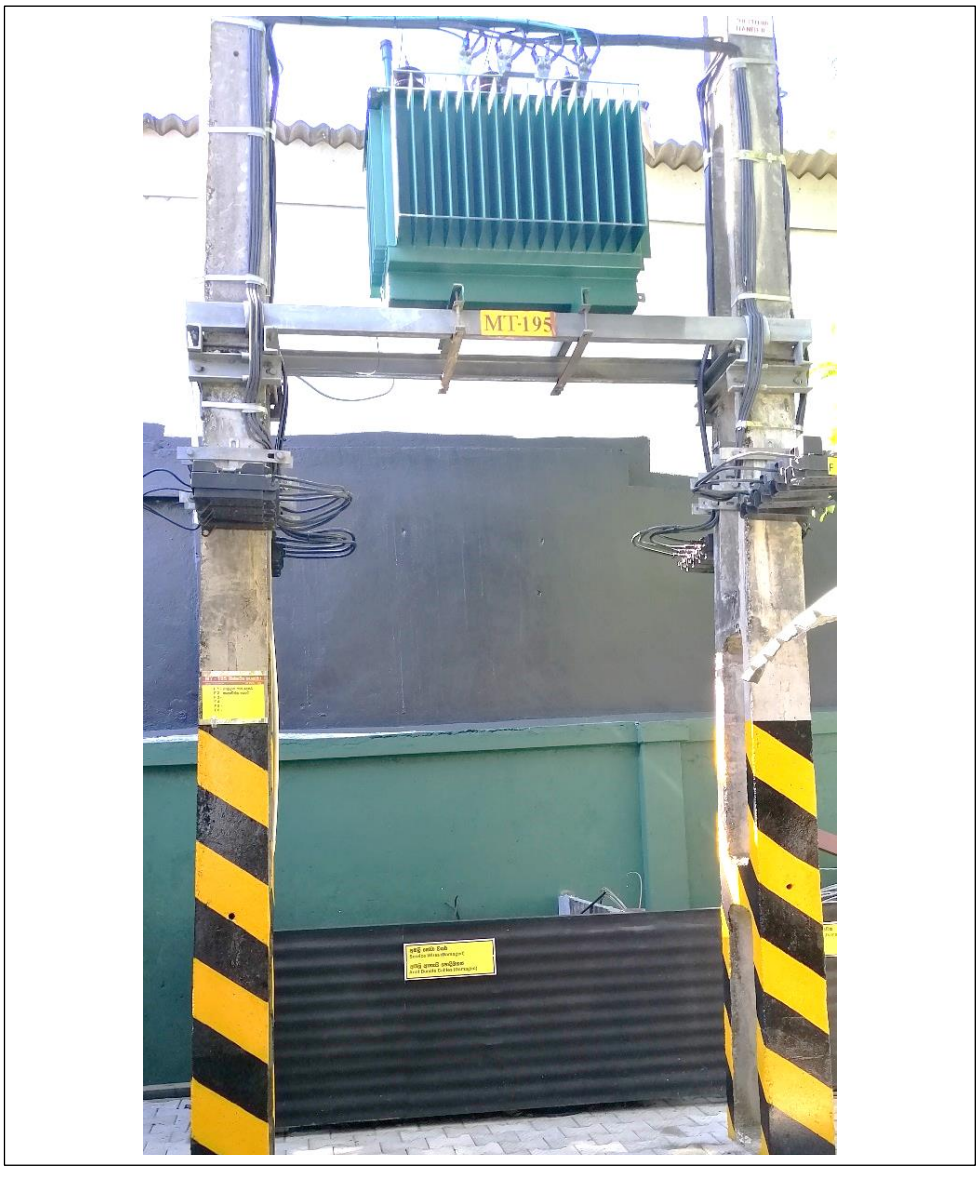
Public Utilities Commission of Sri Lanka

Report on Compliance of Distribution Substations with Electricity Safety Quality and Continuity Regulations



January 2025

Executive Summary

This report provides an assessment of distribution substations' adherence to the *Electricity (Safety, Quality, and Continuity) Regulations, 2016*, focusing on safety, quality, and service continuity. Visual inspections during the years 2023/2024 aimed to ensure compliance with required standards, especially given the public safety risks posed by substations located near pedestrian areas. Key findings underscore critical areas for immediate improvement to enhance public safety and regulatory compliance.

