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IEEE Recommended Practice for the Repair and Rewinding of Motors for the Petroleum and Chemical Industry

Sponsor

**Petroleum and Chemical Industry Committee
of the IEEE Industry Applications Society**

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Abstract: General recommendations are provided for users of motors that need repair as well as owners and operators of establishments that offer motor repair services. The use of this recommended practice is expected to result in higher quality, more cost-effective, and timely repairs. Guidelines are also provided for evaluating repairs and facilities.

Keywords: horizontal motors; motors, repair and rewinding of; vertical motors

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Introduction

(This introduction is not part of IEEE Std 1068-1996, IEEE Recommended Practice for the Repair and Rewinding of Motors for the Petroleum and Chemical Industry.)

This recommended practice was conceived at the Petroleum and Chemical Industry Conference held in September 1984 in San Francisco, following a panel discussion on motor repair. The Project Authorization Request was submitted 26 September 1984, and was approved by the IEEE Standards Board on 13 December 1984. The project was sponsored jointly by the Petroleum and Chemical Industry Committee (PCIC) of the Industry Applications Society and the Electric Machinery Committee (EMC)* of the Power Engineering Society. The first ballot was mailed out in June 1989. Although the required affirmative votes were received and negative ballots were resolved, it was felt that a reballot was in order, and the second ballot was mailed in November 1989. This recommended practice was put back in the revision cycle in 1991 in anticipation of a need for an early revision. The revised document was balloted in 1995, reballoted in May 1996, and submitted to the IEEE Standards Board in June 1996.

The IEEE Motor Repair and Rewind Working Group, which had members from both the PCIC and the EMC, had the following membership:

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IEEE Recommended Practice for the Repair and Rewinding of Motors for the Petroleum and Chemical Industry

1. Overview

1.1 Scope

This recommended practice covers general recommendations for the repair of electric motors and includes recommendations for both the user and the repair facility. It is not intended to supplant specific instructions contained in the manufacturer's instruction book or in any contractual agreement between a manufacturer and a purchaser of a given machine.

These recommendations apply to horizontal and vertical motors, NEMA frame size 140 and above, having a voltage rating of 15 kV or less. These recommendations apply only to the repair of motors and are not intended to cover major modifications.

Excluded from the scope of this recommended practice are the following:

- Specific requirements, certification, and inspection required for listed explosion-proof and dust-ignition-proof machines.
- Any specific or additional requirements for hermetic motors, hydrogen-cooled machines, submersible motors, or Class 1E nuclear service motors.

1.2 Purpose

This recommended practice is intended to be a basic or primary document that can be utilized and referenced by owners of motors that need repair as well as by owners and operators of establishments that offer motor repair services. It has been developed primarily for the needs of the Petroleum and Chemical Industry but can be adapted to other applications.

The use of this recommended practice by users and repair facilities is expected to result in higher-quality, more cost-effective, and timely repairs. It also provides a means of evaluating repairs and facilities.

2. References

2.1 General

Definitions, construction, and test methods not specifically covered in this recommended practice should comply with the following standards insofar as they are applicable. When the following standards are superseded by an approved revision, the revision shall apply.

API 541-1995, Form-Wound Squirrel-Cage Induction Motors 250 hp and Larger.¹

IEEE Std 1-1986 (Reaff 1992), IEEE Standard General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation (ANSI).²

IEEE Std 100-1996, IEEE Standard Dictionary of Electrical and Electronics Terms.

IEEE Std 112-1991, IEEE Standard Test Procedure for Polyphase Induction Motors and Generators (ANSI).

IEEE Std 115-1983 (Reaff 1991), IEEE Guide: Test Procedures for Synchronous Machines (ANSI).

IEEE Std 432-1992, IEEE Guide for Insulation Maintenance for Rotating Electrical Machinery (5 hp to less than 10 000 hp) (ANSI).

IEEE Std 841-1994, IEEE Standard for the Petroleum and Chemical Industry—Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 500 hp (ANSI).

NEMA MG 1-1993, Motors and Generators.³

2.2 Insulation tests

Where appropriate to the construction, tests should be made in accordance with the following IEEE test procedures:

IEEE Std 43-1974 (Reaff 1991), IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery (ANSI).

IEEE Std 117-1974 (Reaff 1991), IEEE Standard Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery (ANSI).

IEEE Std 275-1992, IEEE Recommended Practice for Thermal Evaluation of Insulation Systems for Alternating-Current Electric Machinery Employing Form-Wound Preinsulated Stator Coils for Machines Rated 6900 V and Below (ANSI).

