Extreme Weather Events and the Urgent Need for Revision of Standards and Specifications of Grid Equipment

Lessons from Recent Events in West Bengal & Kolkata

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The Changing Climate Landscape

Heatwaves

Record temperatures stressing thermal capacity

Tropical Cyclones

Severe wind damage to distribution assets

Monsoon Floods

Urban inundation overwhelming drainage systems

Lightning Strikes

Surge damage across rural networks

India is witnessing a marked rise in extreme weather events that challenge traditional infrastructure design assumptions.

West Bengal ranks among India's top 8 states most exposed to weather-induced disruptions.

Kolkata's Climate Challenges

1

Heavy Monsoon & Urban Flooding

Intense short-duration rainfall overwhelms city drainage systems. Substation plinths often positioned below road level result in frequent inundation of critical electrical equipment.

2

High Humidity & Salt-Laden Air

Coastal proximity brings corrosive atmospheric conditions. Accelerated corrosion of outdoor equipment reduces operational lifespan significantly.

3

Rising Temperature Trend

Average summer temperature has increased by approximately 1.5°C over the last 20 years, pushing equipment beyond design thermal limits.

4

Cyclonic Storms

Recent cyclones including Amphan, Yaas, and Remal have caused severe wind damage to distribution assets, with recovery times extending days beyond normal.

Impact on Grid Infrastructure in West Bengal

Different weather patterns create distinct failure modes across the power system. Understanding these impacts is essential for targeted equipment specification revisions.

Weather Type	Observed Grid Impact (Kolkata & Beyond)
Cyclones (Amphan 2020)	LT pole damage, large-scale tree fall causing feeder outages. Distribution network restoration extended beyond 72 hours in severely affected areas.
Urban Flooding	Kolkata received 251 mm rainfall in 24 hours, leading to the city's wettest day since 1986 and the sixth-highest in 137 years; at least 10 deaths, mostly by electrocution. Chances of electrocution from bare conductor of unattended bare wire of streetlights, water ingress in HT switchgear, joint failures in LT cables. Equipment derating and premature aging observed.
Heatwaves	Transformer overheating, derated cable performance, nuisance tripping. Peak load handling capacity reduced during critical demand periods.
Lightning	Surge damage in rural networks

Key Takeaway: Strategies for preventive maintenance, predictive analytics, and rapid restoration to minimize downtime after extreme events

Consequences Observed Locally

25-30%

Higher Maintenance Costs

Increased equipment failure rate in weather-exposed divisions compared to baseline

2-3×

Extended Recovery Time

Post-cyclone restoration duration compared to design expectations

40%

Accelerated Aging

Reduced switchgear operational life due to repeated flooding exposure

Systemic Impacts

The cumulative effect of inadequate equipment specifications creates a cascading series of operational challenges:

- Repeated flooding events **shorten switchgear service life** by 30-40% compared to manufacturer ratings
- Undergrounding distribution lines prone to repeated cyclones
- Post-cyclone restoration requires 2–3× longer duration due to inadequate design tolerance margins
- **Customer dissatisfaction increases** during extended outage periods
- System losses spike during recovery phases as temporary arrangements operate at lower efficiency

Why Current Standards Are Insufficient

Thermal Limits

Based on ≤40°C ambient temperature — inadequate for Kolkata's **43–45°C peak conditions**

Flood Resilience

No specific elevation standard for substations in high-waterlogging zones

Corrosion Protection

Limited coverage for coastal humidity and saline air exposure conditions

Additional Gaps Identified

- **Lightning protection:** Rural and Semi-urban systems rely on legacy designs not updated for current storm intensity
- **Cable standards:** Lack of mandatory "water-blocking" jointing specifications in IS codes
- **Wind loading:** Tower design parameters insufficient for cyclonic wind speeds observed in recent events

The Case for Revising Grid Equipment Standards

Regional Climate Variability

Local weather patterns in **eastern India not captured** by national average conditions used in standard development

Urban Load Density

Metropolitan networks require equipment designed for rapid recovery and continuous operation under stress

Infrastructure Resilience

Substation and cable resilience must be **central priorities** in CEA and BIS specification revisions

> "Resilience must be engineered into the grid, not retrofitted after failure."

Standards must align with **realistic field conditions** rather than controlled laboratory environments. We recommend developing climate-zone-specific annexures within IS/CEA standards to address regional variations.

This approach would allow utilities to specify equipment appropriate for their actual operating conditions while maintaining national standardization frameworks.

Suggested Areas for Standards Revision

Comprehensive equipment specification updates are required across multiple asset categories to build climate-resilient power systems. Adoption of advanced materials, coatings, and structural reinforcements for improved durability and weather resistance

Equipment Type	Proposed Revision Focus
Transformers	Higher insulation class ratings, improved cooling system design, flood-resistant bushing configurations. Thermal capacity based on 45°C ambient conditions.
Underground Cables	Mandatory water-blocking insulation layers, IP68-rated joint assemblies, improved drainage design at duct crossings and transition points.
Switchgear (6.6/11 kV)	IP65/66 ingress protection minimum, raised installation height specifications, stainless steel or corrosion-resistant enclosures for coastal zones.
Towers & Poles	Enhanced wind loading calculations for cyclonic zones (up to 180 km/h sustained), improved anti-corrosion coating systems, foundation design for saturated soil conditions.
Substation Civil Works	Minimum plinth height standards based on historical flood data plus climate projection margin, comprehensive waterproofing specifications, pump redundancy requirements.

