IEEE/PES Transformers Committee
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"Short-circuit Strength and Short-circuit Testing of Power and Distribution Transformers"

-- Technical Presentation --
Monday, March 17, 4:45-6:00 pm

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1. Abstract

Transformer failures caused by short-circuit events are relatively rare events, but such failures may result in a catastrophic transformer failure, and/or in a major power outage and associated lost of revenues. According to IEEE and IEC standards, transformers shall be designed to withstand the electromagnetic forces and the thermal stresses produced during the flow of a short-circuit current. Such ability to withstand a short-circuit can be demonstrated by short-circuit tests or may be demonstrated by calculations as described in IEEE C57.12.00, IEEE C57.12.90 and IEC 60076-5. The need of requesting a short-circuit test should be based on a technical evaluation of the proposed design and on an economical evaluation of the risk associated with the possible lost of a transformer following a short-circuit event. This tutorial will provide some of the economical and technical aspects to be considered.

Small transformers, particularly those having non-circular coils and or having low X/R, and other special construction transformers as axial-split coil transformers may have particular behavior and/or need particular testing method. Those covered in the proposed revision of C57.12.90 will be presented and explained. Different test methods may be used such as the pre-set and the post-set methods. Both methods will be described and explained and the pros and cons of each method will be identified. Experiences gained in the past years show that the diagnostic methods used during a short-circuit test series as outlined in the standards are sometimes not sufficient to prove that the transformer has survived the test series without internal damages. New diagnostic tools have been developed and will be described.

Finally, recent surveys within high-power test laboratories show that the percentage of transformer designs which survive the test on the first trial is quite low for large power transformers. In addition, a CIGRE worldwide survey regarding transformer short-circuit failures in service show that the occurrence of a short-circuit failures is quite low, while a recent study at Hydro-Quebec showed that transformer failure rate due to short-circuit events is significantly higher than reported by the survey.

2. Learning Objectives

The tutorial will provide:

- Status regarding documents C57.12.00, C57.12.90;
- How transformers are designed to withstand short-circuit stresses;
- Conceptual understanding of the parameters involved in a short-circuit test program;
- Adequacy of calculations vs. performing a test;
- Importance of demonstrating the ability of a transformer to withstand a short-circuit for strategic locations or applications;
- Description of new diagnostic tools.

3. Learning Outcomes

As a result of attending of this tutorial session members will gain:

- An understanding that transformer short-circuit related failures are more frequent than reported;
- An outline of technical and economical parameters to be analyzed when the demonstration of the ability of the transformer to withstand the short-circuit current is considered;
- Inputs regarding test methodology and diagnostic techniques.

4. Presenter's Biographies

Marcel Fortin: Mr. Fortin received his B.Sc.A. in Electrical Engineering from Université Laval, Québec City in 1972, after which he joined Hydro-Québec were he occupied different function in Distribution Planning and Operation, in R&D, and in Health and Safety and as a test engineer at IREQ High-Power Laboratory. He retired from Hydro-Québec in 2001. Since then he acts as consultant in power apparatus and high-voltage and high-power testing.

Marcel is a member of the IEEE Transformers Committee and Switchgear Committee on which he is participating in several subcommittees and working groups and his responsible of working groups and task Forces. Marcel chairs the task force on the revision of short-circuit testing requirements (Clause 12 of C57.12.90). Marcel is a member of IEEE Power Engineering Society and registered as a Professional Engineer in the Province of Québec.

Juergen Gerth: Mr. Gerth is Technical Manager of ABB Inc. Power Transformer Division at Varennes, Quebec, Canada. Previously he was technical manager of ABB Power Transformer plant in Bad Honnef, Germany. He received his diploma degree in 1968 at the Technical University Aachen, Germany in Power Engineering. He joined Brown Boveri & Cie, Mannheim, Germany in the same year and started his carrier as an electrical designer of large power transformers. Responsibilities as an Electrical Design Manager, R&D Manager, and Technical Manager followed.

After the merger of ASEA and Brown Boveri to ABB, Juergen took a major role in the development of the Common ABB Power Transformer Technology. In 2003 he joined ABB Varennes to support this organization to deliver transformers with large power and very high voltages for the North American market.

Richard P. McLaughlin: Mr. McLaughlin received his B. Sc. in Electrical Engineering from Drexel University in Philadelphia in 1994 after which he joined KEMA Powertest, Inc. where he started as a test technician performing different functions in the test operations department of the test laboratory. Since 1996 he is working at the tasks and responsibilities of a Supervising Test Engineer in planning, guiding, implementing, executing and reporting all facets of a wide variety of test programs.

Richard is a member of IEEE Power Engineering Society.

Pierre Riffon: Mr. Riffon received his B.Sc.A. in electrical engineering from École Polytechnique de Montréal in 1980 after which he joined Hydro-Québec's Research Institute (IREQ) as a Test Engineer for the High Power Laboratory. Since 1988, he is working as a Test Specialist for the Hydro-Québec's Quality Control Department and is responsible for type tests on high voltage substation equipment and special project apparatus (static and series compensation, HVDC Converter, etc.).

Pierre is a member of the Transformers Committee on which he is participating in several Subcommittees and Working Groups. In particular, he is Co-chairman of WG on Test Requirements for Instrument Transformers for Nominal Voltage 115 kV and above, and the Chairman of the WG on Revision to the Impulse Tests Section in C57.12.90. He is also the Chairman of the Canadian IEC Technical Committee TC17 and Subcommittees SC17A and SC17C, Switchgear and Controlgear. Mr. Riffon is also the convener of a WG on High-Voltage alternating current by-pass switches and the Canadian representative on SC17A/MT36 for the revision of IEC 62271-100 High Voltage Circuit Breakers. Pierre is a member of IEEE Power Engineering Society and a registered Professional Engineer in the Province of Québec.