Inspections, which included visual and thermographic evaluations, reveal a disconnect between documented standards and real-world application. Licensees, though possessing inspection protocols, need to bridge these gaps. Enhanced awareness of regulatory standards among technical teams, especially at the operational level, is essential for improvement. Recommendations include random inspections by authorized electrical engineers to monitor and validate field compliance effectively.

Immediate actions are recommended to address specific non-compliance issues in respect of distribution substations:

- **Proper use of HRC LV fuses and correct installation**
- **Installation of safety barriers or adequate clearance to prevent accidental contact with live parts**
- **Mitigating theft of grounding conductors (earth wires)**

Implementing these steps promptly can substantially reduce field non-compliances, thereby ensuring safer operational standards for substations in public areas.

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Disclaimer

This report is intended solely for informational and regulatory purposes. The findings and recommendations herein are based on inspections and data available at the time of preparation. The Public Utilities Commission of Sri Lanka (PUCSL) does not accept responsibility for any errors or omissions or for any consequences arising from the use of this information. Stakeholders are advised to conduct their own assessments before making decisions. The PUCSL reserves the right to update or amend this document without prior notice.

For any clarifications regarding this report please contact :

Lilantha Neelawala

Deputy Director – Inspectorate

Public Utilities Commission of Sri Lanka

Email: lilanthan@pucsl.gov.lk

Mobile: +94 77 0126 247

1 Measures have been implemented by Licensee to assure compliance

There are approximately 40000 distribution transformers maintained by distribution licensees. PUCSL obtained substation inspection and maintenance related reporting templates/check lists from the Licensees. Further, PUCSL officers conducted meetings with relevant engineers in several areas to understand and collect information on how the inspections are done.

Areas inspected by PUCSL Officers during 2023 /2024 :
Vauniya/Killinochchi/Jaffna/Mannar/Baticaloa/Alawwa/Monaragala/Ratnapura/Tricomalee/Beliatte/ Tangalle/Embilipitiya/Ambalangoda/Dehiattakandiya/Hasalaka/Deniyaya/Morawaka/Neluwa/Anuradhapura/Bakamuna/Ganewalpola/Dambulla/Jayanthipura/Bandarawela/Galenbindunuwewa/Kahatagasdigiliya/ Matara/Minneriya/Kuliyapitiya/Nikeweratirya/Kahawatte/Puttalam/Negombo/Ekala/Mahabage/Mabola/ Welisara/Galle/Kandana/Weligampitiya

CEB and LECO have thorough check lists/ inspection reporting templates that are required to be filled by technical staff who engage with distribution transformer routine inspection and maintenance activities. Further, the Distribution Construction Standards and operations manuals provide comprehensive guidance to conduct the installation and maintenance activities of outdoor distribution substations. These inspection reports need to be prepared and signed by the relevant Electrical Superintendent.

The reporting templates of LECO are also comprehensive, and it specifically mentioned that these inspection reports should be filled at the signed.

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2 Non-Compliances that were Observed

The inspections identified several violations across various substations. Each non-compliance issue is discussed below with references to the relevant regulatory clauses.

2.1 Use of Improper Fuse arrangements and related installations

Observations: Substitution of standard fuses with copper/aluminum wires.

Weakly connected HRC fuses causing severe hotspots.

Unenclosed HRC fuses at touchable height causing exposed live parts.