Implementation Path:

- Need for revising BIS standards and CEA rules as well as utility-level specifications for poles, conductors, transformers, and switchgear to enhance resilience. Standardization of specifications of important grid equipment (DTs, wires, cables, poles, switchgear) all cross the country
- Incorporation of climate risk modelling and disaster impact simulations in equipment design and procurement processes

Role of Utilities and Regulators

Collaborative Framework for Climate-Resilient Infrastructure

Utility Responsibilities

- Assessment of current equipment performance under extreme weather conditions and identification of failure patterns
- Conduct comprehensive vulnerability audits of existing assets
- Integrate resilience criteria in procurement and vendor evaluation processes
- Develop climate-adaptive maintenance strategies
- Implement proactive asset replacement programs

Regulatory Framework (SERCs)

- Allow cost recovery for resilience investments through tariff mechanisms
- Mandate reporting of climate risk exposure and mitigation measures
- Encourage public-private R&D partnerships for resilient equipment development
- Establish performance standards for extreme weather preparedness

Coordinated Action: Creation of an Infrastructure Resilience Fund to finance projects/interventions enhancing infrastructure durability and adaptability and develop a Resilience Cost-Benefit Analysis (RCBA) tool for eligibility of such funds

CESC's Initiative to Ensure Safety and Public Health Against Urban Flooding and Unwanted Electrocution

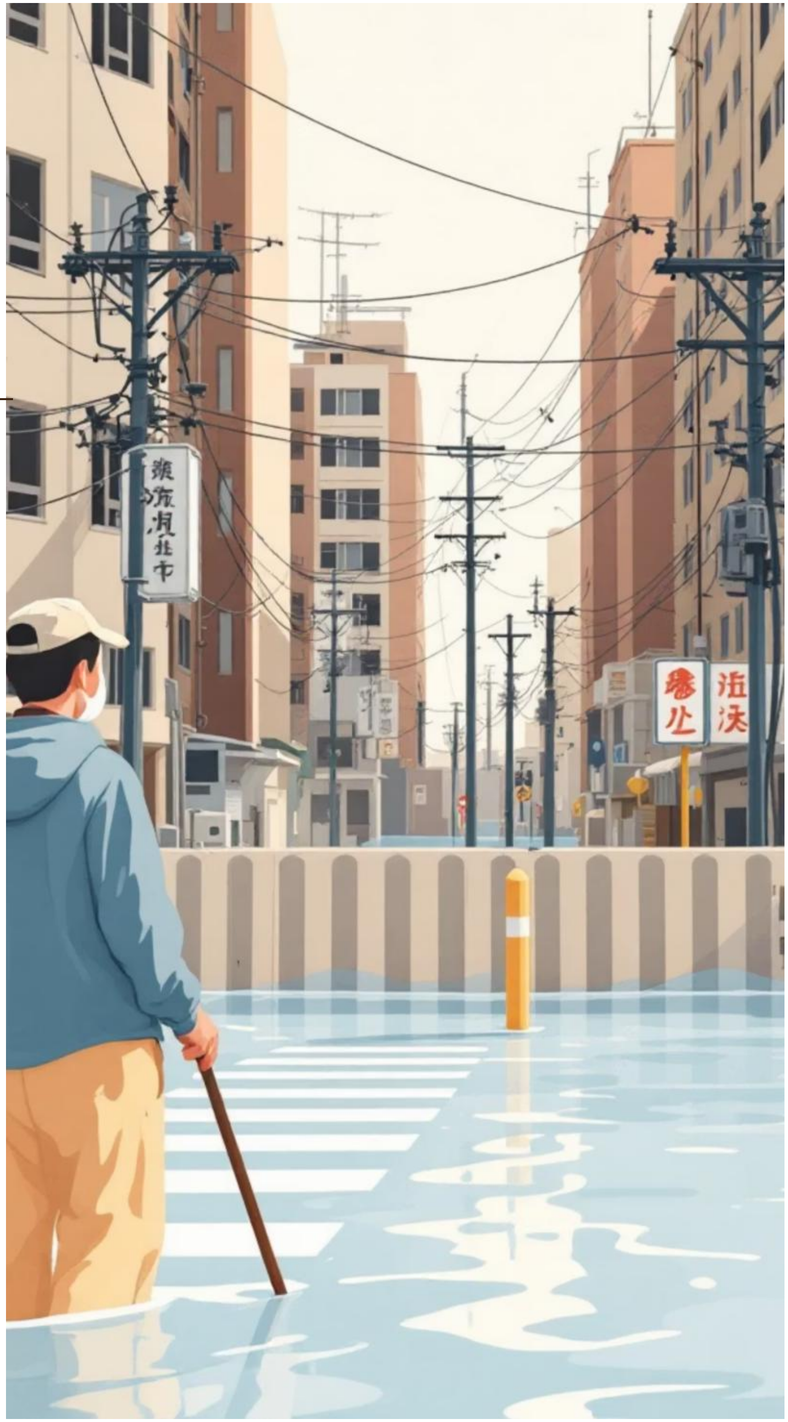
CESC is proactively addressing the health and safety impacts of electrical infrastructure in public areas through a comprehensive safety framework.

CESC's Comprehensive Safety Measures

- Routine checking of earth resistance at individual poles
- Development and introduction of insulated FRP pole-jacket and FRP Pole clamp
- Trimming of tree branches
- Replacement of bare overhead conductors with Aerial Bunched (AB) Cable
- Raising of distribution pillar boxes in low lying areas
- Introduction of IOT based water level sensors
- Overhead transmission and distribution infrastructure monitoring through Drone
- Distribution Transformer Combined Fuse Switch (CFS) Automation

Enhancing Grid Resiliency

CESC, in collaboration with IIT Kharagpur (IIT KGP), had undertaken a critical study to enhance grid resilience post Cyclone Amphan, aiming to build a more robust and adaptive power distribution network.



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