IEEE/PES Transformers Committee
Fall 2024 Meeting
St. Louis MO

"Tutorial IEEE C57.170

Guide for the Condition Assessment of Liquid Immersed Transformers, Reactors and Their Components"

-- Tutorial Presentation --
Thursday, October 24th

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1. Abstract

The objective of this guide is to adequately equip transformer users and asset managers with a process and a tool to properly assess the technical condition of their fleet of transformers in service, as well as their fleet of spare units in their utility/organization and use that, as a basis to identify candidates that may be suitable for major or minor repairs, or as well for making critical decisions about operations, refurbishment, or replacement

Many asset managers currently use a 'Health Index' for this purpose. However, in many cases the index does not provide any indication of how quickly the worst transformers on the list need to be actioned, nor does it provide any indication of the type of action needed i.e. replace, repair or refurbish. Many indices also fail to provide any indication of the confidence that the asset manager should have in the assessments in the index.

Furthermore, many asset managers use their 'health index' to help determine which transformers in their fleet to replace. However, some "unhealthy" transformers can be (relatively) easily repaired and therefore do not need to be replaced. A 'health' index may therefore not be the ideal tool to determine transformer replacement.

Chapters 1 to 7 introduces a process that can be used to assess a transformer and to develop Transformer Assessment Indices to suit the needs of the user. It also introduces the concept of the scoring matrix, which can be developed and used to ensure that scores are allocated to each transformer failure mode or mechanism being assessed in a consist way and regarding the time scale required for action.

Chapters 8 to 12 and Annex A and B deals with the sub components of a transformer and discusses:

- Failure modes and mechanisms, and
- Methods of diagnosing the failure modes and mechanisms for each sub component.

This section is mostly existing knowledge. Annex A provides tables of diagnostic information that are formatted to allow assessment using the methods described in the technical brochure. The information is from IEC & IEEE guides, CIGRE experts, and other industry experts. User can use these values as a starting point when assessing a transformer but should consider if the values are suitable for their fleet of transformers, operating conditions, maintenance practices, and the time scales used in the scoring matrix.

Annex B provides several examples illustrating how to generate different types of Transformer Assessment Indices and how to use the different scoring methods

2. Learning Objectives

The Tutorial provides the following learning opportunities;

- An overview of transformer asset management and condition assessment requirements
- Analysis of different types of indices, how they may be constructed, and their limitations
- Guidance on dealing with missing or obsolete information, including worked examples;
- Detailed worked examples on developing diverse types of indices, including replacement, refurbishment and repair indices.
- Guidance on key transformer components that are considered necessary to build a transformer assessment index, along with suitable diagnostic techniques

3. Learning Outcomes

Those attending this tutorial session, will gain an understanding of the following:

The five key steps to develop a TAI which are:

- Determine the purpose of the Transformer Assessment Score and Index
- Identify the failure modes to be included in the TAI
- Determine how each failure mode will be assessed
- Design a calibrated system for categorizing failure modes (scoring matrix)
- Calculate a TAI Score for each Transformer

4. Presenters' Biographies

Brian Sparling, LSMIEEE is a Life Senior Member of IEEE. He is a Senior Transformer Technical Manager with Kinectrics. Brian has over twenty years of experience in the field of power and distribution transformers. For the last 31 years, he has been involved in all aspects of on-line monitoring and diagnostics and condition assessment of power transformers. He has authored and co-authored more than 34 technical papers on several topics dealing with the monitoring and diagnostics of transformers. He has worked on many guides and standards with the Canadian Electricity Association, IEEE Transformers Committee and, the CIGRÉ A2 Transformer committee.

James G. Cross, P.Eng. (IEEE M '79; SM '17, LSM '22) is currently Director of Transformer Services at Kinectrics, Inc. in Toronto, Canada in which role he leads Kinectrics' testing and consulting efforts in the areas of power, distribution, and specialty transformers. As a subject-matter expert in the field of transformer engineering, he lends his knowledge and experience in transformer design and manufacturing to related project areas at Kinectrics, including asset management, transformer condition appraisals, design reviews, in-plant test witnessing, field testing, forensic and failure mode analyses, component and materials evaluation, and transformer diagnostics.

After graduating from the University of Manitoba with a B.Sc. in Electrical Engineering, he has worked since then with different transformer OEMs in design project engineering on applications up to 500kV, 500MVA class. In addition to undertaking transformer design, he was the technical liaison between the factory and customers around the world. Then with Weidmann as Manager of R&D/Innovation for 18 years before joining Kinectrics.

He has co-authored several papers related to electrical insulating materials and testing, and transformer diagnostics. He has made presentations on insulation design and transformer materials testing at several technical conferences.

He is a Life Senior Member of the IEEE, and a former Chairperson of the IEEE Winnipeg Section and currently active in the IEEE Standards Association on several working groups developing the C57 series of standards and guides. He is a registered Professional Engineer in the Province of Manitoba.

Kumar Mani is a Senior Member of IEEE. He has been working for the last 21 years with Duke Energy in various roles and is currently a Transformer Subject Matter Expert for Duke Energy's Renewable and Regulated Energy Generation. He is an active member of the IEEE PES Transformer Committee and is responsible for developing Asset Management strategies for the entire Duke Energy's generation transformer fleet