	PID faulty report of luster 2023- 24	1981	44 Years	Porcelain	JSL INDIA	Hot and Dry Climatic Condition	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
64	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	28.05.2025	Flashover/pu ncture	1979	46 Years	Porcelain	IEC	Cloudy Hot and Humid Climatic Condition	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)

65	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	31.05.2025	PID faulty report of luster 2023- 24	1981	44 Years	Porcelain	JSL INDIA	Hot and Dry Climatic Condition	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
66	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	01.06.2025	PID faulty report of luster 2023- 24	1981	44 Years	Porcelain	JSL INDIA	Cloudy Rainy Climatic Condition	Replacemen t of damaged insulators	
67	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 2	400 kV	01.06.2025	PID faulty report of luster 2023- 24	1981	44 Years	Porcelain	JSL INDIA	Cloudy Hot and Humid with Climatic Condition	Replacemen t of damaged insulators	
68	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 2	400 kV	01.06.2025	PID faulty report of luster 2023- 24	1981	44 Years	Porcelain	JSL INDIA	Cloudy Hot and Humid with Climatic Condition	Replacemen t of damaged insulators	
69	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 2	400 kV	01.06.2025	PID faulty report of luster 2023- 24	1981	44 Years	Porcelain	JSL INDIA	Hot and Dry Climatic Condition	Replacemen t of damaged insulators	
70	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 2	400 kV	01.06.2025	PID faulty report of luster 2023- 24	1981	44 Years	Porcelain	JSL INDIA	Cloudy and rainy Climatic Condition	Replacemen t of damaged insulators	
71	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	08.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	BMIC	Hot and Dry Climatic Condition	Replacemen t of damaged insulators	

72	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	08.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	BMIC	Hot and Dry Climatic Condition	Replacemen t of damaged insulators
73	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	08.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	BMIC	Hot and Dry Climatic Condition	Replacemen t of damaged insulators
74	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	14.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	JSL INDIA	Cloudy Hot and Humid with Climatic Condition	Replacemen t of damaged insulators
75	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	14.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	JSL INDIA	Cloudy Hot and Humid with Climatic Condition	Replacemen t of damaged insulators
76	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	14.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	JSL INDIA	Hot and Dry Climatic Condition	Replacemen t of damaged insulators
77	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	15.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	JSL INDIA	Cloudy Hot and Humid with Climatic Condition	Replacemen t of damaged insulators
78	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	15.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	JSL INDIA	Cloudy Hot and Humid with Climatic Condition	Replacemen t of damaged insulators



79	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	15.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	JSL INDIA	Hot and Dry Climatic Condition	Replacemen t of damaged insulators	 washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
80	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	15.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	JSL INDIA	Cloudy and rainy Climatic Condition	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
81	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	15.06.2025	PID faulty report of luster 2023- 24	1979	46 Years	Porcelain	JSL INDIA	Hot and Dry Climatic Condition	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
82	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	27.06.2025	Flashover/pu ncture	1979	46 Years	Porcelain	IEC	Hot and Dry Climatic Condition	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
83	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	29.06.2025	Flashover/pu ncture	1979	46 Years	Porcelain	IEC	Hot and Dry Climatic Condition	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)
84	Vashi/ HVDC Padgha	400kV Padgha- Babhaleshw ar 1	400 kV	30.06.2025	Flashover/pu ncture	1979	46 Years	Porcelain	IEC	Hot and Dry Climatic Condition	Replacemen t of damaged insulators	Monitoring 1. Thermovision inspection 2. Leakage current monitoring 3. Drone inspection 4. Routine patrolling 5. Periodic insulator washing 6. Bird guards installed (The replacement of the insulator string under the LES scheme is currently in progress)

85	Vashi Zone	500kV Chandrapur Padghe HVDC line.	500KV	02.05.2025	On 02.05.2025 Voltage reduce incidence was happened Pole 1 of 500kV Chandrapur Padghe HVDC line. After petrolling flashover observed and also disc insulators found polluted, being road crossing location.	1999	26years	GLASS	SEDIVER	SUMMER SEASON	"Emergency outage taken on dt 04.05.2025 @ 02:09hrs to 06:00hrs 1. At CP 983 - Chandrapur side inner bottom 1 nos damaged disc replaced also cold washing of 8 nos of disc done 2. Also cold washing for Suspension loc 978 to 984 was	To avoid failure of Disc Insulators i) Regular petrolling & themoscanning is done. ii) Cold washing, Chemical cleaning is done as per requirement. iii) Also tower earthing is checked regularly & also tower footing resistance is measured. iii) HVDC Line annual outage is taken in the month of Nov every year. All the maintenance activities such as broken insulator disc replacement, chemical cleaning of polluted isulator discs & other observed defecs are attended during the
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GUJARAT ENERGY TRANSMISSION CORPORATION (GETCO) 400KV & 220KV Porcelain/ Composite (SRI) failure Details for the year 2025 (Jan-25 to Dec-25)

Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
1	220KV Otha - Shelavadar line no. 1	220	30-09-2022	11.07.2025	May be due to lightening stroke	2.78	SRI	Shree	Rainy	During the line ground patrolling flashed SRI found at loc. No. 21(SB), B Phase. Same is replaced by new one and charged the line.	
2	220KV Sagapara - Shelavadar line no. 2	220	30-09-2022	29.08.2025	May be due to lightening stroke	2.91	SRI	Shree	Rainy	During the line ground patrolling flashed SRI found at loc. No. 51(T), R Phase. Same is replaced by new one and charged the line.	
3	220kV Savarkundla-GPPL line	220	2014	07.05.2025	Aging effect, May due to cloudy weather and high system voltage due to rainy season	11	SRI	Decosil	Cloudy	Dt.07.05.2025 Loc No-88 R-ph SRI replaced.	
4	220KV Savarkundla(220Kv) - Bhavnagar Energy Company Limit - 1	220	2014	26.05.2025	Aging effect, May due to cloudy weather and high system voltage due to rainy season	11	SRI	Decosil	Cloudy	Dt.26.05.25 Flashed SRI replacement at loc 323(S) R phase(02:25Hrs)	
5	220KV Savarkundla(220Kv) - Mesanka (Gariyadhar) - 1	220	2015	23.05.2025	Aging effect, May due to cloudy weather and high system voltage due to rainy season	10	SRI	Decosil	Cloudy	Dt.25.05.2025 Loc No-118(S) replaced.	
6	220kV Savakundla-GPPL line	220	2015	16.06.2025	Aging effect, May due to cloudy weather and high system voltage due to rainy season	10	SRI	Decosil	Rainny	Dt.16.06.2025 Flash SRI Repaced.	
7	220kV GPPC-Sintex line	220	2016	27.06.2025	Aging effect, May due to cloudy weather and high system voltage due to rainy season	10	SRI	Goldston	Rainny	Dt.27.06.2025 Loc No.8(T) B-ph SRI Replaced.	
8	220kV Savarkundla-Otha line	220	2016	01.07.2025	Aging effect, May due to cloudy weather and high system voltage due to rainy season	10	SRI	Goldston	Rainny	Loc No-01.07.25: Loc No-89(S) R-ph flash SRI replaced.	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
9	220kV Savarkundla-Kovaya line	220	2016	06.07.2025	Aging effect, May due to cloudy weather and high system voltage due to rainy season	10	SRI	ABI	Rainny	Dt.06.07.2025 Loc No-132(S) R-ph SRI replaced.	
10	220kV GPPC-Dhokadava line	220	2016	01.08.2025	Aging effect, May due to cloudy weather and high system voltage due to rainy season	10	SRI	Goldston	Rainny	Dt.01.08.2025 Loc No-3(S) B-ph Pilot SRI replaced.	
11	220kV Savarkundla-GPPC line	220	2016	14.08.2025	May due to cloudy weather and high system voltage due to rainy season	10	SRI	Decosil	Rainny	Dt.14.08.2025 Loc No-209(S) B-ph SRI Replaced.	
12	220kV Savarkundla-Kovaya line	220	2016	29.08.2025	May due to cloudy weather and high system voltage due to rainy season	10	SRI	Decosil	Rainny	Dt.30.08.2025 Loc No-123(S) R-ph SRI replaced.	
13	220kV Savarkundla-Amreli line-2	220	2014	06.09.2025	May due to cloudy weather and high system voltage due to rainy season	11	SRI	Decosil	Rainny	Dt.06.09.2025 Loc No-84(S) R-ph SRI Replaced.	
14	220kV Savarkundla-Amreli line-2	220	2014	10.10.2025	May due to cloudy weather and high system voltage due to rainy season	11	SRI	Goldston	Rainny	Dt.10.10.2025 Loc No-114(S) R-Ph SRI replaced.	
15	220kV Savarkundla-Amreli line-2	220	2014	05.11.2025	May due to cloudy weather and high system voltage due to rainy season	11	SRI	Decosil	Clear	Dt.05.11.25 Loc No-81(S) R-ph SRI replaced.	
16	220kV Sagapara-Mesanka line	220	2021	20.10.2025	flashover with in insulator	4 Years	SRI	decosil	clear weather	SRI replaced by new one	
17	220kV Sagapara-Shelavadar line no.2	220	2022	29.08.2025	flashover with in insulator	3 Years	SRI	Shree	cloudy	SRI replaced by new one	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
18	220kV Vartej-Valbhipur line	220	2017	11.01.2025	Flashover SRI in Y-ph loc. no :-45	8 Years	SRI	Not visible	Costal area	SRI replaced by new one	
19	220kV Vartej-Pachham line	220	2017	08.07.2025	Flashover SRI Loc. no 588(S)	8 Years	SRI	Decosil (90KN)	Costal area	SRI replaced by new one	
20	220KV Vartej-BECL	220KV	2013	29.04.2025	Internal fault	12 Years	SRI	Decosil	Summer clean	SRI replaced by new one	
21	220KV BECL-Savarkundla	220KV	26.06.2015	09.05.2025	Internal fault	10 Years	SRI	Goldstone	Summer clean	SRI replaced by new one	
22	400KV Varsana SS	400	11-02-2010	08-10-2025	Loc No. 108 Y Ph. SRI Broken	5718	SRI	As per Embross Name "SED JW"	Normal	SRI Replace	
23	220kV Bhimasar-Chardva line No.1	220kV	17.05.2012	17.08.2025	Flashover	13.3 Year	Composite(SRI)	Goldstone Pvt.Ltd	Rainiy	SRI Change with new one	
24	220kV Nanikhakhar-Suthari Line no.2	220kV	22.12.2006	01.12.2025	SRI found flashed	19 years	Composite(SRI)	NA	saline,humid, Gusty wind zone	SRI replacement arried out.	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
25	220kV Nanikhakhar-Suthari Line no.2	220kV	22.12.2006	16.08.2025	SRI found flashed	19 years	Composite(SRI)	NA	saline,humid, Gusty wind zone	SRI replacement arried out.	
26	220kV Nanikhakhar-Suthari Line no.1	220kV	22.12.2006	17.06.2025 at 01:58 hrs	SRI found flashed	19 years	Composite(SRI)	NA	saline,humid, Gusty wind zone	SRI replacement arried out.	
27	220kV Nanikhakhar-Suthari Line no.1	220kV	22.12.2006	17.06.2025 at 16:50 hrs	SRI found flashed	19 years	Composite(SRI)	NA	saline,humid, Gusty wind zone	SRI replacement arried out.	
28	220kV Nanikhakhar-Sindhodi Line no.1	220kV	02.07.2009	05.07.2025	SRI found flashed	17 years	Composite(SRI)	NA	saline,humid, Gusty wind zone	SRI replacement arried out.	
29	220kV Nanikhakhar-Sindhodi Line no.1	220kV	02.07.2009	05.07.2025	SRI found flashed	17 years	Composite(SRI)	NA	saline,humid, Gusty wind zone	Suspention bridge type location & both SRI found Flashed hence both SRI replaced	
30	220kV Nanikhakhar-Sindhodi Line no.2	220kV	02.07.2009	17.06.2025	SRI found flashed	17 years	Composite(SRI)	NA	saline,humid, Gusty wind zone	SRI replacement arried out.	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
31	220kV Nanikhakhar-Sindhodi Line no.2	220kV	02.07.2009	11.09.2025	SRI found flashed	17 years	Composite(SRI)	NA	saline,humid, Gusty wind zone	SRI replacement arried out.	
32	400kV APL(Mundra)-Mansar Line	400kV	13.01.2011 LILO at mansar on Dt.24.11.2021	17.11.2025	SRI found broken.	14 Years	Composite(SRI)	NA	saline,humid, Gusty wind zone	SRI replacement arried out.	
33	400kV APL(Mundra)-Mansar Line	400kV	13.01.2011 LILO at mansar on Dt.24.11.2021	28.06.2025	SRI found broken.	14 Years	Composite(SRI)	NA	saline,humid, Gusty wind zone	SRI replacement arried out.	
34	220KV Shivilakha - Welspun corp Ltd-1	220	21-04-2007	02-01-2025	Flash Over	21/4/2007	SRI	Radhe	sunny weather	Replacement with new one	
35	220KV Sankhari - Shivilakha - 1	220	30-03-2004	04-12-2025	Bird Fault	30/3/2004	SRI	Radhe	sunny weather	Replacement with new one	
36	220KV NAKHATRANA-PANDHRO LINE-1	220KV	2016	12-02-2025	Y-PHASE SRI BROKEN	9	SRI	GOLD STONE	SALTY	SRI Replacement	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
37	220KV Nakhatrana - Akrimota line	220KV	2016	07-07-2025	HEAVY FAULT DUE TO RAIN	9	SRI	GOLD STONE	RAINY AND SALTY	SRI Replacement	
38	220KV Nakhatrana - Akrimota line	220KV	2016	07-07-2025	HEAVY FAULT DUE TO RAIN	9	SRI	GOLD STONE	RAINY AND SALTY	SRI Replacement	
39	220KV Nakhatrana - Akrimota line	220KV	2016	11.07.2025	HEAVY FAULT DUE TO RAIN	9	SRI	GOLD STONE	RAINY AND SALTY	SRI Replacement	
40	220KV Akri - Panandhro line-2	220KV	2016	17-07-2025	HEAVY FAULT DUE TO RAIN	9	SRI	GOLD STONE	RAINY AND SALTY	SRI Replacement	
41	220KV AKRI-PANDHRO LINE	220KV	2016	25-07-2025	HEAVY FAULT DUE TO RAIN	9	SRI	GOLD STONE	RAINY AND SALTY	SRI Replacement	
42	220KV Akri - Panandhro line-2	220KV	2016	17-08-2025	HEAVY FAULT DUE TO RAIN	9	SRI	GOLD STONE	RAINY AND SALTY	SRI Replacement	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI)),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
43	220kv Bhachunda jamanwada Line 1 /400 KV Bhachunda	220 KV	N/A	24-08-2025	due to high current	N/A	SRI	N/A	Rain	yes	
44	220kv Bhachunda jamanwada Line 2 /400 KV Bhachunda	220 KV	N/A	24-07-2025	R phase conductor fallen	N/A	SRI	N/A	Rain	yes	
45	400kV Chorania-Amreli line	400KV	2013	06.05.2025	Due to mechanical failure SRI Broken	12	SRI	DECOSIL	Sunny	Failed SRI has been replaced by new one	
46	220KV Gondal-Kamlapur	220KV	not visible	17.06.2025	Due to Rain & high lighting stroke	Not traceable	SRI	DECOSIL	Rainy	Failed SRI has been replaced by new one	
47	220KV Gondal-Kamlapur	220KV	2009	04.11.2025	Due to foggy wheather	16	SRI	DECOSIL	Foggy	Failed SRI has been replaced by new one	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
48	Jetpur-Amreli Line	400kV	2013	02.04.2025	Mechanical Failure	12	SRI	DECOSIL	Clear sunny	SRI Replaced And Mail Sent To OEM M/S Deccan Enterprise	
49	Jetpur-Amreli Line	400kV	2013	18.04.2025	Mechanical Failure	12	SRI	DECOSIL	Clear sunny	SRI Replaced And Mail Sent To OEM M/S Deccan Enterprise	
50	Jetpur-Amreli Line	400kV	2013	14.05.2025	Mechanical Failure	12	SRI	DECOSIL	Clear sunny	SRI Replaced And Mail Sent To OEM M/S Deccan Enterprise	
51	Jetpur-Amreli Line	400kV	2013	13.09.2025	Mechanical Failure	12	SRI	DECOSIL	Moist	SRI Replaced And Mail Sent To OEM M/S Deccan Enterprise	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
52	220KV Morbi-Lalpar	220KV	2012	45873	SRI deteriorated due to Heavily Polluted Area due to Surrounding Ceramic Industries	13	SRI	Not visible	Rainy Atmosphere	SRI replaced	
53	220KV Morbi-Vondh	220KV	2012	45859	Location at Krik area & aging effect	13	SRI	Not visible	Rainy Atmosphere	SRI replaced	
54	220KV Vondh-Hadala	220KV	2012	45845	Location at Krik area & aging effect	13	SRI	Not visible	Rainy Atmosphere	SRI replaced	
55	400KV Varsana-Hadala	400KV	2011	45838	Broken SRI & aging effect	14	SRI	Not visible	Rainy Atmosphere	SRI replaced	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
56	220KV Vondh-Hadala	220KV	2012	45834	Due to aging effect of disc insulator	13	SRI	Not visible	Rainy Atmosphere	SRI replaced	
57	400KV Varsana-Hadala	400KV	2011	45815	Location at Krik area & aging effect	14	SRI	Not visible	Clean Atmosphere	SRI replaced	
58	220KV Sartanpar Ghiyavad Line	220kV	08.11.2012	15.08.2025	SRI Flashed	12.75	SRI	Not readable	Heavy Rain Bed weather	SRI replaced	
59	400 kV Hadala Varshana line	400 kV	2011	09.05.25	Mech. Break	14	SRI	DECOSIL	Clear weather	New SRI provided	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
60	400 kV Hadala Varshana line	400 kV	2011	10.09.25	Mech. Break	14	SRI	DECOSIL	Rainy season	New SRI provided	
61	220 kV Hadala Wankaner line	220 kV	2014	13.08.25	Flash over spot observed	11	SRI	DECOSIL	Lightning stroke	New SRI provided	
62	220 kV Hadala Nyara 3 line	220 kV	2015	06.07.25	Mech. Break	10	SRI	Not readable	Rainy season	New SRI provided	
63	220 kV Hadala Wankaner line	220 kV	2014	26.06.25	Flash over spot observed	11	SRI	DECOSIL	Clear weather	New SRI provided	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
64	220 kV Hadala Jamnagar line 1	220 kV	2017	20.02.25	Mech. Break	8	SRI	Not readable	Foggy weather	New SRI provided	
65	220KV Nyara - Kalavad (Khandhera) - 1	220	18.01.2014	03.07.25	NA	11 Yrs & 05 Months	SRI	Dalian Make	Dry & Normal	Replaced on Dt:-03.07.25	
66	220KV Nyara - Kalavad (Khandhera) - 1	220	18.01.2014	06.08.25	NA	11 Yrs & 06 Months	SRI	Dalian Make	Dry & Normal	Replaced on Dt:-19.08.25	
67	220KV Metoda (GIS) - Gondal - 1	220	15.12.2013	10.10.25	heavy rain and lightning	11 Yrs & 9 Months	SRI	Decosil	Dry & Normal	Replaced on Dt:-10.10.25	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
68	220KV Nyara - Kalavad (Khandhera) - 2	220	18.01.2014	14.02.25	Due to Damaged	11 Yrs	SRI	Dalian Make	Dry & Normal	Replaced on Dt:-14.02.25	
69	220KV Gondal - Kamlapur - 1	220	22.03.2010	16.06.25	heavy rain and lightning	15 Yrs & 02 Month	SRI	Goldstone	Dry & Normal	Replaced on Dt:-17.06.25	
70	220KV Gondal - Kamlapur - 1	220	22.03.2010	04.11.25	heavy rain and lightning	15 Yrs & 07 Month	SRI	Goldstone	Dry & Normal	Replaced on Dt:-06.11.25	
71	220kV Jamnagar-Essar Line- 2	220kV	2012	30-01-2025	Due to kite thread	13 Years	Composite(SRI)	DECOSIL	Humid & Polluted	NA	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
72	220kV Jamnagar-Hadala Line- 1	220kV	2011	13-02-2025	Connecting rod broken (Mechanical Failure)	14 Years	Composite(SRI)	GKXEPL	Humid & Windy	NA	
73	132kV Jamnagar - Sikka Line- 1	132kV	NA	21-02-2025	Electrical Failure	13 Years, 03 Months	Composite(SRI)	NA	Humid & Polluted	NA	
74	132kV Jamnagar - Tankara Line	132kV	2014	16-06-2025	Electrical Failure	11 Years	Composite(SRI)	DECOSIL	Humid & Windy	NA	
75	400kV Bhogat SS 220kV Ranavav Line bay	220kV	2022	01.08.2025	External insulation failure of SRI	4	Composite(SRI)	Radhe	Rainy and Saline Coastal atmosphere	Spare bay SRI installed and allotment asked for the replaced one	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
76	400kV Bhogat SS 220kV Kalavad Line bay	220kV	2022	22.08.2025	External insulation failure of SRI	4	Composite(SRI)	Radhe	Rainy and Saline Coastal atmosphere	Spare bay SRI installed and allotment asked for the replaced one	
77	400kV Bhogat SS 220kV Babarzar Line bay	220kV	2022	23.08.2025	External insulation failure of SRI	4	Composite(SRI)	Radhe	Rainy and Saline Coastal atmosphere	Spare bay SRI installed and allotment asked for the replaced one	
78	220KV Bhatia Bhogat Line 2	220kV	2020	27.06.2025	Internal damage in FRP rod of SRI	5	Composite(SRI)	Deccan	Rainy and Saline Coastal atmosphere	Spare bay SRI installed and allotment asked for the replaced one	
79	220KV Bhatia Bhogat Line 1	220kV	2020	27.06.2025	Internal damage in FRP rod of SRI	5	Composite(SRI)	Deccan	Rainy and Saline Coastal atmosphere	Spare bay SRI installed and allotment asked for the replaced one	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
80	220KV Bhatia Bhogat Line 1	220kV	2020	27.06.2025	Internal damage in FRP rod of SRI	5	Composite(SRI)	Deccan	Rainy and Saline Coastal atmosphere	Spare bay SRI installed and allotment asked for the replaced one	
81	220KV Bhatia Bhogat Line 2	220kV	2020	17.08.2025	Internal damage in FRP rod of SRI	5	Composite(SRI)	Deccan	Rainy and Saline Coastal atmosphere	Spare bay SRI installed and allotment asked for the replaced one	
82	Main bus-1/220kv Babarzar ss	220KV	2025	26-06-2025	due to wet weather SRI flashed	0	Composite(SRI)	Shree Radhe Insulators	Monsoon	Faulty SRI Replaced by New SRI	
83	400KV Vadinar-Hadala line No.01	400kV	2011	03-07-2025	Due to Mechanical failure	14	Composite(SRI)	NOT Visible	Monsoon	Faulty SRI Replaced by New SRI	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
84	220kV Motigop-Tebhda Line 2 / 220kV Motigop S/S	220kV	2018	06.05.2025	L-L Earth Fault	6 Years	SRI	DECOSIL	HUMID	Loc. 45 R-ph conductor Snapped due to SRI break from Connecting rod, so SRI replaced with R-ph re-stringing	
85	220kV Motigop-Tebhda Line 2 / 220kV Motigop S/S	220kV	2018	17.06.2025	Earth Fault	6 Years	SRI	DECOSIL	HUMID	Loc. 35 R-ph SRI Replaced	
86	220kV Kalawad-Motigop Line 2 / 220kV Motigop S/S	220kV	2018	18.06.2025	Line under PF, Failed during test trial	6 Years	SRI	DECOSIL	HUMID	Loc. 202 R-ph SRI Replaced	
87	220kV Kalawad-Motigop Line 2 / 220kV Motigop S/S	220kV	2018	19.06.2025	Line under PF, Failed during test trial	6 Years	SRI	DECOSIL	HUMID	Loc. 222 Y-ph SRI Replaced	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
88	220kV Motigop-Tebhda Line 1 / 220kV Motigop S/S	220kV	2018	22.06.2025	Earth Fault	6 Years	SRI	DECOSIL	HUMID	Loc. 46 Y-ph SRI Replaced	
89	220kV Motigop-Tebhda Line 1 / 220kV Motigop S/S	220kV	2018	27.06.2025	Earth Fault	6 Years	SRI	DECOSIL	HUMID	Loc. 27 Y-ph SRI Replaced	
90	220kV Motigop-Tebhda Line 2 / 220kV Motigop S/S	220kV	2018	27.06.2025	Earth Fault	6 Years	SRI	DECOSIL	HUMID	Loc. 36 Y-ph SRI Replaced	
91	220kV Kalawad-Motigop Line 2 / 220kV Motigop S/S	220kV	2018	27.06.2026	Line under PF, Failed during test trial	6 Years	SRI	DECOSIL	HUMID	Loc. 220 Y-ph SRI Replaced	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
92	220kV Motigop-Tebhda Line 1 / 220kV Motigop S/S	220kV	2018	28.06.2025	Line under PF, Failed during test trial	6 Years	SRI	DECOSIL	HUMID	Loc. 48 Y-ph SRI Replaced	
93	220kV Motigop-Tebhda Line 2 / 220kV Motigop S/S	220kV	2018	29.06.2025	Line under PF, Failed during test trial	6 Years	SRI	DECOSIL	HUMID	Loc. 33 Y-ph SRI Replaced	
94	220kV Nyara-Motigop Line 2 / 220kV Motigop S/S	220kV	2018	03.07.2025	Earth Fault	6 Years	SRI	DECOSIL	HUMID	Loc. 197 B-ph SRI Replaced	
95	220kV Motigop-Tebhda Line 2 / 220kV Motigop S/S	220kV	2018	03.07.2025	Line under ESD, Failed during test trial	6 Years	SRI	DECOSIL	HUMID	Loc. 48 R-ph SRI Replaced	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
96	220kV Motigop-Tebhda Line 1 / 220kV Motigop S/S	220kV	2018	04.08.2025	Earth Fault	6 Years	SRI	DECOSIL	HUMID	Loc. 24 Y-ph SRI Replaced	
97	220kV Motigop-Tebhda Line 2 / 220kV Motigop S/S	220kV	2018	05.08.2025	Earth Fault	6 Years	SRI	DECOSIL	HUMID	Loc. 41 B-ph SRI Replaced	
98	220kV Nyara-Motigop Line / 220kV Motigop S/S	220kV	2018	06.08.2025	Earth Fault	6 Years	SRI	DECOSIL	HUMID	Loc. 224 Y-ph SRI Replaced	
99	220kV Motigop-Tebhda Line 1 / 220kV Motigop S/S	220kV	2018	14.08.2025	Line under PSD, Failed during test trial	6 Years	SRI	DECOSIL	HUMID	Loc. 178 B-ph SRI Replaced	
100	220 Kv Motipaneli-Sadodar Line 1	220	28.02.2007	22.06.2025	Electrical	13	Composite (SRI)	Goldstone	Monsoon	Replacement	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
101	220 Kv Motipaneli-sardargadh Line 1	220	21.02.2012	22.06.2025	Electrical	18	Composite (SRI)	Goldstone	Monsoon	Replacement	
102	220 Kv Motipaneli-Sadodar Line 1	220	28.02.2007	28.06.2025	Electrical	14	Composite (SRI)	Goldstone	Monsoon	Replacement	
103	220kV Motipaneli Sardargadh line	220	05.07.2010	26.06.2025	Electrical	10	Composite (SRI)	Goldstone	Monsoon	Replacement	
104	220kV Keshod-Shapur line	220	30.12.1988	30.06.2025	Electrical	13 YEARS , 03 MONTHS, 20 DAYS	Composite (SRI)	Decosil	Monsoon	-	
105	220kv Dhokadava Sintex line	220	07.09.2016	22.06.2025	Electrical	-	Composite (SRI)	Decosil	Monsoon	-	
106	220kV Jetpur-Shapur 2 Line	220	-	20-07-2025	Electrical	-	Composite (SRI)	SEDJW	Monsoon	-	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
107	220kV Shapur-Keshod Line	220	-	22-07-2025	Electrical	-	Composite (SRI)	Decosil	Monsoon	-	
108	220kv Dhokadava GPPC line	220	11.09.2016	07.07.2025	Electrical	-	Composite (SRI)	-	Monsoon	-	
109	220kv Timbdi- Keshod line	220	-	16.07.2025	Electrical , Due To Ageing	-	Composite (SRI)	Goldstone	Monsoon	-	
110	220kV Jetpur Ranavav line	220	-	11.07.25	Electrical , Due To Ageing	-	Composite (SRI)	Goldstone	Monsoon	-	
111	220 Kv Motipaneli-Sadodar Line 1	220	-	03.07.2025	Electrical	-	Composite (SRI)	Goldstone	Monsoon	Replacement	
112	220 Kv Motipaneli-Sadodar Line 1	220	-	05.07.2025	Electrical	18	Composite (SRI)	Goldstone	Monsoon	Replacement	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
113	220 Kv Motipaneli-Sadodar Line 1	220	28.02.2007	03.08.2025	Electrical	18	Composite (SRI)	Goldstone	Monsoon	Replacement	
114	220kV Keshod-Timbadi Line	220	09-01-1989	22.08.2025	Electrical	13 YEARS , 00 MONTHS, 12 DAYS	Composite (SRI)	DECOSIL	Monsoon	Replacement	
115	220KV Sardargadh-Shapur Line	220	18.12.1997	16.08.2025	Electrical	01 Month 13 Year 04 Days	Composite (SRI)	Decosil	Monsoon	Replacement	
116	220KV Timbdi keshod line	220	31.12.89	19.08.2025	Electrical	-	Composite (SRI)	-	Monsoon	-	
117	220kV Motipaneli-Jetpur Line	220	07.03.98	14.09.25	Electrical	13	Composite (SRI)	Goldstone	Monsoon	Replacement	
118	220kV Motipaneli-Sikka Line 1	220	20.08.2015	15.09.25	Electrical	10	Composite (SRI)	BHEL	Monsoon	Replacement	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
119	220kv Dhokadava Timbdi line	220	08.02.1994	29.09.2025	Electrical	-	Composite (SRI)	BHEL	Monsoon	-	
120	220 Kv Motipaneli-Sardargadh 2	220	21.02.2012	02.10.25	Electrical	13	Composite (SRI)	Goldstone	Monsoon	Replacement	
121	220 Kv Motipaneli-Sardargadh 1	220	21.02.2012	07.10.25	Electrical	13	Composite (SRI)	Goldstone	Monsoon	Replacement	
122	220 Kv Motipaneli-Jetpur	220	2010	14.10.25	Electrical	15	Composite (SRI)	Goldstone	Monsoon	Replacement	
123	220kV Keshod-Timbadi Line	220	10-08-2012	01.10.2025	Electrical	13 YEARS , 01 MONTHS, 21 DAYS	Composite (SRI)	Decosil	Monsoon	-	
124	220kV Keshod-Shapur line	220	10-03-2012	02.10.2025	Electrical	13 YEARS , 06 MONTHS, 22 DAYS	Composite (SRI)	Decosil	Monsoon	-	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
125	220 Kv Motipaneli-Jetpur	220	2010	08.11.25	Electrical	15	Composite (SRI)	Decosil	Monsoon	Replacement	
126	220kV Shapar Babra Line 2	220	2022	02-10-2025	Failed during tripping	3	SRI	SHREE Radhe	CLOUDY	Failed SRI Replaced with New One and Line Put in charge	
127	220kV Shapar Babra Line 1	220	2022	11-09-2025	Failed during tripping	3	SRI	SHREE Radhe	CLOUDY	Failed SRI Replaced with New One and Line Put in charge	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
128	220kV Shapar Babra Line 2	220	2022	10-09-2025	Failed during tripping	3	SRI	SHREE Radhe	CLOUDY	Failed SRI Replaced with New One and Line Put in charge	
129	220kV Shapar Choraniya Line	220	N.A.	10.10.2025	Failed during tripping	N.A.	SRI	Decosil	CLOUDY	Failed SRI Replaced with New One and Line Put in charge	
130	400kV Charal-Kosamba Line	400	07.09.2018	05.12.2025	Mechanical failure	Yes	Composite(SRI)	DECOSIL	Normal	Replaced with New One	
131	220kv Viaramgam-Dhanki	220kv	17.01.2005	26.06.2025	Aging	20	Porcelain	BHEL	Rainy	Replace by new SRI	
132	220kV Viramgam - Neno 1 Line	220kV	27.10.2009	11.02.2025	whole Disc string got flashed, Due to foggy weather	16	Porcelain	JSI	foggy	R-Phase Location 43, Replaced with SRI	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
133	220kv Soja-Mehsana-1	220kv	2017	02.09.2025	Flashed	8	SRI	Decosil	Normal	Replaced by new SRI	
134	220Kv Soja-Gandhinagar-2	220kv	22017	04.09.2025	Flashed	8	SRI	GIL	Normal	Replaced by new SRI	
135	220kv Agiyol -Bhutiya line 01	220kv	30.10.2004	03.08.25	Due to tripping of 220kv Agiyol -Bhutiya line 01 Auto reclosed oprated from both end on dt 03.08.25	19 years	Porcelain	India-JSI-H 90KN 1-2003	Cloudy And Rainy condition	Disc insulator Replaced on dt 06.08.25 at loc no 102(S) R-ph Top.	
136	220KV Faredi-Dhansura Line No-1/220kv Fraedi	220 KV	30/03/2015	10-11-2025	Heavy Rain & Electrolight	10	Disc Insulator	SIL INDIA-82KN	Cloudy	Replace By SRI, MAKE-GIL-90KN	
137	220KV Faredi-Dhansura Line No-1/220kv Fraedi	220 KV	30/03/2015	24/10/2025	Heavy Electrolight	10	SRI	VC-BNF19	Cloudy	Replace By SRI, MAKE-GIL-90KN	
138	220KV Faredi-Dhansura Line No-2/220kv Fraedi	220 KV	30/03/2015	17/11/2025	Rain	10	SRI	VC-BNF19	Cloudy	Replace By SRI, MAKE-GIL-90KN	
139	220 kv DhansuraWanakbori-1/220 kv Dhansura	220 KV	1991	07-03-2025	Lightning stroke	34	Porcelain	Bhel india	Rainy	failed porcelain disc replaced by SRI	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
140	221 kv DhansuraWanakbori-2/220 kv Dhansura	220 KV	1992	07-05-2025	Mechanical damage	33	Porcelain	Bhel india	Rainy	failed porcelain disc replaced by porcelain disc	
141	220KV CHHATRAL-GANDHINAGAR	220KV	15.05.16	18.06.2025	AGEING EFFECT	9 Years	SRI	NA	NORMAL	LINE CHARGED AFTER GP	
142	220KV CHHATRAL-VADAVI	220KV	11.01.17	02.08.2025	AGEING EFFECT	8 years	SRI	NA	CLOUDY/RAINY	SRI REPLACED	
143	220KV CHHATRAL-VADAVI	220KV	11.01.17	31.10.2025	AGEING EFFECT	8 years	SRI	NA	CLOUDY/RAINY	SRI REPLACED	
144	Vadavi no.1 / 220kv Mitha ss	220kv	2007	07.07.2025	Due to Bird Mud Accumulation	18 year	Porcelain	NA	Rainy		
145	Bechraji no.1 /220kv Mitha ss	220kv	2016	07.07.2025	Due to Bird Mud Accumulation	9 Year	SRI	NA	Normal	Cleaned the Flashed SRI	
146	220 kV Salejada Bhat Line no.2	220 kV	19.06.2010	04.04.2025	Due to heavy foggy atmosphere	19.06.2010	Porcelain	NA	Rainy	DI replaced by SRI	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI)),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
147	220 kV Salejada Gavasad Line no.1	220 kV	31.03.2025	19.06.2025	Due to heavy rain & lightning stroke	31.03.2025	Porcelain	NA	Rainy	DI replaced by SRI at Loc. No. 14 R phase on dtd. 21.06.2025 by Agency	
148	220KV Bhat-Charal Line No.2	220KV	2010	04.04.2025	Due to Very foggy atmosphere & Pollution	14 Year	Porcelain	JSI-H	Very foggy atmosphere & Pollution	Insulator string replaced by SRI	
149	Kasor-Pachcham-1	220kV	2016	31.01.2025	Probable Bird fault	8	SRI	CHINA		Bird Guard Provided	
150	Kasor-GEPEC	400kV	2019	16.03.2025	Under Gotri juris.	5	SRI		Clear		
151	Kasor-Gavasad-2	220kV	2023	04.04.2025	Heavy Foggy atmosphere	2	SRI	Aditya Birla	Heavy Foggy		
152	Kasor-Gavasad-2	220kV	2023	13.04.2025	Heavy Foggy atmosphere	2	SRI	Aditya Birla	Heavy Foggy		
153	Kasor-Gavasad-2	220kV	2023	18.04.2025	Heavy Foggy atmosphere	2	SRI	Aditya Birla	Heavy Foggy		

