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IEEE Recommended Practice for the Detection and Measurement of Partial Discharges (Corona) During Dielectric Tests

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IEEE Recommended Practice for the Detection and Measurement of Partial Discharges (Corona) During Dielectric Tests

Sponsor
Power System Instrumentation and Measurements Committee
of the
IEEE Power Engineering Society

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Foreword

(This Foreword is not a part of IEEE Std 454-1973, Recommended Practice for the Detection and Measurement of Partial Discharges (Corona) During Dielectric Tests.)

This document is based on IEC Publication 270-1968, Partial Discharge Measurements. It adheres closely to the IEC recommendations with the following exceptions:

(1) The terms *partial discharge energy* and *partial discharge power* are not used in this document but are defined for future reference.

(2) Likewise, the corona discharge reference source shown in Fig 5 of the IEC document has been omitted since it is not in common use in the United States.

(3) An Appendix concerning calibration techniques has been added since it is felt that the IEC recommendation is lacking in this respect. It is hoped that this Appendix will be added to the IEC recommendation when it is revised.

This standard was prepared by the DC, AC, and Partial Discharge Working Group of the Techniques for Dielectric Tests Subcommittee. This working group had the following membership.

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IEEE Recommended Practice for the Detection and Measurement of Partial Discharges (Corona) During Dielectric Tests

1. Scope

This Recommended Practice applies to the detection of partial discharges occurring in the insulation of electrical apparatus or its components, and to the measurement of the associated apparent charge at the terminals, when an alternating test voltage is applied. Tests for partial discharges using direct voltage are discussed in Appendix E.

This Recommended Practice is concerned with general principles only. Where specific apparatus is covered by standards documents that include corona detection and measurement procedures, those standards should be followed.

2. Object

The object of this document is to assemble the general principles that apply to the detection of partial discharges. This objective is accomplished by defining terms and relevant quantities; describing test circuits, instruments, and test procedures; and recommending methods of calibration.

3. Definitions

apparent charge (terminal charge). That charge of a partial discharge which, if injected instantaneously between the terminals of the test object, would momentarily change the voltage between its terminals by the same amount as the partial discharge itself. The apparent charge should not be confused with the charge transferred across the discharging cavity in the dielectric. Apparent charge is expressed in coulombs.

average discharge current. The sum of the rectified charge quantities passing through the terminals of the test object due to partial

discharges during a time interval, divided by this interval. The average discharge current is expressed in coulombs per second (amperes).

partial discharge (corona). Within the terms of this document, an electrical discharge that only partially bridges the insulation between conductors. The term corona has also frequently been used with this connotation. It is recommended that such usage be discontinued in favor of the term partial discharge.

partial discharge power.¹ The power fed into the terminals of the test object due to partial discharges. The average discharge power is expressed in watts.

partial discharge energy.¹ The energy dissipated by an individual discharge. The partial discharge energy is expressed in joules.

partial discharge extinction voltage (corona extinction voltage). The voltage at which partial discharges exceeding a specified level cease under specified conditions when the voltage is gradually decreased from a value exceeding the inception voltage. This voltage is expressed as the peak value divided by the square root of two.

partial discharge-free test voltage (corona-free test voltage). A specified voltage applied in a specified test procedure, at which the test object is free from partial discharges exceeding a specified level. This voltage is expressed as a peak value divided by the square root of two.

partial discharge inception voltage (corona inception voltage). The lowest voltage at which partial discharges exceeding a specified level are observed under specified conditions when the voltage applied to the test object is gradually increased from a lower value. This voltage is expressed as the peak value divided by the square root of two.

¹This term is not used in this Recommended Practice, but is defined for future reference.

4. Methods of Partial Discharge Detection and Measurement

4.1 General Requirements. Various test circuits and instruments for measurement of partial discharges are described. The test circuits and measuring instruments used should be checked and calibrated as specified in Sections 5.1 through 5.3.1 and should meet the requirements for minimum measurable level that may be specified when required. See Section 6.6.3.

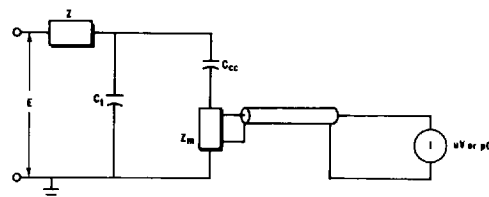
If not otherwise specified, any of the test circuits mentioned in Section 4.2 and any of the instruments mentioned in Section 4.3 are acceptable. More detailed specifications, not covered by this Recommended Practice, may be required for the use of a specific type of measuring instrument or test circuit.

Nonelectrical methods of partial discharge detection are not recommended for quantitative measurements, but they are useful for special purposes. See Section 4.4 for information.

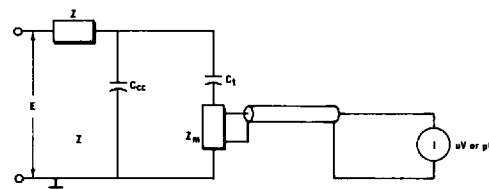
4.2 Pulse Detection Circuits. Most circuits for the measurement of individual pulses include a measuring impedance in addition to the test object, a voltage supply, and other circuit elements. A partial discharge in the test object causes charge transfers in the circuit, giving rise to a current pulse through the measuring impedance. The resulting voltage pulse is amplified and measured. By a calibration procedure the measurement may be made in terms of the charge transferred through the terminals of the test object. The terminal charge may be related to the partial discharge energy under certain assumptions. Most circuits for the measurement of pulses resulting from partial discharges can be derived from three basic circuits shown in Figs 1(A), 1(B), and 1(C). Variations of these circuits are shown in Figs 2(A), 2(B), and 3. Each circuit consists of

- (1) A test object, which in many cases can be regarded as a capacitor C_t (see Appendix C)
- (2) A coupling capacitor C_{cc} or a second test object C_{t1}
- (3) A measuring impedance Z_m and sometimes a second impedance Z_{m1}
- (4) A measuring instrument

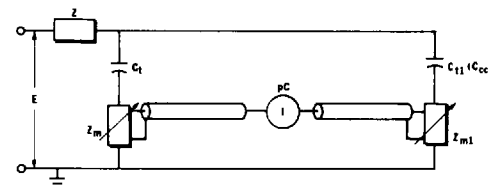
Frequently an impedance or filter Z , to prevent discharge pulses from being bypassed



(A) Instrument Connected in Series with the Coupling Capacitor



(B) Instrument Connected in Series with the Test Object



(C) Balanced Circuit Arrangement

Fig 1
Basic Partial Discharge Test Circuits

through the high-voltage supply and to reduce interference from the source, may be used.

The coupling capacitor should be free from discharges up to the highest test voltage. In some cases, if a large coupling capacitance is needed, or in balanced circuits, a second test object is used in place of the coupling capacitor.

The measuring impedance generally consists of a resistor, parallel resistor, and inductor, or a damped tuned circuit. Usually it acts as a four-terminal impedance. This impedance, in combination with the test object and coupling capacitor, determines the duration and shape of the measured pulses. The measuring impedance can also be designed to prevent test supply frequency components from reaching the instrument.

Individual pulses produced across the measuring impedance may be observed and measured by an oscilloscope. The maximum pulse can be measured by a peak-reading meter. By a gate and counter arrangement, pulses ex-