IEEE/PES Transformers Committee
Spring 2006 Meeting
Costa Mesa, California, USA

"Environmental Impact of Audible Sound Produced by Transformers and Reactors"

-- Technical Presentation --
Monday, March 20; 4:45 to 6:00 p.m.

By Ramsis Girgis, Christoph Ploetner, Klaus Papp, Jane Ann Verner & Others

1. Abstract

All electrical power equipment produces sound. With increasing urbanization, electrical power equipment is now often installed in close proximity to where people work and live. Additionally with the bulk transfer of electrical power using both A.C. power transmission and HVDC, the environmental impact of "hub" substations, in both urban and rural environments, is a key consideration; including the acoustic impact. Therefore the characterization, predictive modeling, measurement and control of sound emitted by the wide variety of electrical power equipment has taken on an even increasing importance; including the impact on electrical power equipment standards development.

The focus of the tutorial will be the environmental impact of audible sound produced by transformers and reactors. The rapid urbanization that has taken place in many countries has resulted in an increased focus on the environmental impact related to the application of power equipment such as transformers and reactors. Audible sound and the affect on people living near installations of power equipment is a key issue. Key subject areas that will be covered include:

- Regulatory requirements, including factors that influence zoning sound levels, examples of zoning requirements and project specific initiatives to meet zoning requirements.
- Sources and characteristics of different contributors to transformer noise will be described and with a focus on load noise; including a perspective of its significance re new power transformer designs.
- The unique sound characteristics of transformers biased with direct current or loaded with harmonic current in specific applications, such as converter transformers for HVDC, will be presented.
- The unique characteristics and special nature of the audible sound produced by oil-immersed shunt reactors will be addressed.
- The audible sound produced by dry-type air-core reactors including shunt reactors, filter reactors and HVDC smoothing reactors will be described. Sound mitigation approaches will be presented.
- The sound intensity method of audible sound determination will be presented as it is being considered for inclusion in IEEE standards.

2. Learning Objectives

This tutorial will provide basic background information; including

- Appreciation of the scope and direction of regulatory requirements
- Modern transformer design strategy and the impact on audible sound
- Characterization and basic theory of sound generated by transformers and reactors, oil immersed and dry type, based on application and current loading (including DC current and harmonics)
- Designs for reduced audible sound and mitigation

3. Learning Outcomes

Attendees will gain

- A general understanding of the physics of audible sound generation in transformers and reactors.
- Improved perspective on environmental impact and regulatory requirements
- A qualitative understanding of the audible sound generation mechanism plus possible mitigation and achievable results will allow attendees to better understand the environmental acoustic aspect of applying transformers and reactors in urban sensitive areas.
- Increased knowledge to participate in this aspect of standards development and also in the application of this content area of standards for equipment design, purchase and application.

4. Presenter's Biographies

Ramsis S. Girgis, Ph.D.: Dr. Ramsis S. Girgis is presently the Technical Manager of ABB Power Transformer Division located in St. Louis, Missouri. He is also the leader of the global ABB R&D activities in the "Transformer Core Performance" area. Ramsis received his Ph.D. degree from the University of Saskatchewan, Canada, in Electrical Power Engineering in 1978. He has over 35 years of R&D experience in the area of power, distribution, and high frequency transformers, rotating machines, and pulse power components. His main areas of expertise at present are core performance, leakage flux, and audible noise of power transformers. He was awarded the IEEE Fellow Grade in 1986. He is the past Technical Advisor representing the US National Committee in the IEC Power Transformer Technical Committee (14).

Klaus Papp: Mr. Papp is R&D manager of Trench Austria GmbH in Linz, Austria where he has been employed since 1970. He received the Dipl.-Ing. Degree from the University of Technology, Vienna, Austria in 1970. His interests include the design, production, testing and application of reactors for power systems. He is a member of the IEC maintenance team for revision of IEC 60076-6 "Reactors" and he is a member of the HVDC Converter Transformers & Smoothing Reactors Subcommittee of the IEEE/PES Transformers Committee.

Christoph Ploetner, Ph.D.: Dr. Christoph Ploetner graduated from the Technical University of Ilmenau, Germany and received his Ph.D. in Electrical Engineering in 1998 from the same University. In 1999 he joined Siemens Power Transformer Factory Nuremberg, Germany as specialist for transformer modeling, magnetic and current related issues, including noise problems. He became Head of the Electrical Design Department in the Nuremberg Transformer Factory in 2005. Dr. Ploetner actively participates in the IEEE transformer committee and serves currently as convener for the maintenance team of the standard IEC 60076-6 "Reactors".

Jane Ann Verner, P.E.: Jane Ann Verner is the Manager of Pepco's Substation Engineering and Design Department. She has been the responsible project engineer on new substation projects, power transformer and switchgear installations. She also has worked on a number of generation interconnection projects. Jane obtained her Bachelor's Degree in Electrical Engineering from the University of Pittsburgh and is a registered professional engineer in Pennsylvania, Maryland and the District of Columbia. She is an IEEE member and is a member of various working groups within the IEEE Transformers Committee.