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
154	Kasor-Gavasad-2	220kV	2023	14.07.2025	Probable Bird fault	2	SRI	Aditya Birla	Heavy Foggy	Bird Guard Provided	
155	Kasor-Pachcham -1	220kV	2016	18.08.2025	Rainy Atmosphere	8	SRI	CHINA	Rainy		
156	Kasor-Pachcham -2	220kV	2016	10.09.2025	Rainy Atmosphere	8	SRI	CHINA	Rainy		
157	Kasor-Karamsad -1	220kV	1997	18.12.2025	Probable Bird fault	28	Porcelain	BHEL INDIA	Clear	Bird Guard Provided	
158	220kv vyankatpura Sevaliya-01	220kV	27-03-2023	07-11-2025	complete failure including silicon rubber & flashover in FRP rod	2years 3 months & 14 days	Composite SRI	Shree (398)	Cloudy Atmosphere	Replacement of SRI	
159	220kv Sevaliya -WTPS line-01	220kV (Double tension)	27-03-2023	09-07-2025	complete failure including silicon rubber & flashover in FRP rod	2 years 5 Months & 11 days	Composite SRI	Shree (2050&2095)	Rainy Atmosphere	Replacement of SRI	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI)),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
160	220KV Khanpur (220 Kv) - TORRENT POWER LIMITED - 1	220KV	08.01.1999	17.11.2025	Due to Flashing of Insulator	26 Yrs	Porcelain	BHEL	Normal	Insulator string replaced by IP India 90KN, 02/2010	
161	220KV Kansari Deodar Line-2/400KV Kansari SS	220KV	2010	20-03-2025	-	15	Porcelain	India JSL-H	Clear(Hot&Dry)	Replaced on Dated 22/03/2025	
162	400KV Kansari Soja Line-1/400KV Kansari SS	400KV	2000	15-11-2025	-	25	Porcelain	India JSL-H	Clear(Warm&Cool)	Replaced on Dated 18/11/2025	
163	220KV Charanka(400) - Jangral (220Kv) - 1	220	29-03-2016	21-05-2025	its hardware broken (mechanical fault) and SRI hanging.	9 year	SRI	G.K. Xianghe Electricals Pvt Ltd	Dry land and high soil salinity. Intense heat in summer.	Meachnical failure of SRI is high due to weather condition. Replaced before corrosion damage.	
164	66KV Vakha - 66KV RVNL - 1	66	31-03-2022	14-07-2025	Not found	3 year	SRI	Not visible	dry and clear weather	Replaced with new one	
165	220KV Veloda - Radhanpur (220Kv) - 3	220	13-08-2018	20-07-2025	SRI Flashover Spot observed	6 year	SRI	G.K. Xianghe Electricals Pvt Ltd	Dry land and high soil salinity. Intense heat in summer.	due to foggy weather condition SRI flashover. Replaced with new.	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI)),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
166	220KV Charanka(400) - Jangral (220Kv) - 2	220	30-03-2016	26-08-2025	SRI Flashover Spot observed	9 year	SRI	G.K. Xianghe Electricals Pvt Ltd	Dry land and high soil salinity. Intense heat in summer.	due to foggy weather condition SRI flashover. Replaced with new.	
167	220KV Charanka(400) - Jangral (220Kv) - 1	220	29-03-2016	08-09-2025	SRI Flashover Spot observed	9 year	SRI	G.K. Xianghe Electricals Pvt Ltd	Dry land and high soil salinity. Intense heat in summer.	due to foggy weather condition SRI flashover. Replaced with new.	
168	66KV Radhanpur (220Kv) - Un - 2	66	29-02-2016	03-12-2025	Disc Insulator flashed	9 year	Porcelain	Not available	Dry land and high soil salinity. Intense heat in summer.	Replaced with SRI	
169	220KV Jambuva-PGCIL line No.1	220KV	13.11.2020	07.07.25	May be due rainy weather.	4.7 Years	120KN Tension Type Composite(SRI)	Shree Radhe Insulator	Rainy	Fault Patrolling of line carried out from Loc.No.1 to 24. At Loc.No.21(T) R Ph Tension 120KN SRI failed which was replaced by new SRI Make:SP, Sr.No.14309 and line taken in service	
170	220KV Jambuva-PGCIL line No.2	220KV	13.11.2020	04.09.25	May be due rainy weather.	4.9 Years	120KN Tension Type Composite(SRI)	Shree Radhe Insulator	Rainy	Fault Patrolling of line carried out from Loc.No.33 to 53. At Loc.No.41(T) R Ph Tension 120KN SRI failed which was replaced by new SRI Make:Decosil and line taken in service	
171	220Kv Jambuva Dhuvaran Line No 1	220KV	2020	31-08-2025	Heavy Lightening at the time of tripping	5	SRI	SREE RADHE INSULATOR	Heavy Rain with Lightening strokes	Replaced Twin SRI	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
172	220kv Asoj-IOCL LINE	220 kV	2020	19.06.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
173	220kv Dumad-Jawaharnagar line	220 kV	2020	02.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
174	220kv Dumad-Jawaharnagar line	220 kV	2020	07.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
175	220kv Dumad-Jawaharnagar line	220 kV	2020	10.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
176	220kv Asoj-IOCL LINE	220 kV	2020	14.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
177	220kv Asoj-IOCL LINE	220 kV	2020	15.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
178	220kv Dumad-Jawaharnagar line	220 kV	2020	15.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
179	220kv Asoj-IOCL LINE	220 kV	2020	16.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
180	220kv Asoj-IOCL LINE	220 kV	2020	22.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
181	220kv Asoj-IOCL LINE	220 kV	2020	24.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
182	220kv Asoj-IOCL LINE	220 kV	2020	24.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
183	220kv Asoj-IOCL LINE	220 kV	2020	27.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
184	220kv Asoj-IOCL LINE	220 kV	2020	28.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
185	220kv Asoj-IOCL LINE	220 kV	2020	28.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
186	220kv Asoj-IOCL LINE	220 kV	2020	29.07.25	deterioration	5 years	SRI	Decosil	raining	SRI replaced	
187	22KV Asoj -IOCL Line - 2	220KV	2020	06-08-2025	Mfg Defect	5	Composite(SRI)	DECOSIL (DECCAN)	Rainy	Defected SRI replaced	
188	220kV Gavasad DFCC Line No.01	220kV	2018	03-09-2025	Electrical Failure - Flash spot observed	7	SRI	China	Cloudy/Rainy	Replaced by new one.	
189	220kV Gavasad DFCC Line No.01	220kV	2018	17-09-2025	Electrical Failure - Flash spot observed	7	SRI	China	Cloudy/Rainy	Replaced by new one.	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
190	220kV Gavasad DFCC Line No.01	220kV	2018	17-11-2025	Electrical Failure - Flash spot observed	7	SRI	NA	CLEAR	Replaced by new one.	
191	220kV Gavasad DFCC Line No.02	220kV	2018	23-07-2025	Electrical Failure - Flash spot observed	7	SRI	NA	Cloudy/Rainy	Replaced by new one.	
192	220kV Gavasad DFCC Line No.02	220kV	2018	30-07-2025	Electrical Failure - Flash spot observed	7	SRI	NA	Cloudy/Rainy	Replaced by new one.	
193	220kV Gavasad DFCC Line No.02	220kV	2018	22-08-2025	Electrical Failure - Flash spot observed	7	SRI	NA	Cloudy/Rainy	Replaced by new one.	
194	220kV Gavasad DFCC Line No.02	220kV	2018	27-08-2025	Electrical Failure - Flash spot observed	7	SRI	China	Cloudy/Rainy	Replaced by new one.	
195	220kV Gavasad DFCC Line No.02	220kV	2018	06-09-2025	Electrical Failure - Flash spot observed	7	SRI	NA	Cloudy/Rainy	Replaced by new one.	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
196	220kV Gavasad DFCC Line No.02	220kV	2018	09-10-2025	Electrical Failure - Flash spot observed	7	SRI	NA	CLEAR	Replaced by new one.	
197	220kV Gavasad DFCC Line No.02	220kV	2018	05-11-2025	Electrical Failure - Flash spot observed	7	SRI	NA	CLEAR	Replaced by new one.	
198	220kV Gavasad DFCC Line No.02	220kV	2018	13-01-2025	Electrical Failure - Flash spot observed	7	SRI	NA	CLEAR	Replaced by new one.	
199	220kV Karamsad GPEC Line No.02	220kV	2000	05-12-2025	Electrical Failure - Flash spot observed	25	SRI	SRI INDIA	CLEAR	Replaced by new one.	
200	220kV Karjan-SLPP Line	220kV	2012	26-06-2025	Electrical Failure - Flash spot observed from bottom to top	13	SRI	BHEL	Cloudy/Rainy	Replaced by new one.	
201	220kV Gavasad Kasor Line No.01	220kV	2002	11-02-2025	Electrical Failure - Flash spot observed	23	SRI	BHEL	HUMID	Replaced by new one.	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
202	220kV Gavasad Kasor Line No.02	220kV	2016	14-02-2025	Electrical Failure - Flash spot observed	9	SRI	SHREE	HUMID	Replaced by new one.	
203	220kV Gavasad - Karjan Line	220kV	2014	25-02-2025	Electrical Failure - Flash spot observed	11	SRI	FXBW4 CHINA	CLEAR	Replaced by new one.	
204	220kV Gavasad - Karjan Line	220kV	2014	25-02-2025	Electrical Failure - Flash spot observed	11	SRI	FXBW4 CHINA	CLEAR	Replaced by new one.	
205	220kV Gavasad - Karjan Line	220kV	2014	25-02-2025	Electrical Failure - Flash spot observed	11	SRI	BHEL	CLEAR	Replaced by new one.	
206	220kV Gavasad - Suva Line	220kV	2013	07-03-2025	Electrical Failure - Flash spot observed	12	Porcelain	I.P INDIA	CLEAR	Replaced by new one.	
207	220kV Karamsad GPEC Line No.01	220kV	2012	14-05-2025	Electrical Failure - Flash spot observed	13	SRI	DECOSIL	CLEAR	Replaced by new one.	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
208	220kV Karamsad GPEC Line No.01	220kV	2012	14-05-2025	Electrical Failure - Flash spot observed	13	SRI	DECOSIL	CLEAR	Replaced by new one.	
209	220kV Karamsad GPEC Line No.02	220kV	2012	16-05-2025	Electrical Failure - Flash spot observed	13	SRI	DECOSIL	CLEAR	Replaced by new one.	
210	220kV Karamsad GPEC Line No.02	220kV	2012	16-05-2025	Electrical Failure - Flash spot observed	13	SRI	DECOSIL	CLEAR	Replaced by new one.	
211	220kV Gavasad DFCC Line No.02	220kV	2018	27-05-2025	Electrical Failure - Flash spot observed	7	SRI	DECOSIL	CLEAR	Replaced by new one.	
212	220kV Gavasad DFCC Line No.02	220kV	2018	24-07-2025	Electrical Failure - Flash spot observed	7	SRI	DALIAN	CLEAR	Replaced by new one.	
213	220kV Gavasad DFCC Line No.02	220kV	2018	24-07-2025	Electrical Failure - Flash spot observed	7	SRI	DALIAN	CLEAR	Replaced by new one.	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
214	220kV Gavasad DFCC Line No.02	220kV	2018	30-07-2025	Electrical Failure - Flash spot observed	7	SRI	ABI	CLEAR	Replaced by new one.	
215	400kV Kasor - GPEC Line	400kV	2019	25-09-2025	Electrical Failure - Flash spot observed	6	SRI	SHREERADH E	CLEAR	Replaced by new one.	
216	220kV Gavasad - Kosamba Line	220kV	2013	08-10-2025	Electrical Failure - Flash spot observed	12	Porcelain	I.P INDIA	CLEAR	Replaced by new one.	
217	220kV Gavasad Amod Line No.02	220kV	2019	17-10-2025	Electrical Failure - Flash spot observed	6	SRI	GKXEPL	CLEAR	Replaced by new one.	
218	220kV Gavasad Kasor Line No.01	220kV	2008	18-10-2025	Electrical Failure - Flash spot observed	17	Porcelain	WS	CLEAR	Replaced by new one.	
219	220kV Karamsad GPEC Line No.01	220kV	2012	28-10-2025	Electrical Failure - Flash spot observed	13	SRI	DECOSIL	CLEAR	Replaced by new one.	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
220	220kV Karamsad GPEC Line No.01	220kV	2012	28-10-2025	Electrical Failure - Flash spot observed	13	SRI	DECOSIL	CLEAR	Replaced by new one.	
221	220kV Gavasad Amod Line No.01	220kV	2019	29-10-2025	Electrical Failure - Flash spot observed	6	SRI	GKXEPL	CLEAR	Replaced by new one.	
222	400kV Kosamba-Asoj Line	400kV	2012	14.04.2025	May be due to aging	13	Porcelain	BHEL	Weather Clear	Replaced by New SRI	
223	400kV Kosamba-Ukai Line-2	400kV	NA	06.05.2025	Mechanical Failure	Line comm. in 2016	SRI	Gold Stone	Weather Clear	Replaced by New SRI	
224	400kV Kosamba-Ukai Line-2	400kV	NA	10.05.2025	Mechanical Failure	Line comm. in 2016	SRI	Gold Stone	Weather Clear	Replaced by New SRI	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
225	400KV Kosamaba - Vav line,220KV Kim ss	400KV	23.05.2015	26.06.2025	Mechanical failure of SRI	10	Composite (SRI)	Gold stone,2012	Rainy & cloudy whether	Replced by New & proposal submitted single suspension SRI to Double Suspension SRI (to bear mechanical stress)	
226	220KV Kim - Gothan line, 220KV Kim ss	200KV	NA	25.07.2025	SRI found flashed,may be lighting storke	15	Composite (SRI)	Bhel, 2009	Rainy & cloudy whether	Replced by New	
227	400KV Kosamaba - Vav line,220KV Kim ss	400KV	23.05.2015	03.08.2025	Mechanical failure of SRI	10	Composite (SRI)	Gold stone,2012	Rainy & cloudy whether	Replced by New & proposal submitted single suspension SRI to Double Suspension SRI (to bear mechanical stress)	
228	220KV Kim - Utarn line - 1, 220KV Kim ss	200KV	14.04.2022	26.08.2025	May be Qulity	3	Composite (SRI)	Decosil ,2020	High humidity in whether	Replced by New	
229	220KV Kosamba - Mota line, 220KV Kim ss	200KV	30.10.2023	06.09.2025	May be Qulity	2	Composite (SRI)	Shree,05/2023	High humidity in whether	Replced by New, Letter to M/s Shree SRI ,Manufatures for investigation .	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI)),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
230	220KV Kim -Kosamba line - 1, 220KV Kim ss	200KV	21.11.2023	10.09.2025	May be Quality	2	Composite (SRI)	Shree,05/2023	High humidity in whether	Replced by New, Letter to M/s Shree SRI ,Manufatures for investigation .	
231	220KV Kosamba - Mota line, 220KV Kim ss	200KV	30.03.2011	11.11.2025	SRI failed found with broken on multiple point rod.	14	Composite (SRI)	NA	Clear	Replced by New	
232	220kv Zagadia- Mangrol line 1 / 220kv Zagadia	220kv	1998	16-11-2025	SRI broken of Y-phase from between due to corrosion	27	Composite (SRI)	RADHE	HEAT	NEW 220KV SRI PROVIDED	
233	220kv Achhalia Hydro line-2	220KV	2009	24-01-2025	Dust Deposition	16	SRI	Goldstone/2008	Winter/Foggy/Wet	Loc.No.323(S) Rph Flashover same was Replaced By New Old SRI Make:Goldstone 220kv 90kN. New SRI Make:GoldStone 220kv 90kN.	
234	220KV Achhalia Kawant - 1	220KV	2014	22-05-2025	Dust Deposition	11	SRI	Goldstone/8-2012	Summer/Heat Wave/Dry	Loc.No.160(S) Bph SRI Flashover same was repl. By new SRI New SRI Make:Goldstone , 220kv 90KN Old SRI Make: Decosil ,220kv 90KN	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI)),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
235	220kV Achhalia Kawant - 1	220KV	2014	27-05-2025	Dust Deposition	11	SRI	Goldstone/8-2012	Summer/Heat Wave/Dry	Loc.No.130(S) Bph SRI Flashover same was repl. By new SRI New SRI Make:Goldstone , 220kV 90KN Old SRI Make: Decosil ,220kV 90KN	
236	220KV Jambuva - Achhalia - 4	220KV	2014	04-09-2025	Lightening Stroke	11	SRI	Goldstone/8-2012	Monsoon/Rainy/Wet	Loc.No.71(S) Rph SRI Flashover same was repl. By new SRI New SRI Make:Goldstone , 220kV 90KN Old SRI Make: Decosil ,220kV 90KN	
237	220kV GPEC Karamsad	220	2011	22.06.2025	Flashed	14	SRI	NA	Thunder, lightning stroke	Replaced	
238	220kV Haladarwa Dahej 1	220	2012	04.06.2025	Flashed	13	SRI	NA	Thunder, lightning stroke	Replaced	
239	220 kv Vapi- Sarigam line	220	2018	16.06.25	SRI Defect	3	SRI	DECOSIL INDIA	Very heavy rain fall	SRI replaced with new	
240	220 kv Vapi- Sarigam line	220	2018	18.06.25	SRI Defect	3	SRI	DECOSIL INDIA	Very heavy rain fall	SRI replaced with new	
241	220 kv Vapi- Sarigam line	220	2018	18.06.25	SRI Defect	3	SRI	DECOSIL INDIA	Very heavy rain fall	SRI replaced with new	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI)),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
242	220 kv Vapi- Sarigam line	220	2018	19.06.25	SRI Defect	3	SRI	DECOSIL INDIA	Very heavy rain fall	SRI replaced with new	
243	220 kv Vapi- Sarigam line	220	2018	21.06.25	SRI Defect	3	SRI	DECOSIL INDIA	Very heavy rain fall	SRI replaced with new	
244	220 kv Sarigam - Tarpur line	220	2018	16.06.25	SRI Defect	3	SRI	DECOSIL INDIA	Very heavy rain fall	SRI replaced with new	
245	220 kv Sarigam - Tarpur line	220	2018	19.06.2025	SRI Defect	3	SRI	DECOSIL INDIA	Very heavy rain fall	SRI replaced with new	
246	220 kv Sarigam - Tarpur line	220	2018	28.06.2025	SRI Defect	3	SRI	DECOSIL INDIA	Very heavy rain fall	SRI replaced with new	
247	220 kv Sarigam - Tarpur line	220	2018	28.06.2025	SRI Defect	3	SRI	DECOSIL INDIA	Very heavy rain fall	SRI replaced with new	
248	220kV Virpur ss	220	2021	04.08.2025	SRI Defect/Rainy atmosphere	4	SRI	Shree	Heavy Rain and Lightening	SRI replaced with new	
249	220kV GSEG Kosamaba Line No1	220	2011	05.07.2025	Due to Aging & RainyWeather	15	Porcelain	Not Visible	Rainy	SRI replaced with new	
250	220kV GSEG Kosamaba Line No2	220	2011	03.07.2025	Due to Aging & RainyWeather	15	Porcelain	BHEL	Rainy	SRI replaced with new	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI)),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
251	220kV GSEG Kosamaba Line No1	220	2011	20.08.2025	Due to Aging & RainyWeather	15	Porcelain	Not Visible	Rainy	SRI replaced with new	
252	220kV GSEG Talangpore	220	2010	23.08.2025	Due to Aging & RainyWeather	16	Porcelain	Not Visible	Rainy	SRI replaced with new	
253	220kV GSEG Talangpore	220	2010	30.08.2025	Due to Aging & RainyWeather	16	Porcelain	Not Visible	Rainy	SRI replaced with new	
254	400KV Vav Kosamba line Loc. 88(T) Y & B Ph	400	2020	28.06.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
255	400KV Vav Dastan line Loc. 6(T) R Ph	400	2020	No tripped	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
256	440KV Vav Zonor line loc. no. 10(T) B ph & 27(T) B ph	400	2020	10.07.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
257	400KV Vav Zonor loc. no. 19 (T) B ph	400	2020	28.07.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
258	400KV Vav Zonor line Loc. 27(T) Y Ph	400	2020	30.07.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI)),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
259	400KV Vav Zanor line Loc. 19(T) Y Ph	400	2020	30.07.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
260	400KV Vav Ukai line loc. 63(T)	400	2020	15.07.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
261	400KV Vav Kosamba line Loc. 70(T) Y Ph SRI Flash & Broken	400	2020	03.08.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
262	400KV Vav Ukai line loc. 92(T)	400	2020	12.08.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
263	400KV Vav Dastan line	400	2020	17.08.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
264	400KV Vav Kosamba line	400	2020	01.09.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
265	400kV Vav Zanor line	400	2020	06.09.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
266	400KV Vav Dastan line	400	2020	29.09.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
267	400KV Vav Kosamba Line	400	2020	26.09.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
268	400kV Vav- Ukai line	400	2020	01.11.2025	Manufacturing defect	5	SRI	Decosil	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	