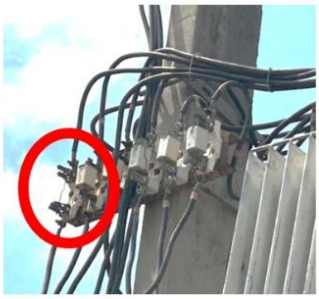
Explanation: Failure to ensure secure and correct fuse connections demonstrates neglect in protecting the public from potential hazards associated with the distribution network. The distribution licensee is responsible for ensuring all installation methods adhere to safety regulations and standards.

By improperly connecting HRC fuses, which results in weak connections, demonstrates the failure of DL to ensure that these critical protection devices are properly installed and secured in their slots. Weak connections lead to resistive hotspots under normal current loads, which can escalate to high temperatures, melting, or even fires, compromising both equipment safety and continuity of supply.

Evidence

N-15*

Nikaweratiya



C-458

Chilaw

C-247

Chilaw

W-117

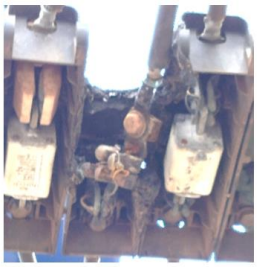
Wennappuwa

C-065

MInneriya

A-030

Galenbindunuwewa

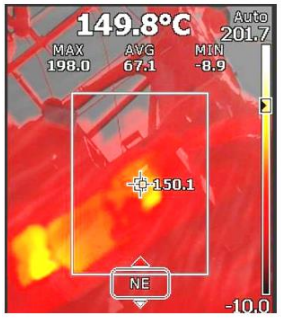


E-077

Kahatagasdigiliya

A-284

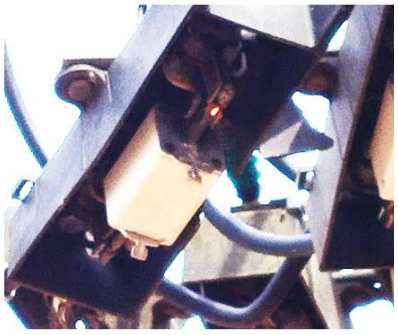
Anuradhapura



N-117

Nikaweratiya

Kahawatte Town



A-279

Galenbindunuwewa

2.2 Lack of Protective Barriers for Exposed Live Parts

Observations : Inadequate barriers to prevent accidental access to exposed live parts

Explanation: Some substations, specially the plinth mounted substations have open live parts and inadequate barriers, posing significant risks to public safety. Substations should have appropriate enclosures to prevent unauthorized access and reduce the risk of injury.

Particular attention is required for live parts situated below 3 meters, as these are more susceptible to public interaction or accidental contact. Any live equipment within this height, if not adequately shielded by barriers, clearly breaches regulatory requirements. Exposed live equipment must be secured with a surrounding fence or wall at least 2.4 meters high to prevent unauthorized access and accidental touch.

For installations below 3 meters, implementing barriers or protective enclosures is essential to comply with safety protocols. If a distribution licensee has unprotected live parts within this range, they fail to meet the obligations set forth in Regulation 19(2)(c). Even for equipment placed above 3 meters, it remains critical to install clear warning signs or protective markers in accordance with industry safety standards. Failure to provide such safeguards, especially in areas frequented by the public, could be deemed negligent and compromise public safety.

Evidence:

C-018
Minneriya

N-033
Nikaweratiya

B-058

B-067
Bandarawela

E-173
Mahawannammaduwa

Dehiattakandiya

TB-290
Beliatte

D-025
Trincomalee

2.3 Non-availability of Earthing (Neutral/ Surge Arresters)

Observations: Removal(theft) of surge arrester earth.

Removal(theft) of neutral earth.

Explanation: Several transformers and surge arresters lack proper earthing connections (owing to theft), increasing the risk of electrical faults and equipment damage. Further it was observed that use of aluminum cables to reconnect the void of removed portion of the copper earth cable.

The removal of earthing conductors due to theft poses a threat to the safety and functionality of distribution systems. Neglecting to replace these stolen components reflects a lapse in the licensee's duty, to mitigate identifiable hazards. With the absence of neutral earthing, over voltages can appear on consumers' supply leading to equipment failure. With the absence of surge arrester earthing, transformer failure can occur owing to lightning surges and these surges can be passed on to LV system putting the consumer installations to unsafe conditions.

