

IEEE Guide for Partial Discharge Measurement in Liquid-Filled Power Transformers and Shunt Reactors

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Abstract: The detection and measurement by the wide-band apparent charge method of partial discharges occurring in liquid-filled power transformers and shunt reactors during dielectric tests are covered. This standard covers the measuring instrument, calibrator characteristics, test circuits, calibration procedure, and partial discharge measurement during induced-voltage tests.

Keywords: Liquid-filled transformer, partial discharge, shunt reactor

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Foreword

(This foreword is not a part of IEEE C57.113-1991, IEEE Guide for Partial Discharge Measurement in Liquid-Filled Power Transformers and Shunt Reactors.)

As a long-term trend beginning in the 1950's, the combination of lower insulation levels and higher system voltages brought about increased interest in the detection and measurement of partial discharge activity within the insulation structure of a transformer. As the name implies, a partial discharge is the breakdown of a small section of the insulation path and is undesirable because of deterioration of the insulation and formation of gas that may accumulate at a critical stress area. In general, electrical measurements of partial discharge activity should be made on the basis of the resultant momentary change in the voltage at the terminals of the transformer. Such change may be expressed as a voltage change or, by suitable calibration, as an apparent charge. An apparent charge is that charge in coulombs that, if injected between terminals, would cause the same voltage change as that resulting from the partial discharge.

The initial efforts at measuring partial discharge levels, particularly in regard to acceptance criteria between the user and the manufacturer, utilized NEMA 107-1940, which provided radio influence voltage (RIV) readings in microvolts (μV) on a quasi-peak basis at or near 1.0 MHz. Later, this approach was modified by using the bushing tap instead of a separate coupling capacitor and eventually was included as the standard method of measuring partial discharges in transformers in IEEE C57.12.90-1980.

Meanwhile, however, the industry has recognized that measuring partial discharges in terms of apparent charge has many advantages over the RIV approach. Two advantages are (1) the differences in internal capacitance between transformers are compensated by the calibration procedure, thus the measured level is more closely related to the true level of the partial discharge, and (2) a generally lower specified measuring frequency provides for less attenuation of partial discharge located deep within the transformer insulation structure.

The problems that have delayed a change to apparent charge measurements as an industry standard have been that (1) the RIV approach has had the advantage of being based on a recognized and established circuit, and (2) the industry has gained a great deal of experience with the circuit including appropriate acceptance levels. To take advantage of the apparent charge approach required first that a standard circuit be developed. This was undertaken by the Task Force for the Measurement of Apparent Charge within the IEEE Transformers Committee. This document is the result of that effort. Apparent charge measurements may be made on a wide-band or narrow-band basis, as both systems are recognized and widely used. Without giving preference to one or the other, it is the object of this document to describe the wide-band method. General principles of partial discharge measurements including the narrow-band method are covered in IEC 270 (1981), IEC 76-3 (1980), and IEEE Std 454-1973. The Task Force that prepared this document hopes and expects that users and manufacturers of transformers will make apparent charge measurements on new transformers so that an adequate base of experience can be developed and so that the apparent charge method will eventually become the standard method of measuring partial discharge within transformers. This document was developed by the Task Force for the Measurement of Apparent Charge and the Working Group on Partial Discharge Tests in Transformers of the IEEE Transformers Committee.

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IEEE Guide for Partial Discharge Measurement in Liquid-Filled Power Transformers and Shunt Reactors

1. Scope

This test procedure applies to the detection and measurement by the wide-band apparent charge method of partial discharges occurring in liquid-filled power transformers and shunt reactors during dielectric tests, where applicable.

2. Purpose

Partial discharge measurements in transformers and shunt reactors may preferably be made on the basis of measurement of the apparent charge. Relevant measuring systems are classified as narrow-band or wide-band systems. Both systems are recognized and widely used. Without giving preference to one or the other, it is the object of this document to describe the wide-band method. General principles of partial discharge measurements, including the narrow-band method, are covered in IEEE Std 454-1973 [7]¹, IEC 270 (1981) [2], and IEC 76-3 (1980) [1].

3. References

The following publications shall be used in conjunction with this standard. When the standards referred to in this guide are superseded by an approved revision, the latest revision shall apply.

[1] IEC 76-3 (1980), Power transformers; Part 3: Insulation levels and dielectric tests.²

[2] IEC 270 (1981), Partial discharge measurements.

¹The numbers in brackets correspond to those of the references in Section 3

²IEC publications are available from IEC Sales Department, Case Postale 131, 3 rue de Varembe, CH 1211, Genève 20, Switzerland/Suisse. IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.