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Sr. No.	Name of line /SS	Voltage level of the line (KV)	Year of commissioning of Insulator	Date of Failure	Reason for insulator failure	In-service years of the Insulators before failure	Type of Insulator (Porcelain/ Composite(SRI),	Make of the Insulator	Prevailing climatic conditions	Remedial action taken	Relevant pictures of the failed insulators, so that identification of failure patterns across voltage levels (220 kV, 400 kV, 765 kV) and climatic zones can be done.
269	220KV Vav-Mota Line no 1	220	2003	06.07.2025	Manufacturing defect	23	SRI	NA	Rainy	Replaced and Inform to M/S Decocil for rectify the failure	
270	220KV Ambheta - DFCCIL(Devdha) - 2	220KV	07.03.2023	05.05.2025	Manufacturing defect	2	SRI	Shree Radhe Industries Vadodara	Weather - Rainy	SRI Replaced by new one	
271	220KV Ambheta - DFCCIL(Devdha) - 1	220KV	07.03.2023	01.06.2025	Manufacturing defect	2	SRI	Shree Radhe Industries Vadodara	Weather - Rainy	SRI Replaced by new one	
272	220KV Ambheta - DFCCIL(Devdha) - 2	220KV	07.03.2023	21.06.2025	Manufacturing defect	2	SRI	Shree Radhe Industries Vadodara	Weather - Rainy	SRI Replaced by new one	
273	220KV Ambheta - DFCCIL(Devdha) - 2	220KV	07.03.2023	06.09.2025	Manufacturing defect	2.5	SRI	Shree Radhe Industries Vadodara	Weather - Rainy	SRI Replaced by new one	
274	220KV Navsari-Atul	220KV	2008	31.10.2025	Manufacturing defect	17	SRI	Decosil	Weather - Rainy	fault observed at loc no. 12(S) B-ph SRI found flashed over same has been replaced by new one	

