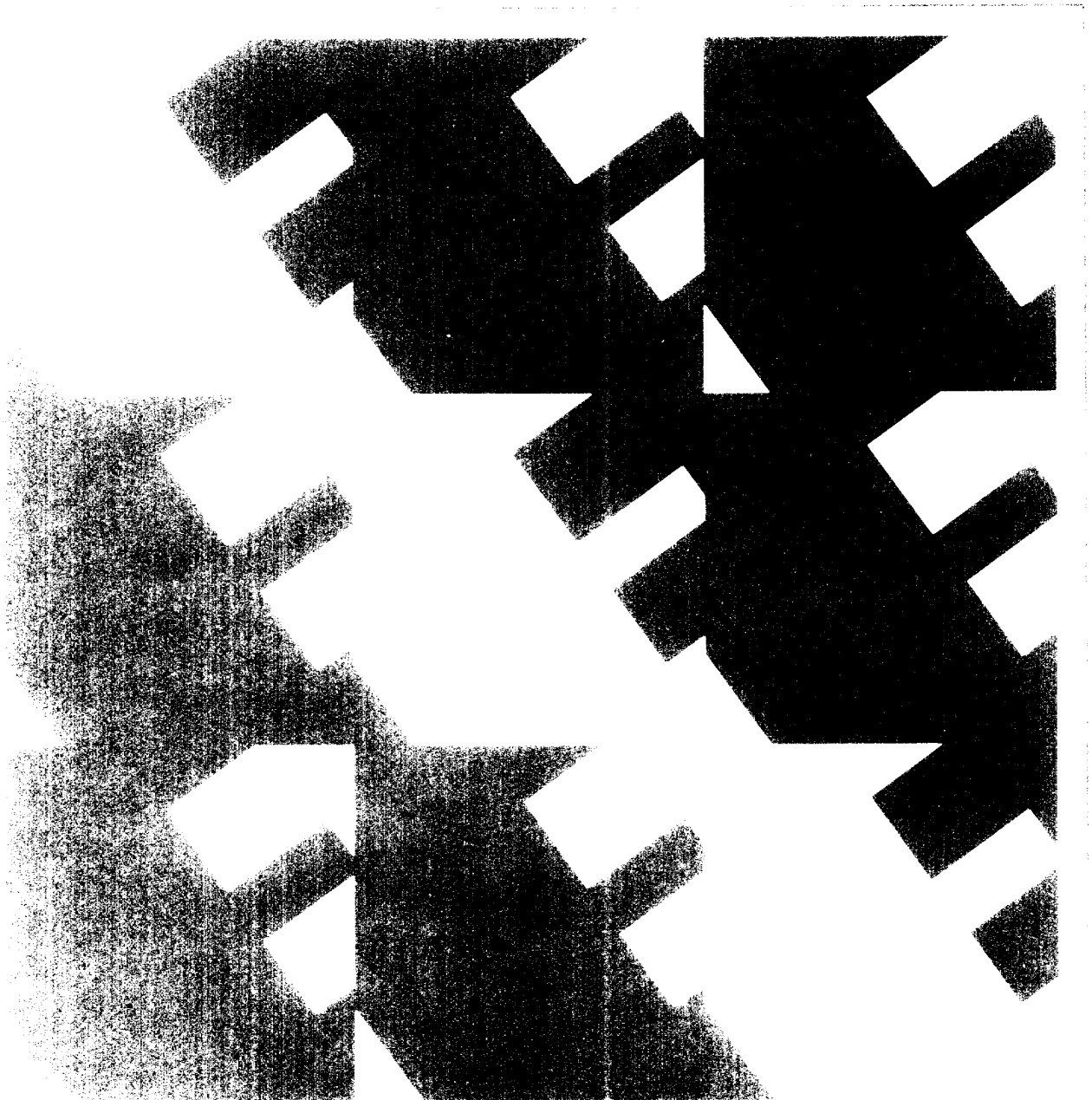


IEEE Guide for Insulation Maintenance for Rotating Electrical Machinery (5 hp to less than 10 000 hp)



ANSI/IEEE Std 432-1976



Published by The Institute of Electrical and Electronics Engineers, Inc., 47th Street, New York, NY 10017, USA

An American National Standard

**IEEE Guide for Insulation Maintenance
for Rotating Electrical Machinery**
(5 hp to less than 10 000 hp)

Sponsor
Rotating Machinery Committee of the IEEE Power Engineering Society

Approved September 4, 1975
Reaffirmed March 11, 1982

IEEE Standards Board

Approved November 28, 1977
Reaffirmed January 27, 1984

American National Standards Institute

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Foreword

(This foreword is not part of IEEE Std 432-1976 Guide for Insulation Maintenance for Rotating Electrical Machinery (5 hp to less than 10 000 hp))

The purpose of this guide is to present information necessary to permit an effective evaluation of the insulation systems of medium and small rotating electrical machines. Such an evaluation would serve as a guide to the degree of maintenance or replacement which might be deemed necessary and also offer some indication of the future service reliability of the equipment under consideration.

To fulfill these functions the following should be reviewed:

- (a) service conditions reducing insulation life,
- (b) insulation systems in general use,
- (c) visual inspection methods,
- (d) insulation maintenance testing principles,
- (e) electrical insulation tests,
- (f) methods for cleaning insulation structures.

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IEEE Guide for Insulation Maintenance for Rotating Electrical Machinery

— (5 hp to less than 10 000 hp) —

1. Scope

This insulation maintenance guide is intended to apply in general to industrial air-cooled rotating electrical machines rated from 5 hp to 10 000 hp.

