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IEEE Guide for Functional Evaluation of Insulation Systems for Large High- Voltage Machines

Sponsor
**Rotating Machinery Committee
of the
IEEE Power Engineering Society**

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Foreword

(This Foreword is not a part of IEEE Std 434-1973, IEEE Guide for Functional Evaluation of Insulation Systems for Large High-Voltage Machines).

The Rotating Machinery-Insulation Subcommittee, Power Engineering Society, IEEE, has been actively developing functional testing guides during the past two decades for rotating machines under the authorization of IEEE Std 1-1969, General Principles for Temperature Limits in the Rating of Electric Equipment. In 1965, the working group assigned to develop a test procedure for machines rated at 50 to 2000 hp and below 6600 V completed their task. After more than a decade of work by two working groups, a revised test procedure was issued in December, 1966 as IEEE Std 275-1966, Test Procedure for Evaluation of Systems of Insulating Materials for AC Electric Machinery Employing Form-Wound Preinsulated Stator Coils.

It has become the custom at these working group meetings to devote a short time to the consideration of functional test procedures for larger machines than those included within the scope of IEEE Std 275-1966. With the discharge of the old working group, a new task force was established at the February, 1965 meeting of the Rotating Machinery Insulation Subcommittee. Its charter was: "To review available means of functional evaluation of insulation for large, high-voltage machines, and report on the feasibility of standardizing test procedures for this purpose." This report was favorable and was accepted at the February, 1966 meeting of the Insulation Subcommittee. At the same time, the task force was reconstituted as a regular working group to prepare a suitable guide for the functional testing of this class of machines.

Over the past six years, five drafts of the new guide have been prepared and the final version successfully balloted through the Insulation Subcommittee, the Rotating Machinery Committee, and the Standards Committee of IEEE with no negative votes or unresolved comments.

There was considerable doubt in 1965 that an IEEE standard could be written for insulation functional evaluation of large, high-voltage machines. Many thought the effort was premature and that ten years or more would be spent by working groups before a useful, acceptable document could be written.

It is recognized that this standard does not describe all of the functional tests currently in use by manufacturers of large, high-voltage rotating machines, and that these additional tests may be essential to a complete evaluation and classification of a new insulation system. The tests described in the guide are, however, in widespread use and are generally performed prior to the newer, more complex and less generally used model tests which have recently been described in technical papers. A period of experience with this guide and the continued rapid development of new test methods will enable a revised edition to be developed within a few years.

Active participants in the present document will continue their IEC roles in Technical Committee 63 (Insulation Systems) and Technical Committee 2 (Rotating Machines) by transmitting IEEE viewpoints to these international organizations.

The membership of the Working Group is:

E.A. Boulter, *Chair*
V.S. McFarlin, *Secretary*

J. C. Botts
J. M. Brown
A. W. W. Cameron
E. M. Fort

M. M. Fromm
J. L. Kuehlthau
P. Lonseth
C.V. Maughan

J.A. Oliver
P. Richardson
C.C. Sargeant
E.S. Yates

CLAUSE	PAGE
1. General	1
1.1 Purpose	1
1.2 Scope	1
1.3 General Considerations	1
1.4 Interpretation of Results	3
2. Thermal Aging	4
2.1 Purpose	4
2.2 Scope	4
2.3 Test Specimens	4
2.4 Test Exposure	4
2.5 Measurements	5
3. Voltage Endurance	6
3.1 Purpose	6
3.2 Scope	6
3.3 Time Dependence of Electric Strength	6
3.4 Test Specimens	7
3.5 Preparation of Test Specimens	7
3.6 Application of Heat	7
3.7 Application of Voltage	8
3.8 Recording of Results	9
3.9 Conclusion	9
4. Thermomechanical Forces	9
4.1 Purpose	9
4.2 Scope	9
4.3 General Considerations	10
4.4 Test Equipment	11
4.5 Test Specimens	11
4.6 Test Operation	12
4.7 Measurements	12
4.8 Means for Acceleration of Test	13
4.9 Interpretation of Results	13
5. Electromechanical Forces	14
5.1 Purpose	14
5.2 Scope	14
5.3 Test Specimens	14
5.4 Test Conditions	14
5.5 Impact (Sudden Short Circuit)	15
5.6 Vibration	15

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1. General

1.1 Purpose

The purpose of this guide is to describe classification test methods which may be used to compare insulation systems in use, or proposed for use, in large high-voltage rotating machines.

1.2 Scope

1.2.1

The tests outlined in this guide are applicable to the insulation systems used in coils of generators, motors, and synchronous condensers operating at 6600 V and above.

1.2.2

The basic ingredient of these insulation systems is usually mica combined with reinforcing, bonding, and impregnating materials. This guide is based on the experience of the industry with micaceous systems; any evaluation of nonmicaceous systems should, however, consider the requirements of this guide.

1.3 General Considerations

1.3.1 Factors Causing Deterioration

1.3.1.1

The factors causing deterioration of insulation in large high-voltage machines are temperature, voltage, thermomechanical forces, electromechanical forces, and environment.

1.3.1.2

In order to determine the effect of these factors on insulation systems in a reasonable length of time, it is necessary that the tests be accelerated; however, the more acceleration, the less the test conditions resemble service conditions. The procedures outlined in the guide represent a compromise between too much acceleration and too long a test period.

1.3.2 Types of Tests

1.3.2.1

In the following sections of this guide, tests are described to determine the effects of various deteriorating influences. Section 2 covers thermal aging; Section 3, voltage endurance; Section 4, thermomechanical forces, and Section 5, electromechanical forces.

1.3.2.2

The interactions between the factors causing deterioration of insulation are provided for in the separate tests of this guide by maintaining all factors at normal service levels except for the one factor being accelerated. This does not preclude use of a periodic overvoltage test between stress exposure periods to determine an end point or a comparison voltage-endurance test of stress-aged test samples with new samples.

1.3.2.3

The tests described in this guide are normally conducted in air, since in this way they can be performed simply and without danger. It is recognized that the windings of the largest machines operate throughout their lifetimes in an atmosphere of hydrogen. Although testing in a hydrogen atmosphere is more complex than testing in air, mechanisms of insulation breakdown for some materials may be significantly different than in air. Nothing in this guide should be construed as preventing testing in hydrogen atmosphere if it is believed that this factor may be important in providing more realistic test results.

1.3.3 Environmental Influences

1.3.3.1

These influences include gas atmosphere, moisture, oil vapor, carbon dust, brake dust, and other contaminants. Separate tests are not included in this guide but may be added later. Large machines often have closed cooling systems which permit control of contaminants. The environment of the test station is likely to be more severe than that inside the machine in its effect on insulation. It is expected that the insulation system evaluated will withstand normal environments and contaminants.

1.3.3.2

Tests for insulation systems designed for use in open ventilated machines, where contaminants may be present, may include these substances in the test environment.

1.3.4 Interrelationship of Tests

1.3.4.1

Each effect should be tested separately; that is, additional samples should be used for each part of this guide.