SN	Particulars (to be filled appropriately wherever applicable)	Details
1	Utility Name	
2	Name of the Line on which the Insulator failed	
3	Type of Insulator (Polymer/ Porcelain/ Glass/ Porcelain with RTV/ Glass with RTV)	
4	Name of the Manufacturer	
5	Location of the tower (Place, District)	
6	GPS coordinates (Latitude, Longitude)	
7	Date of construction of tower (Month, Year)	
8	Date of commissioning of the insulator string (Month, Year)	
9	Date of energization of the insulator string (Month, Year)	
10	Altitude of the line w.r.t Mean Sea Level (< 1000 m/ >1000 m)	
Transmission System Details		
11	System Voltage (66/110/132/220/230/400/765) kV, (500/ 800 HVDC) kV	
12	Value and duration of temporary over voltages (if any)	
13	Isokeraunic (thunderstorms / year) level	
Environmental Details		
14	Location geography of the tower (Plain/ Hill/ Coastal/ Industrial/ Agricultural/ Forest)	
15	Pollution classification (as per CPRI-2023 Pollution Mapping) (Light/ Medium/ Heavy/ Very Heavy)	
16	Nearest Pollution source within 30 km (Desert/ Marine/ Chemical/ Cement/ Agricultural/ Smoke/ Nil)	
17	Weather (seasonal conditions) at the time of the incident (Dry/ Humid/ Rain/ Foggy/ Snow/ Cyclone/ Normal Climate)	
Incident Details		
19	Mode of Failure (Brittle Fracture/ Flashover/ Arcing marks in Corona Ring/ Tracking and Erosion/ Flash-under/ FRP Decay/ Puncture Marks/ Shed Damage/ Flash-Over/ Bird Biting)	
20	Brief description of the incident	
21	Electrical activity marking on the insulator (near Conductor End/ near Tower End)	
22	Mechanical damage to the insulator (near Conductor End/ near Tower End)	
23	System voltage at the time of incident	
24	System short-circuit current at the time of the incident	

