



## “Frequency Conversion of Measured Transformer Performance Parameters”

-- Technical Presentation --  
Tuesday, October 7, 5:45-7:00 p.m.

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### 1. Abstract

While it is most preferable that the performance parameters of a transformer be measured at the frequency at which it will be in operation, this is not always possible. Transformer manufacturers normally establish their testing facilities for the power frequency of the main market(s) they serve (50 Hz or 60 Hz). Only a few manufacturers have testing facilities to measure transformer performance parameters at both power frequencies. In situations where manufacturers do not have equipment to perform measurements at the rated power frequency required by the customer, manufacturers must convert the measured values from the measurement frequency to the desired frequency. Today, there exists a wide discrepancy amongst frequency conversion factors used by different manufacturers. Hence, it is advantageous for both the manufacturers and users to have a standard / uniform set of conversion factors to be used by all manufacturers. To address this, the IEEE/PES Transformers Committee requested the development of such conversion factors for no-load loss, exciting current, load loss, noise level, etc.

### 2. Learning Objectives

This tutorial presentation will provide the background to the development of the proposed frequency conversion factors using analytical methods confirmed by measurements for the different transformer performance parameters. It will also explain the theory behind the proposed formulae for thermal and short-circuit tests. Finally, the text of this frequency conversion, implemented in the new revision of both the C57.12.00 and C57.12.90 Standards, as agreed upon by the PCS and ASV Subcommittees, will be presented.

### 3. Learning Outcomes

As a result of attending this tutorial session, members will gain an understanding of the following:

1. Effect of operating power frequency on no-load loss, exciting current, load loss, no-load and load sound level, and temperature rises in windings and structural parts of power and distribution transformers.
2. Theoretical work, assumptions, and test results used to develop the proposed frequency conversion factors.
3. Advantages of using a standard set of conversion factors by all manufacturers.
4. Conditions to be observed by both manufacturers and customers for appropriate frequency conversion of the different performance parameters of transformers tested at a different power frequency than the eventual operating frequency.

#### **4. Presenters' Biographies**

**Ed teNyenhuis**: Ed is presently Technical Manager at ABB's Transformer Remanufacturing and Engineering Services in Brampton, Ontario. Ed was born in Barrie, Canada. He received his B.A.Sc. degree from the University of Waterloo, Canada, in 1990 and his M. Eng. Degree from North Carolina State University, USA, in 2000, all in electrical engineering. Ed has worked in the power transformer industry for 18 years. His past experience includes positions at ABB Power Transformers in Guelph Canada, Ludvika Sweden, ABB Electrical Systems Technology Institute in Raleigh, NC, USA. Ed has published several technical papers in IEEE, SMM, Doble and 2DM pertaining to power transformers, magnetics, and electrical steel. He is presently Chair of the IEEE/PES Transformers Committee's Working Group on Loss Measurement and Tolerances of Power and Distribution Transformers.

**Dr. Ramsis Girgis**: Ramsis is presently the Technical Manager of ABB Power Transformer Division located in St. Louis, Missouri. He is also the leader of the ABB's global R&D activities in the area of "Transformer Core Performance" and the co-leader of the global R&D activities in the area of "Transformer Noise & Vibrations". Most recently, he has been the project leader for developing the ABB technology for designing, manufacturing, and noise testing of ultra-low noise transformers for a US utility. Ramsis received his Ph.D. degree from the University of Saskatchewan, Canada, in Electrical Power Engineering in 1978. He has over 40 years of R&D experience in the area of power, distribution, pulse power, high-frequency transformers, and rotating machines. He has published and presented over 70 scientific papers in IEEE, IEE, CIGRE, and other international journals. He was awarded the IEEE Fellow Grade in 1986. He is presently the Chair of the IEEE/PES Transformers Committee's Sub-committee on "Performance Characteristics". Ramsis co-authored chapters in two electrical engineering handbooks on transformer design and transformer noise. He is the past Technical Advisor representing the US National Committee in the IEC Power Transformer Technical Committee (14).