CIGRE Study committe A2

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG A2.76

NAME OF THE CONVENOR
Dastous Jean-Bernard (CANADA)

TITLE
Power Transformer Passive Protection Against Internal Arcing Faults

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-ofthe-art technological advances

SUSTAINABLE DEVELOPMENT GOAL
0 / Other SDGs or not applied

BACKGROUND :

CIGRE Brochure 537 “Guide for Transformer Fire Safety Practices”, which was published in 2013, delivered several conclusions and recommendations regarding the transformer tank design, the most important being that:

- The probability of a tank rupture (and a possible fire) from an arc will depend on the arcing energy available and the tank pressure withstand capability.
- The effectiveness of venting devices cannot be relied upon to provide adequate and sufficiently fast pressure relief to prevent tank rupture for high energy arcing faults.
- IEC Standard and most national standards for transformers are deficient in that they do not provide any guidance on the requirements and methods of verification of designs of transformer tanks.

CIGRE brochure 537, as well IEEE Std C57.156, provide generals guidelines for good transformer fire safety practices to help transformer designers and users. These documents provide methodologies to evaluate the pressure resulting from an arc of specified energy within a tank. However, the required calculation methodologies and rupture criteria to design and evaluate transformer tanks to withstand the resulting pressure rises were not specified, nor were they sufficiently developed at the time of these publications.

Accordingly, some utilities and manufacturers had to develop their own arc resistance requirements and/or calculation methodologies to procure tanks that can withstand specified levels of arc energy, while failing safely beyond. Manufacturers have been able to meet these requirements by adapting their tank design towards an efficient combination of flexibility and strength, thus achieving significantly improved arc containment capabilities.

In 2022, the A2 CIGRE Task Force: “Power Transformer Tank Specification for Passive Protection Against Internal Arc” with 11 participants from 8 countries was formed to generate a reference paper on this topic. After two years of work and 3 drafts, a comprehensive report was generated whose content largely exceeded the size of a reference paper. It was then recommended that the task force transition to a working group since sufficient material for a brochure is readily available and only requires some further development.

PURPOSE / OBJECTIVE / BENEFIT OF THIS WORK :

Passive protection is defined as designing a transformer main tank and its internal and external components to withstand the effects from an internal arc, without using additional external devices.

The purpose of this work is to develop a brochure that will enable users to:

- understand the phenomenon of low impedance arcing and how to calculate the corresponding energy released during such events;
- evaluate the design pressure in the main tank and its internal and external components, such as OLTC’s and bushings;
- understand the concept of passive protection design;
- understand the available calculation methodologies to assess the strength of a given transformer design;
- understand the available testing methodologies that can be used to verify experimentally the arc withstand capability of a given transformer design;
- know the best design practices and calculation parameters to appropriately assess and design an arc resistant tank;
- identifying the key elements that should be part of a standard on passive protection against internal arcing.

The main benefit of this work will be to provide the industry with state-of-the-art: arc resistant tank design practices, calculation and testing methodologies. This will contribute to the development of a harmonized approach on power transformer passive protection design, with the goal of lending itself eventually to an international standardization.

SCOPE :

The scope of the work is based on expanding the report of the task force with additional material and content in order to produce an exhaustive brochure covering all aspects of passive protection design. Therefore, the content of the brochure is set to follow the structure of the task force report, covering the following aspects:

- Arcing phenomenon in liquid immersed equipment: Arc energy determination for design in main tank and on-load tap changers, gas generation in mineral oil and in alternative insulation fluids.
- Design pressure: Core tanks versus shell tanks, design pressure in other components, effects of arc outside the main tank, pressure rise in radiators, effects of arc in tap changers, passive protection designs.
- Calculation Methodologies: Static nonlinear Finite-Element Analysis (FEA), Explicit dynamic analysis, Computational Fluid Dynamic (CFD).
- Testing methodologies: Arcing test, static pressure test, gas injection test, instrumentation.
- Implementation examples: Passive protection designs from utilities and manufacturers, case studies.
- Arc-resistant tank specification: Main requirements, materials and manufacturing audit, approval and verification methodologies (simulation or test), recommendation towards the development of an IEC standard.

DELIVERABLES AND EVENTS

Deliverables Types
Electra report
Technical Brochure and Executive Summary in Electra
Tutorial
Webinar

Time schedule

Q4	2024	Recruit members (National Committees, WiE, NGN)
Q1	2025	Develop final work plan
Q2	2026	Draft Technical Brochure for Study Committee review
Q4	2026	Final draft Technical Brochure
Q1	2027	Tutorial
Q2	2027	Webinar

APPROVAL BY TECHNICAL COUNCIL CHAIRMAN:
Rannveig S. J. Løken
November 29th, 2024