25	No. of attempts by auto-recloser	
26	Photographs of insulators involved in the incident to be attached	
27	IR/ UV camera data (last inspection & present inspection)	
	Tower and Insulator Configuration Details	
28	Type of Tower (Suspension/ Tension/ Dead-end)	
29	Type of tower structure (A/ B/ C/ D)	
30	Tower Earthing (Rod or Pipe/ Counter Poise Wire)	
31	Tower footing resistance	
32	Number of circuits (1/2/3/4/6)	
33	No. of ground wires (o/1/2)	
34	Phase at which fault occurred (R/Y/B)	
35	Position of faulty phase (Top/ Middle/ Bottom)	
38	Tensile strength rating of the insulator (90 kN/ 120 kN/ 160 kN/ 210 kN/ 320 kN/ 420 kN)	
	Additional details w.r.t failed Insulator	
39	CLRI hydrophobicity classification (HC1/ HC2/ HC3/ HC4/ HC5/ HC6/ HC7)	
40	Brittleness of the shed	
41	Tracking marks on the shed	
42	Damage to the shed	
43	Damage on the Mold parting line	
44	Exposure of FRP	
45	Damage on the corona ring	
46	Exposure of triple junction	
47	Arcing marks on hardware	

MANUFACTURING QUALITY PLAN

Manufacturer's Name	Customer	Vendor Code	Item	MQP NO.:
	Utility		Composite Long Rod Insulators up to 765 kV & up to 210 kN for HVAC and upto 800 kV & up to 420 KN for HVDC	REV NO.:
				DATE:
				Validity:

Code followed	
Code 1 Indicate place where testing is planned to be performed i.e. Inspection location A At Equipment Manufacturer's works B At Component Manufacturer's works C At Authorised Distributor's works D At Independent Lab E At Turn Key Contractor's location F Not specified	Code 2 Indicate who has to perform the tests i.e. Testing Agency J The Equipment Manufacturer K The Component Manufacturer L The Third Party M The Turnkey Contractor
Code 3 Indicate who shall witness the tests i.e. Witnessing Agency P Component Manufacturer itself Q Component Manufacturer and Equipment Manufacturer R Component Manufacturer, Equipment Manufacturer and contractor S Equipment Manufacturer itself T Equipment Manufacturer and Contractor U Equipment Manufacturer and/or Contractor and Utility Third Party V itself	Code 4 Review of Test Reports/Certificates W By Equipment Manufacturer during raw material / bought out component inspection X By Contractor during product / process inspection Y By Utility during product / process inspection Z By Contractor and / or Utility during product / process inspection
Code 5 Whether specific approval of sub-vendor / component make is envisaged? E Envisaged N Not Envisaged	Code 6 Whether test records required to be submitted after final inspection for issuance of CIP/MICC Y Yes N No

Manufacturer's Name		Customer	Vendor Code	Item	MQP NO.:
		Utility		Composite Long Rod Insulators up to 765 kV & up to 210 kN for HVAC and upto 800 kV & up to 420 KN for HVDC	REV NO.:
					DATE:
					Validity:
NOTES:					
1	This MQP should be read in conjunction with Utility specification and shall deem to include additional tests, if any required as per the contract.				
2	Utility specification shall include provisions of letter of Notification of award, Specific Agreements, Utility approved drawings/technical data sheet/BOM/ guaranteed technical particulars/test schedule/ test procedures as applicable to the specific contract.				
3	In case of any contradiction between MQP and Utility Technical specification/Approved Drawing, the Technical specifications/Approved Drawing of respective project shall have precedence over this MQP.				
4	It shall be ensured by the CLRI manufacturer, that this document is readily available at their works, as well as the relevant portion of document (alongwith these notes) are available at the works of their sub- vendors, in order to avoid any delay at the time of inspection.				
5	The manufacturer shall ensure that their, as well as, their sub-vendor's control, Metering and Testing instruments are duly calibrated and should have calibration certificates traceable to National/International standards. Calibration records should be available during Inspection by Utility . Valid calibration certificates of various testing and measuring instrument / equipments from Labs, accredited as per ISO/IEC -17025 which operates in accordance with the requirements of ISO/IEC 17011 having full membership & MRA of ILAC/APLAC, shall be maintained.				
6	In case of any test being carried out at the third party lab, the same should be accredited as per ISO/IEC -17025 which operates in accordance with the requirements of ISO/IEC 17011 having full membership & MRA of ILAC/APLAC				
7	All raw materials/bought-out items should be procured from Utility approved source only.				
8	The manufacturer shall maintain proper co-relation(consistent with the process) of test certificates from the raw material stage to finished product stage and the records should be available during inspection by Utility .				
9	Manufacturer shall show the approval Utility Engineering for all contract specific type tests as per the Utility specification at the time of final inspection. All type test requirements and procedures to be decided and finalized with Utility Engineering department on contract to contract basis.				
10	As indicated in TS, all insulators shall be packed in suitable PVC/ plastic tubes of atleast 3 mm thickness or water-resistant packing material and the packaging shall not break during storage & transportation even in overhang condition during transportation. All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each case/crate shall have all the markings stenciled on it in indelible ink.				
11	One copy of the test report, CIP/MICC shall be sent alongwith the consignment to every destination.				
12	Inspection of spare items ordered by Utility shall also be governed by the provisions of this MQP.				
13	Any material rejected during Utility Inspection shall be indelibly marked (to prevent mixing), stacked in separate place within the works of the manufacturer, and offered to Utility inspector for verification of marking. Documentary evidence of disposal shall be submitted for review by the Inspecting Engineer.				
14	Each composite long rod unit shall be legibly and indelibly marked with the trade mark of the manufacturer, name of Utility and month & year of manufacturing. The guaranteed combined mechanical and electrical strength shall be indicated in kilo Newton followed by the word 'kN' to facilitate easy identification and to ensure proper use. Holder of grading rings shall be legibly and indelibly marked with trade mark of the composite insulator supplier. One 10 mm thick ring or 20 mm thick spot of suitable quality of paint shall be marked on the cap/ end fitting of each composite long rod of particular strength for easy identification of the type of insulator. (Black for 70 kN, Red for 90 kN, Yellow for 120 kN, Green for 160 kN, Blue for 210 kN, Pink for 320 kN and Purple for 420 kN). Paint shall not have deteriorating effect on performance of insulator.				

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					REV NO.:
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		Utility		Composite Long Rod Insulators up to 765 kV & up to 210 kN for HVAC and upto 800 kV & up to 420 KN for HVDC	
15	The guaranteed Electro- Mechanical Strength shall be indicated in kN.				
16	Utility may review the effective implementation of the process during the product inspection/process inspection. In case of any violation in process or process parameters are observed, the reason along with corrective & preventive measure shall be conveyed to Utility .				
17	The manufacturer should progressively align their Quality system and sub-vendors Quality system to the requirements of ISO 9000 series Quality standards and in due course of time should get their quality system certified to ISO 9001.				
18	If any activity (for which manufacturer is already approved) is being outsourced due to some exigencies/ unforeseen circumstances, then prior approval from Utility needs to be taken.				
19	Any addition / change in new vendor / design / process shall call for review by Utility and change in MQP, if necessary				
20	The manufacturer shall verify the test certificates of raw materials and shall maintain records properly for verification by Utility .				
21	Design and type test: All design & type tests to be carried out as per Utility specifications and as per contract agreement approval of design and type test by Utility Engineering Department or waiver thereof to be shown at the time of final inspection for issuance of MICC.				
22	Manufacturer should have calibrated gauges confirming to IEC 61466 for checking the dimensions of sockets and balls.				
23	All ferrous parts shall be hot dip galvanized to give a minimum average coating as mentioned in various clauses of this MQP. However, under marine/extreme environment/coastal areas, as specifically mentioned in BPS, the end fittings shall have a minimum average coating of zinc equivalent of 790 gms / sq m (equivalent to 110 microns) of surface area and the steel holder/ keeper shall have a minimum overall zinc coating of 900 gms / sq m (126 microns) of surface area. Also, in such case, stainless steel bolts/ nuts shall only be used. Spring washers shall be electro-galvanised. Stainless steel washer may be used as an alternative.				
24	Bolts and nuts for grading rings shall conform to IS1367 or equivalent International standards and shall be galvanized as per IS 1367 (Part 13)/ IS 2629.				
25	Last 20% quantity of insulators shall be packed in PVC/ plastic tubes only to ensure long storage of about 5 years. The packing shall provide protection against rodent. For marine transportation, crates shall be palletted.				
26	Operator performing Ultra sound test on insulators should have a valid Level-I certificate from an ASNT Level-II accredited Institution.				
27	In the event of failure of the sample to satisfy the acceptance test(s), the retest procedure shall be as per IS 16784.				

	MANUFACTURING QUALITY PLAN													
	Manufacturer's Name				Customer	Vendor Code	Item	MQP NO.:IND 115						
					Utility	3000001385	Composite Long Rod Insulators up to 765 kV & up to 210 kN for HVAC and upto 800 kV & up to 420 KN for HVDC	REV NO.:R2						
								DATE:16-04-2025						
								Validity: As per date mentioned in Approval Letter						
SL. NO	Component/Operation & Description of test		Type of Check	Quantum of Check /sampling with basis	Reference documents for Testing	Acceptance Norms	Format of Record	APPLICABLE CODES						Remark
								1	2	3	4	5	6	
1	RAW MATERIAL													
1.1	Silicon Rubber Compound											E		
1.1.1	At Supplier's Works													
1.1.1.1	Tensile Strength	Mechanical	1 Sample/Batch	DIN 53504-A-S1/ ASTM D 412	Min . 4 N/mm²	Supplier's Test Report	B	K	P	W		N		
1.1.1.2	Elongation at break	Mechanical		DIN 53504-A-S1/ ASTM D 412	Min. 150 %		B	K	P	W		N		
1.1.1.3	Tear Strength	Mechanical		ASTM D 624 -B	Min 15 kN/m		B	K	P	W		N		
1.1.1.4	Hardness (Shore-A)	Mechanical		DIN 53505-A/ ASTM D 2240	61 - 75		B	K	P	W		N		
1.1.1.5	Specific gravity	Physical		ISO 1183-1 A/ ASTM D 792	1.48 - 1.58		B	K	P	W		N		
1.1.1.6	Di-electric strength test	Electrical		ASTM A 149	Min 20 kV/mm		B	K	P	W		N		
1.1.1.7	D.C. Volume Resistivity	Electrical		IEC 60093	Min 1.0 x 10^14		B	K	P	W		N		
1.1.1.8	Tracking and erosion test	Electrical		IEC 60587	Class 1A 4.5 (Max Depth of Erosion <0.5 mm)		B	K	P	W		N		
1.1.1.9	Silicone Content by Weight	Electrical		ASTM E1131	Min 32%/ As per TS/drawing		B	K	P	W		N		
1.1.1.10	Flammability	Chemical		IEC 62217	Category - Vo		B/D	K/L	P/V	W		N		
1.1.1.11	Arc Resistance test	Electrical		As per Plant Standard	>240sec		B/D	K/L	P/V	W		N		
1.1.2	At CLRI Manufacturer's Works													
1.1.2.1	Tensile Strength	Mechanical	1 Sample/Batch	DIN 53504-A-S1/ ASTM D 412	Min . 4 N/mm²	CLRI Manufacturer's Test Report	A	J	S	W		N		
1.1.2.2	Elongation at break	Mechanical		DIN 53504-A-S1/ ASTM D 412	Min. 150 %		A	J	S	W		N		
1.1.2.3	Tear Strength	Mechanical		ASTM D 624 -B	Min 15 kN/m		A	J	S	W		N		
1.1.2.4	Hardness (Shore-A)	Mechanical		DIN 53505-A/ ASTM D 2240	61 - 75		A	J	S	W		N		
1.1.2.5	Specific gravity	Physical		ISO 1183-1 A/ ASTM D 792	1.48 - 1.58		A	J	S	W		N		
1.1.2.6	Di-electric strength test	Electrical		ASTM A 149	Min 20 kV/mm		A	J	S	W		N		

