

CIGRE Study committee D1

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

JWG D1/A2.84

NAME OF THE CONVENOR

Lukic Jelena (SERBIA)

TITLE

Silver Corrosion in Power Transformers

THE WG APPLIES TO DISTRIBUTION NETWORKS: YES

ENERGY TRANSITION

0 / Not applied

POTENTIAL BENEFIT OF WG WORK

3 / likely to contribute to new or revised industry standards

6 / work likely to contribute to improve safety

STRATEGIC DIRECTION

1 / The electrical power system of the future reinforcing the End-to-End nature of CIGRE: respond to speed of changes in the industry by preparing and disseminating state-of-the-art technological advances

SUSTAINABLE DEVELOPMENT GOAL

9 / Industry, innovation and infrastructure

BACKGROUND :

Historically, the phenomenon of copper corrosion has garnered significant attention within the CIGRE community, primarily due to the elevated risk of failure associated with the deposition of copper sulphide on paper insulation. Incidents of silver corrosion, despite posing potentially greater risks in certain scenarios, received comparatively less focus due to their less frequent occurrence and hindered manifestation caused by deficiency of detection methods.

For decades, the challenge of silver corrosion in transformers has been acknowledged, with several standards, including DIN 51353 (1985) and ASTM D1275-15 (2015), establishing testing protocols to ascertain the corrosive potential of insulating oil. Moreover, the IEC 62697 series introduced quantitative tests to measure the concentrations of various sulfur compounds, enhancing understanding and detection capabilities.

Traditionally, instances of silver corrosion were predominantly linked to the presence of reactive sulfur in mineral oil, emanating from inadequate refining processes, contamination, or flawed oil reclamation practices. However, recent incidents have underscored a gap in the collective understanding of sulphur corrosion sources and mechanisms of copper and silver corrosion and have questioned the adequacy of existing measures to prevent such failures. Apart from corrosiveness of mineral oils (containing DBDS, S8 and other disulphides), as still very much present nowadays, corrosive sulphur species were detected in ester based insulating liquids. This has indicated a need for further investigation and potential revision of current practices.

PURPOSE / OBJECTIVE / BENEFIT OF THIS WORK :

Screening of the silver corrosion problem was done in short-term activity of the Task force A2.02. However, sulphur corrosion is still very much affecting both copper and silver with insulating liquids in a wide range of concentrations of different corrosive sulphur species, starting from sub ppm range (below 1 ppm) to dozen and hundreds of ppm.

Available detection and quantification methods should be revised since they were found not to be adequate to mirror service experiences, considering both ester-based liquids and mineral oils. This new D1/A2 joint WG should

propose revision of existing and/or new sulphur corrosion tests and quantification methods to address adequately different corrosive sulphur species reactivity and better simulate conditions in power transformers.

Risk assessment of power transformers should be based on proper setting of insulating liquids propensity to react with silver and copper, including materials compatibility affecting corrosion. One of the important influential factors in risk assessment is the mechanism and kinetics of silver sulfide formation which should be studied and elaborated.

Guidelines for risk assessment, remedial actions as well as short-term and long-term mitigation techniques should be recommended (from change and treatment of liquids, change and cleaning of corroded contacts, considering materials compatibility and LCA), to provide sustainable solutions.

SCOPE :

- Collect and document recent cases of silver corrosion problems
- Investigate the root causes and the origin of corrosive agents
- Elaborate on silver sulphide formation mechanism and kinetics
- Review existing standards for silver corrosion detection and if necessary, improve existing silver strip corrosion tests to adequately address different types of corrosive sulphur species and better correlate to real ratio of sulphur to silver
- Improve limits of detection and quantification of existing sulphur quantification methods to adequately address low sulphur contents (bellow 1 ppm)
- Propose new methods for elemental sulphur quantification in low concentration range (bellow 1 ppm)
- Propose revision of General specifications tests, as well as tests prior to energization, for all types of unused insulating liquids
- Propose revision of material compatibility tests in relation to copper and silver corrosion
- Provide guidelines and recommendations for Power Transformer Risk Assessment, covering also main accessories such as Tap Changer and bushings.
- Propose recommendations for short-term and long-term remedial actions and mitigation techniques.

DELIVERABLES AND EVENTS

Deliverables Types

Annual progress and activity report to Study Committee
Technical Brochure and Executive Summary in Electra
Tutorial
Webinar

Time schedule

Q4	2025	Recruit members (National Committees, WiE, NGN)
Q1	2026	Develop final work plan
Q4	2028	Draft TB for Study Committee Review
Q1	2029	Final TB
Q2	2029	Tutorial
Q2	2029	Webinar

APPROVAL BY TECHNICAL COUNCIL CHAIRMAN:

Rannveig Loken
November 06th, 2025