The procedures detailed herein may be found useful for other types of machines.

2. The Significance of Maintenance

Rotating electrical machines are complex structures which are subjected to mechanical, electrical, and thermal stresses of varying magnitude. Of the various components, the insulation systems are the most susceptible to aging or damage due to these stresses. The service life of an electrical machine will, therefore, largely depend on the serviceability of the insulation systems.

Where reliability is of concern, adequate inspection and testing programs are advocated to assure the equipment is maintained in satisfactory condition to minimize the possibility of in-service failure.

The experience and data obtained from regular maintenance inspection and testing programs can, in addition to providing an evaluation of the present condition of the piece of equipment, give some indication of long-term trends and probable need for future repair or replacement.

The extent to which a maintenance program is pursued will depend largely on the operator's own experience and philosophy, but should also take into account the importance of service reliability for the equipment. Where high service reliability is required, a regular maintenance program involving periodic disassembly and knowledgeable visual examination of the equipment together with the

application of electrical tests of proven significance is strongly recommended.

It should be recognized that some over-potential tests may be damaging to insulation in marginal condition. Where there is uncertainty, consultation with the manufacturer is recommended. This is implicit in setting up any maintenance testing program.

3. Service Conditions Reducing Insulation Life

As has been stated, electrical machines and their insulation systems are subjected to mechanical, electrical, and thermal stresses which give rise to many deteriorating influences, the most significant of which are:

(a) **Thermal aging.** Normal load/temperature deteriorating influence on insulation.

(b) **Overtemperature.** Unusually high temperature from causes such as overload, high ambient temperature, restricted ventilation, etc.

(c) **Overvoltage.** An abnormal voltage higher than the normal service voltage such as caused from switching or lightning surges.

(d) **Contamination.** This deteriorates electrical insulation by actually conducting current over insulated surfaces, or by attacking the material reducing its electrical insulating quality or its physical strength, or by thermally insulating the material forcing it to operate at higher than normal temperatures. Included here are:

- wetness or extreme humidity
- oil or grease
- conducting dusts and particles
- nonconducting dusts and particles
- chemicals of industry.

(e) **Physical damage.** This contributes to electrical insulation failure by opening leakage paths through the insulation. Included here are:

- physical shock
- vibration
- overspeed
- short-circuit forces
- erosion by foreign matter
- damage by foreign objects
- thermal cycling.

(f) **Ionization effects.** Ionization which may occur at higher operating voltages is accompanied by several undesirable effects such as chemical action, heating, and ionic bombardment. (See Appendix.)

4. Insulation Systems in General Use

4.1 Insulated Parts. Insulation is present in various machine components but the complexity of the structure is such that no attempt is being made here to describe these in detail. However, such detailed information plus knowledge of modes of insulation failure permit more meaningful evaluation.

4.1.1 Armature Winding. For the purpose of this guide, the armature winding can be considered to be the main current-carrying winding, usually the stator in ac machines and the rotor in dc machines, including associated leads where applicable. The armature coils usually have wire, turn, and ground insulation.

DC armatures have commutator insulation, while insulated wedges, blocks, and other insulated mechanical supports are common to both ac and dc machines.

4.1.2 Field Windings. The fields of ac machines are either salient or cylindrical-pole type, while in dc machines they comprise stationary coils. In all cases, they have turn and ground insulation, insulated mechanical supports, and lead insulation. AC machines, in addition, would have collector ring insulation.

4.1.3 Brush Rigging. Both ac and dc machines may have insulated brush rigging.

4.1.4 Core and Frame Assembly. The principal insulation components in this assembly are the insulation between laminations in the core and insulation on through bolts (when used).

4.1.5 Other Parts. Insulation is sometimes used on bearings and other parts.

4.2 Armature Winding Insulation

4.2.1 Wire Insulation. The individual wires of armature coil conductors are usually insulated with organic resin films or fibers, paper, cotton, asbestos, glass or polyester glass fiber, or mica in various forms. (Note that the alternative term "strand" is used for these components in IEEE Std 56-1958 (reaff 1971) (ANSI C50.25-1972.))

4.2.2 Turn Insulation. Groups of wires forming a single conductor may be insulated and held together with insulating tapes including cotton, fiberglass, films, papers, micas, etc. Individual wire insulation, as described in Section 4.2.1, may also be used as turn insulation, including those applied as liquid resin coatings or as applied by taping with various materials such as cotton, fiberglass, films, papers, micas, etc.

4.2.3 Ground Insulation. Ground insulation is generally defined as that insulation intended to actually insulate the current carrying components (such as the coils, the commutator, the slip rings, and connections thereto) from the non-current carrying components (such as the core iron, the shaft, and other structural members).

Ground insulation takes on many different forms depending on the type of machine, intended use, and ambient conditions, design, temperature class, and manufacturer's standard practice.

Ground insulation is generally a dry-type multi-layered system comprising various insulating materials bonded and filled by different processes. Mica or micaceous products are generally preferred in high-voltage machines for at least a part of the ground insulation system. However, the more recent developed materials have also proven acceptable. On low-voltage machines, many different materials have proven acceptable, consistent with the machine's temperature classification.

4.2.4 Commutator Insulation. A commutator is a cylindrical assembly of wedge-shaped copper segments separated from each other and ground by insulation which is usually micaceous. This structure is mechanically locked together by various techniques including vee grooves, cones and support rings