Manufacturer's Name				Customer	Vendor Code	Item	MQP NO.:						
				Utility		Composite Long Rod Insulators up to 765 kV & up to 210 kN for HVAC and upto 800 kV & up to 420 KN for HVDC	REV NO.:						
							DATE:						
							Validity:						
SL. NO	Component/Operation & Description of test	Type of Check	Quantum of Check /sampling with basis	Reference documents for Testing	Acceptance Norms	Format of Record	APPLICABLE CODES						Remark
							1	2	3	4	5	6	
1.1.2.7	Tracking and erosion test	Electrical	1 Sample/Batch	IEC 60587	Class 1A 4.5 (Max Depth of Erosion <0.5 mm)	CLRI Manufacturer's Test Report	A	J	S	W		N	
1.1.2.8	D.C. Volume Resistivity	Electrical	1 sample/lot/Month	IEC 60093	Min 1.0 x 10^14		A	J	S	W		N	
1.1.2.9	Silicone Content by Weight	Electrical		ASTM E1131	Min 32%/ As per TS/drawing		A/D	J/L	S/V	W		N	
1.1.2.10	Water Absorption	Chemical		As per Plant Standard	< 0.25%		A/D	J/L	S/V	W		N	
1.1.2.11	SEM Analysis with EDS on Cross Section	Physical	Once in 06 months	As Per Utility Specification	As per Plant Standard		A/D	J/L	S/V	W		N	
1.1.2.12	Surface Analysis by Optical Spectograph	Physical					A/D	J/L	S/V	W		N	
1.2	Core Material (FRP Rods)										E		
1.2.1	At Supplier's Works												
1.2.1.1	Visual Inspection and Dimension	Physical	100%	Physical measurement	As per approved drawing	Supplier's Test Report	B	K	U/P	W/Z		N	Testing of FRP rod shall be witnessed by Utility representative on monthly basis on two samples of each size
1.2.1.2	Dye Penetration	Chemical	1 sample/batch	IS 16784	No penetration of dye allowed during test duration ≥20 minutes		B	K	U/P	W/Z		N	
1.2.1.3	Water Absorption	Chemical		ASTM D 570	Average 0.05% (Max)		B	K	U/P	W/Z		N	
1.2.1.4	Water Diffusion	Electrical		IS 16784	No Puncture at 12 kV and current shall be <0.1 mA		B	K	U/P	W/Z		N	
1.2.1.5	Hardness of FRP Rod	Mechanical		ASTM D 2583	75-85		B	K	U/P	W/Z		N	
1.2.1.6	Glass Content	Physical		ASTM D 2584	80-83%		B	K	U/P	W/Z		N	
1.2.1.7	Specific Gravity	Physical		ASTM D 792	2.0-2.2		B	K	U/P	W/Z		N	
1.2.1.9	Tensile Strength	Mechanical	1 sample/RM batch	ASTM D 638	Min 760 Mpa		B/D	K/L	U/P/V	W/Z		N	
1.2.1.10	Flexural Strength	Mechanical		ASTM D 349/ ASTM D 4476	Min 750 Mpa		B/D	K/L	U/P/V	W/Z		N	
1.2.1.11	Boron Content	Chemical		ASTM D 578	Boron Free (50ppm min)		B/D	K/L	U/P/V	W/Z		N	
1.2.1.12	Glass Transition Temperature	Physical		ASTM D 3418	Min 140° C/ As per TS/Drawing		B/D	K/L	U/P/V	W/Z		N	
1.2.1.13	Void Content	Physical		ASTM D2734	<1%		B	K	U/P	W/Z		N	

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							DATE:								
							Validity:								
SL. NO	Component/Operation & Description of test	Type of Check	Quantum of Check /sampling with basis	Reference documents for Testing	Acceptance Norms	Format of Record	APPLICABLE CODES						Remark		
							1	2	3	4	5	6			
1.2.2	At CLRI Manufacturer's Works														
1.2.2.1	Visual Inspection	Physical	100%	Physical measurement	As per approved drawing	CLRI Manufacturer's Test Report	A	J	S	W		N	in case rods are procured from DAPL then, all the test indicated at 1.2.1 shall be carried out at DAPL & only 1.2.2.8 & 1.2.2.11 at DEPL.		
1.2.2.2	Dimension	Physical	2%	Physical measurement	As per approved drawing		A	J	S	W		N			
1.2.2.3	Dye Penetration	Chemical	1 sample /lot	IS 16784	No penetration of dye allowed during test duration ≥20 minutes		A	J	S	W		N			
1.2.2.4	Water Absorption	Chemical		ASTM D 570	Average 0.05% (Max)		A	J	S	W		N			
1.2.2.5	Water Diffusion	Electrical		IS 16784	No Puncture at 12 kV and current shall be <0.1 mA		A	J	S	W		N			
1.2.2.6	Hardness of FRP Rod	Mechanical		ASTM D 2583	75-85		A	J	S	W		N			
1.2.2.7	Glass Content	Physical		ASTMD D 2584	80-83%		A	J	S	W		N			
1.2.2.8	Brittle Fracture Resistance Test	Mechanical/ Chemical	Once in 3 months	Utility Spec/ IEC TR 62039-2021	Shall perform for 96 Hrs at 340Mpa stress, No cracks		A	J	S	W		N			
1.2.2.9	Specific Gravity	Physical	1 rod per Lot	ASTM D 792	2.0-2.2		A	J	S	W		N			
1.2.2.10	Glass Transition Temperature	Physical	1 sample/lot/Month	ASTM D 3418	Min 140° C/ As per TS/Drawing		A/D	J/L	S/V	W		N			
1.2.2.11	Dry Power Frequency Voltage Test	Electrical	10%	As per Plant Standard	As per Plant Standard /Voltage of 250kV/1000mm for 15 minutes shall be applied followed by thermos-vision scanning - No Hotspot should occur and Temperature rise shall be <1 °C		A	J	S	W		N			
1.2.2.12	SEM (Scanning Electron Microscopic) Analysis with EDS (Energy Dispersive Spectroscopy) on FRP rod cross-section, Surface analysis by optical spectrograph, FTIR Signature analysis	Electrical	Once in 06 months	As per Utility Spec	As per Utility Spec	A/D	J/L	S/V	W		N				

Manufacturer's Name				Customer	Vendor Code	Item	MQP NO.:						
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							DATE:						
							Validity:						
SL. NO	Component/Operation & Description of test	Type of Check	Quantum of Check /sampling with basis	Reference documents for Testing	Acceptance Norms	Format of Record	APPLICABLE CODES						Remark
							1	2	3	4	5	6	
1.3	Metal Fittings- Ball and Socket Fittings												
	Metal Fitting- Ball & Sockets										E		
1.3.1	At Supplier's Works												
1.3.1.1	Visual Inspection	Visual	100%	---	Free from defects	Supplier's Test Report	B	K	P	W		N	
1.3.1.2	Dimension	Physical	1% of Batch, Minimum 10 Nos	Approved Drawing	Approved Drawing		B	K	P	W		N	
1.3.1.3	Chemical Composition	Chemical	1 sample/ Heat of Raw material	As per Approved Drawing/IS 1865	As per Approved Drawing/IS 1865		B	K	P	W		N	
1.3.1.4	Microstructure	Metallurgical		IS 7739 – part 5	Ferrite + Pearlite		B	K	P	W		N	
1.3.1.5	Socket and ball Coupling profile	Physical	1% of Batch Minimum 10 Nos	IS 2486 – Part 2	Conform to Gauges as per IS 2486 – Part 2		B	K	P	W		N	
1.3.1.6	Hardness	Mechanical	2 samples/Batch	IS 1500	As per approved drawing		B	K	P	W		N	
1.3.1.7	Galvanizing- purity of zinc	Chemical	1 sample/ Batch	IS 209	99.95% (Min)		B	K	P	W		N	
1.3.1.8	Magnetic Particle Inspection	NDT	100%	IS 3703	No surface cracks		B	K	P	W		N	
1.3.1.9	Tensile Strength (Mpa)	Mechanical	1 sample per Heat of Raw material	As per Approved Drawing	As per Approved Drawing		B	K	P	W		N	
1.3.1.10	Yield Strength (Mpa)	Mechanical			As per Approved Drawing		B	K	P	W		N	
1.3.1.11	% Elongation	Mechanical			As per Approved Drawing		B	K	P	W		N	
1.3.1.12	Uniformity of Zinc Coating	Chemical	1sample per batch of 5000 nos	IS 2633	No Permanent deposit of Copper after 6dips of each 1 Min		B	K	P	W		N	
1.3.1.13	Thickness of Zinc Coating	Physical	10% of batch	By Elecometer	Average 127 microns (Min)		B	K	P	W		N	
1.3.2	At CLRI Manufacturer's Works												
1.3.2.1	Visual Examination-Roughness	Visual	100%	IS 16784	IS 16784	CLRI Manufacturer's Test Report	A	J	S	W		N	
1.3.2.2	Dimension	Physical	10% of batch	Approved Drawing	Approved Drawing		A	J	S	W		N	
1.3.2.3	Socket and ball Coupling profile	Physical	100%	IS 2486-part-2	Conform to Gauges as per IS 2486-part 2		A	J	S	W		N	

Manufacturer's Name				Customer	Vendor Code	Item	MQP NO.:								
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							DATE:								
							Validity:								
SL. NO	Component/Operation & Description of test	Type of Check	Quantum of Check /sampling with basis	Reference documents for Testing	Acceptance Norms	Format of Record	APPLICABLE CODES						Remark		
							1	2	3	4	5	6			
1.3.2.4	Magnetic Particle Inspection	NDT	Once in 6 months for each type per source	IS 3703	No surface cracks	CLRI Manufacturer's Test Report	A/D	J/L	S/V	W		N			
1.3.2.5	Chemical Composition	Chemical	1 per 5000 nos (for HVDC Application)for each type per source & Once in 6 months (for AC application) for each type per source	Approved Drawing	As mentioned in Approved Drawing		A/D	J/L	S/V	W		N			
1.3.2.6	Microstructure	Metallurgical I		IS 7739 Part 5	Ferrite + Pearlite		A/D	J/L	S/V	W		N			
1.3.2.7	Hardness	Mechanical	1 sample per batch	IS 1500	As mentioned in Approved Drawing		A	J	S	W		N			
1.3.2.8	Failing Load Test: 70 kN, 90 kN, 120 kN, 160 kN, 210 kN, 320 kN & 420 kN	Mechanical	1 sample/batch of 1000Nos and part there of	Plant Standards	>= Specified Load		A/D	J/L	S/V	W		N			
1.3.2.9	Galvanization Visual Examination	Visual	100%	IS 16784	IS 16784		A	J	S	W		N			
1.3.2.10	Uniformity of Zinc Coating	Chemical	1 sample per batch of 5000nos	IS 2633	No Permanent deposit of Copper after 6 dips of each 1 Min		A	J	S	W		N			
1.3.2.11	Thickness of Zinc Coating	Physical	10% of batch	By Elcometer	Average 127 microns (Min)		A	J	S	W		N			
1.4	Bonding Agent														
1.4.1	At CLRI Manufacturer's Works										N				
1.4.1.1	Visual Examination	Visual	Batch wise	Plant Standard	Plant standards	CLRI Manufacturer's Test Report	A	J	S	W		N			
1.4.1.2	Specific Gravity	Physical		ASTM D 1298	<1.0		A	J	S	W		N			
1.5	Split Pin														
1.5.1	At Supplier's Works										E				
1.5.1.1	Chemical Composition	Chemical	1 sample/ Batch	IS 2486 part 1, IS 6603	Grade X02Cr19Ni10 /X04Cr19Ni9/ As per grade mentioned in approved drawing/TS	Supplier's Test Report	B	K	P	W		N			
1.5.1.2	Hardness	Mechanical		IS 2486 – part 4	160HV / 152 BHN /83.4 HRB(Min)		B	K	P	W		N			
1.5.1.3	Visual Examination	Physical	100%	IS 2486 – part 3	IS 2486 – part 3		B	K	P	W		N			
1.5.1.4	Dimensional verification	Physical	10 nos per batch	IS 2486 – part 3	IS 2486 – part 3		B	K	P	W		N			
1.5.1.5	Resistance to bending	Mechanical		IS 2486 Part 4	No crack after bending		B	K	P	W		N			