Evidence:

T-717

Kurunegala

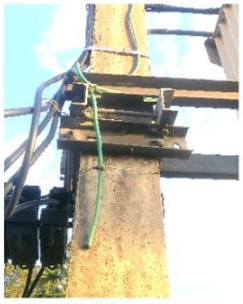
Kahawatte Town

A-332

Anuradhapura

DT-M-145

Mannar



G-001

Trincomalee

E-049

Ehaliyagoda

3 Specific Sections of Safety Quality and Continuity Regulations (2016) to be Complied with:

Section 2(a): Standard goods or materials to be used.

Section 4(a) (b) : DLs' obligation towards public safety and to prevent injury or damage.

Section 6(a) : requires Licensee to assess risks to their equipment from potential interference, vandalism, or unauthorized access, and to implement appropriate safeguards.

Section 9: Requires that all materials and installations in the network conform to the relevant standards.

Section 11: obligates the distribution licensee to inspect the network frequently enough to identify any actions needed to comply with the regulations and maintain a record of inspections.

Section12: Requires that protective measures be in place within the network to prevent any hazardous currents, that can make parts of the network unsafe. Which requires DL to install fuses to meet the specified standards, without exposing the network to risks of uncontrolled current flow.

Section 19 : Any metalwork associated with network equipment that is not intended to serve as a phase conductor must be connected to earth where necessary to prevent danger.

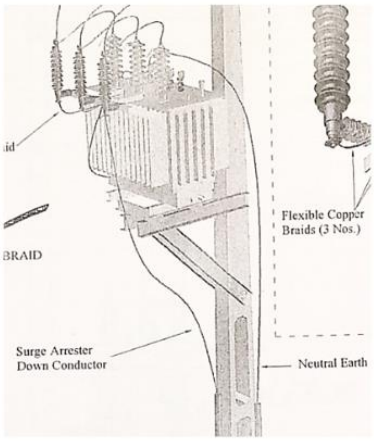
Section 20(a)(i),(ii): Mandates barriers around live equipment under 3 meters to prevent unauthorized access and accidental contact.

4 Other Observations:

Use of metal pipes to cover surge arrester earth wire.

As per the information provided by CEB, down conductors of earthing are passed through a PVC pipe filled with concrete or cement. However, we have come across places where metal tubes have been used for the same purpose. From an electrical perspective, this method requires careful consideration to avoid affecting the earthing system's performance during surge events due to a potential increase in inductance.

Use of 2 separate earth wires for surge arrester earth and transformer body earth (against the CEB distribution construction standard- 2023).



2 earth wires

3 earth wires

5 Recommendations :

i. Random Visual Inspections :
Conduct random visual inspections by a responsible engineer to evaluate the workmanship and proper implementation of the Distribution Licensees' (DLs) standards/guidelines of his/her staff in respect of distribution substations.

ii. Consumer awareness :
Distribution Licensee (DL) to aware nearby consumers who are fed through the relevant substation, about copper theft and consequences that can happen, and encourage them to inform DL immediately if such incident came to notice.

iii. Aware the Police officers in respective area:
DL to aware relevant police officers in the relevant areas about the importance of protecting the earths from theft, to consumer safety and reliability.

iv. DL to Evaluate the consequences (increased inductance) of using steel enclosures (eg: GI pipes) to protect earthing wires (from theft) of substation. Accordingly decide and provide instructions to areas where they are using steel pipes to encase surge arrester earth wires to prevent theft.

v. Use of non-copper or less copper material: Evaluate the use of metals with lower resale value, as earthing conductors and implement if it is feasible and serve the purpose of using 50sqmm copper conductors. (eg: Aluminium)

vi. Study on cost effective methods to deter thieves:
DL to review theft detection methods used by distribution utilities in other countries to prevent theft at pole and plinth-mounted substations for potential adoption.