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							DATE:								
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SL. NO	Component/Operation & Description of test	Type of Check	Quantum of Check /sampling with basis	Reference documents for Testing	Acceptance Norms	Format of Record	APPLICABLE CODES						Remark		
							1	2	3	4	5	6			
1.5.2	At CLRI Manufacturer's Works														
1.5.2.1	Visual Examination	Visual	100%	IS 2486 - Part 3	IS 2486 part-3	CLRI Manufacturer's Test Report	A	J	S	W		N			
1.5.2.2	Dimension	Physical	IS 2486 - Part 4	IS 2486 - Part 3	IS 2486 part-3		A	J	S	W		N			
1.5.2.3	Chemical Composition	Chemical	1 sample per Batch	IS 2486 Part – 1, IS 6603	Grade X02Cr19Ni10 /X04Cr19Ni9/ As per approved drawing/TS		A/D	J/L	S/V	W		N			
1.5.2.4	Hardness	Mechanical		IS 2486 – part 4	160HV / 152 BHN /83.4 HRB (Min)		A	J	S	W		N			
1.5.2.5	Operational test						A	J	S	W		N			
	i) Load Fmin- Fmax (N)	Mechanical		IS 2486- part 4	50 – 500		A	J	S	W		N			
	ii)F Max @ 500N Check	Mechanical		IS 2486- part 4	No removal		A	J	S	W		N			
1.6	Grading Rings and Clamps														
1.6.1	At Supplier's Works									E					
1.6.1.1	Chemical Composition of Ingot & Aluminium Extruded pipe	Chemical	1 sample/ Batch	As per grade indicated in approved drawings/ Technical Specification	As per grade indicated in approved drawings/ Technical Specification	Supplier's Test Report/Third Party Lab report	B/D	K/L	P/V	W		N			
1.6.1.2	Visual Inspection	Physical	2% per batch of 1000 or part thereof	As per Plant Standard	Smooth Surface, Free from Defects	Supplier's Test Report	B	K	P	W		N			
1.6.1.3	Dimensions	Physical		As per Approved drawing	As per Approved drawing		B	K	P	W		N			
1.6.1.4	Thickness of Zinc coating of Holder (if applicable)	Physical	5 nos. per 1000 or part thereof	By Elecometer	As per Approved drawing		B	K	P	W		N			
1.6.2	At CLRI Manufacturer's Works														
1.6.2.1	Visual Examination	Visual	10% of Batch	----	Free from defects	CLRI Manufacturer's Test Report	A	J	S	W		N			
1.6.2.2	Dimension including thickness of wall (Ring and Holder)	Physical	10 nos per lot	Approved Drawing	Approved Drawing		A	J	S	W		N			
1.6.2.3	Chemical Composition as per Drawing	Chemical	1 sample per month	As per grade indicated in approved drawings/ Technical Specification	As per grade indicated in approved drawings/ Technical Specification	CLRI Manufacturer's Test Report/Third party lab report	A/D	J/L	S/V	W		N			

Manufacturer's Name				Customer	Vendor Code	Item	MQP NO.:						
				Utility		Composite Long Rod Insulators up to 765 kV & up to 210 kN for HVAC and upto 800 kV & up to 420 KN for HVDC	REV NO.:						
							DATE:						
							Validity:						
SL. NO	Component/Operation & Description of test	Type of Check	Quantum of Check /sampling with basis	Reference documents for Testing	Acceptance Norms	Format of Record	APPLICABLE CODES						Remark
							1	2	3	4	5	6	
1.6.2.4	Thickness of Zinc coating of Holder (if applicable)	Physical	5 nos. per 1000 or part thereof	By Elecometer	As per Utility Technical specifications	CLRI Manufacturer's Test Report	A	J	S	W		N	
1.6.2.5	For Holder/Keeper: Check of Fasteners (Nuts & Bolts)												
1.6.2.5.1	Dimension Check	Physical	4 per batch per type	As per approved drawing	As per approved drawing		A	J	S	W		N	
1.6.2.5.2	Thickness of Zinc coating	Physical					A	J	S	W		N	
Note: Grading Ring shall be as per approved drawing: Open Type Grading Ring- Round extruded Aluminium Alloy tube of minimum 50 mm diameter, minimum wall thickness of 2.5 mm or as indicated in TS Covered Grading Ring- Having minimum 2 mm sheet thickness of the cover shall have sloping surface so as to facilitate natural cleaning/removal of any deposition on its surface as per Standard Technical particulars of TS													
2	<u>IN-PROCESS INSPECTION</u>												
2.1	End Fitting Crimping Process										N		
2.1.1	Crimping pressure	Mechanical	100%	As per Plant Standard	As per Plant Standard	CLRI Manufacturer's Test Report	A	J	S	W		N	
2.1.2	Acoustic sensing for detection of cracks during crimping	Physical	100%		No cracks during crimping. Insulator shall be rejected if crack is observed		A	J	S	W		N	
2.2	Injection Moulding										N		
2.2.1	Fixed platen temperature (set values)	Physical	1 time/Shift	As per Plant Standard	As per Plant Standard	CLRI Manufacturer's Test Report	A	J	S	W		N	
2.2.2	Movable Platen temperature (Set value)	Physical	1 time/Shift		As per Plant Standard		A	J	S	W		N	
2.2.3	Curing time & Injection time	Physical	After every 5 shots				A	J	S	W		N	
2.2.4	Visual examination of semi finished insulator.	Physical	100%				A	J	S	W		N	
2.2.5	Checking for soundness of bonding	NDT	100%		No air gap, no voids between sheath and FRP rod		A	J	S	W		N	
2.2.6	Peel Off Test	Physical	As per Plant Standard		Silicone Rubber shall leave traces on metal fittings and FRP surface. Cohesive separation		A	J	S	W		N	
2.2.7	Flash removing process	Physical	100%		Plant standards		A	J	S	W		N	
2.2.8	Sheath Thickness/ Uniformity is checked with ultrasonic tester	Physical	100%		Minimum 3.5 mm/5 mm/ As indicated in TS		A	J	S	W		N	

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							DATE:							
							Validity:							
SL. NO	Component/Operation & Description of test	Type of Check	Quantum of Check /sampling with basis	Reference documents for Testing	Acceptance Norms	Format of Record	APPLICABLE CODES						Remark	
							1	2	3	4	5	6		
3	<u>ROUTINE TESTING</u>													
3.1	Visual Examination	Physical	100%	IS 16784	IS 16784	CLRI Manufacturer's Test Report	A	J	S	W	N	N		
3.2	Mechanical Routine Test	Mechanical		IS 16784	IS 16784		A	J	S	W	N	N		
4	<u>FINAL ACCEPTANCE TEST</u>													
4.1	Verification of Dimensions	Physical	IS 16784	Approved Drawings	Approved Drawings	Acceptance Test Report/Third Party Lab Report	A	J	U	Y		Y	CIP	
4.2	Galvanization test for Metal End Fitting (Ball & Socket) and Bolt & Nut of Grading Ring 1. Mass of Zinc Coating (By using Elcometer) 2. Uniformity of Zinc Coating	Chemical	IS 16784	IEC 60383	IEC 60383		A	J	U	Y		Y	CIP	
4.3	Verification of end fittings	Physical	IS 16784	IS 16784	IS 16784		A	J	U	Y		Y	CIP	
4.4	Verification of Tightness of interface between end fitting and insulator housing and of specified mechanical load	Mechanical	IS 16784	IS 16784	IS 16784		A	J	U	Y		Y	CIP	
4.5	Recovery of Hydrophobicity	Physical	As per relevant Utility specification.	Relevant Power Grid Specification	Relevant Power Grid Specification		A	J	U	Y		Y	CIP	
4.6	Silicon content by Wt	Physical			32% min		A/D	J/L	U/V	Y		Y	CIP	
4.7	Brittle Fracture Resistance test	Mechanical/ Chemical		Utility Spec/ IEC TR 62039-2021	Shall perform for 96 Hrs at 340Mpa stress, No cracks		A	J	U	Y		Y	CIP	
4.8	Dye penetration Test	Chemical		IS 16784	No penetration of dye allowed during test duration ≥20 minutes		A	J	U	Y		Y	CIP	
4.9	Water Diffusion	Thermal & Electrical		IS 16784	IS 16784		A	J	U	Y		Y	CIP	
4.10	Hardness	Thermal & Electrical		IS 16784	The Hardness of specimen shall not change from the preboiled value by more than ± 20%		A	J	U	Y		Y	CIP	

Manufacturer's Name				Customer	Vendor Code	Item	MQP NO.:									
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SL. NO	Component/Operation & Description of test	Type of Check	Quantum of Check /sampling with basis	Reference documents for Testing	Acceptance Norms	Format of Record	APPLICABLE CODES						Remark			
							1	2	3	4	5	6				
4.11	Water Diffusion Test followed by Pull off Test	Thermal	As per relevant Utility specification.	As per Utility Spec/IS 16784/IEC 61109	As per Utility Spec	Acceptance Test Report/Third Party Lab Report	A	J	U	Y		Y	CIP			
4.12	Test on interface and connection of metal fittings	Mechanical / Electrical			a. Pre-stressing involving 5 sudden load release amounting to 30% SML hold for at least 1 minute b. Acceptance criteria for Dry pf voltage test (after steep wave front test): The maximum temperature rise shall be less than 10 K compared to the ref. temperature determined prior to the pf tests.		A/D	J/L	U/V	Y		Y	CIP			
4.13	Chemical composition of Grading ring and clamp(holder)	Chemical			2 samples/Batch /size		As per grade indicated in approved drawings/ Technical Specification	Ingot- LM6 as per BS1490/4600 as per IS 617. Al.Ext- 63400 as per IS 733 or 63401 as per IS 5082	A/D	J/L	U/V	Y		Y	CIP	
4.14	Peel Off	Mechanical			E2		IEC 61109	IEC 61109	A	J	U	Y		Y	CIP	
4.15	Shear Test	Mechanical			2 samples before SML testing		IEC 61109	IEC 61109	A	J	U	Y		Y	CIP	
Note: 1. CLRI manufacturer shall ensure that traceability records/raw material manufacturer test certificates are properly maintained for FRP Rods and Silicone Compound. The same shall be reviewed during final inspection by Utility 2. Test report must indicate dimensional checks of Grading Rings. Total Qty. of Grading Rings offered vs. inspected shall also be indicated in the test reports.																
5	<u>PACKING</u>															
5.1	Visual Examination	Visual	100%	Power Grid Specification	Power Grid Specification	CLRI Manufacturer's Report	A	J	U	W		N	Please refer Clause 14 and 26 of General Notes of this MQP			
5.2	Marking destination details as per Utility norms	Visual	100%				A	J	U	W		N				
5.3	Verification of CIP/MICC/Packing list	Visual	100%	CIP/MICC	CIP/MICC		A	J	U	W		N				