IEEE Std 429-1994, IEEE Recommended Practice for Thermal Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form-Wound Preinsulated Stator Coils for Machines Rated 6900 V and Below (ANSI).

¹API publications are available from the Publications Section, American Petroleum Institute, 1200 L Street NW, Washington, DC 20005, USA.

²IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

³NEMA publications are available from the National Electrical Manufacturers Association, 1300 N. 17th St., Ste. 1847, Rosslyn, VA 22209, USA.

2.3 Other insulation systems

For other insulation systems that do not have established test procedures, similar procedures may be used if it is shown that they properly discriminate between service-proven systems known to be different.

When being evaluated by an established test, a new or modified insulation system should be compared to an insulation system on which there have been two years of service experience. If a comparison is made to a system of the same temperature class, the new system should have equal or longer thermal endurance under the same test conditions; if a comparison is made to a system of a lower temperature class, the new system should have equal or longer thermal endurance at an appropriately higher temperature. When comparing systems of different classes, an appropriate higher temperature should be considered to be 25 °C per class higher than the temperature for the base insulation system class.

3. Definitions

Definitions in this recommended practice are in accordance with the definitions in IEEE Std 100-1996.⁴ Definitions that are unique to this recommended practice are as follows:

3.1 accepted test: A test on a system or model system that simulates the electrical, thermal, and mechanical stresses occurring in service.

3.2 experience: Successful operation for a long time under actual operating conditions of machines designed with temperature rise at or near the temperature rating limit.

3.3 insulation system: An assembly of insulating materials in association with the conductors and the supporting structural parts. All of the components described below that are associated with the stationary winding constitute one insulation system, and all of the components that are associated with the rotating winding constitute another insulation system.

- *Coil insulation with its accessories.* All of the insulating materials that envelop and separate the current-carrying conductors and their component turns and strands, and form the insulation between them and the machine structure; includes wire coatings, varnish, encapsulants, slot insulation, slot fillers, tapes, phase insulation, pole-body insulation, and retaining ring insulation when present.
- *Connection and winding support insulation.* All of the insulation materials that envelop the connections that carry current from coil to coil, and from stationary or rotating coil terminals to the points of external circuit attachment; and the insulation of any metallic supports for the winding.
- *Associated structural parts (insulation system).* Items such as slot wedges, space blocks, and ties that are used to position the coil ends and connections; any nonmetallic supports for the winding; and field-coil flanges.
- *Insulation class.* Divided into classes according to the thermal endurance of the system for temperature rating purposes. NEMA classes of insulation systems used in motors include Classes A, B, F, and H. These classes have been established in accordance with IEEE Std 1-1986. Other classes of insulation are constantly being developed for such use.

⁴Information on references can be found in Clause 2.

Insulation systems shall be classified as follows:

- *NEMA Class A.* An insulation system (105 °C temperature limit including a 40 °C ambient or 65 °C rise) that by experience or accepted test can be shown to have suitable thermal endurance when operating at the limiting Class A temperature specified in the temperature rise standard for the machine under consideration.
- *NEMA Class B.* An insulation system (130 °C temperature limit including a 40 °C ambient or 90 °C rise) that by experience or accepted test can be shown to have suitable thermal endurance when operating at the limiting Class B temperature specified in the temperature rise standard for the machine under consideration.
- *NEMA Class F.* An insulation system (155 °C temperature limit including a 40 °C ambient or 115 °C rise) that by experience or accepted test can be shown to have suitable thermal endurance when operating at the limiting Class F temperature specified in the temperature rise standard for the machine under consideration.
- *NEMA Class H.* An insulation system (180 °C temperature limit including a 40 °C ambient or 140 °C rise) that by experience or accepted test can be shown to have suitable thermal endurance when operating at the limiting Class H temperature specified in the temperature rise standard for the machine under consideration.

3.4 major modification: Includes conversion from one type of machine to another type of machine, conversion from one type of enclosure to another type of enclosure, or conversion from one rating to another rating.

3.5 motor: A rotating machine that converts electrical energy into mechanical energy. As used in this recommended practice, the term can also be used to mean a generator.

3.6 repair: Includes incoming inspection and test, damage appraisal, cleaning, replacement or fixing of damaged part(s) or both, assembly, postrepair inspection and test, and refinishing.

3.7 repair facility: The entity contracted to make repairs; includes the “on site” repair(s) made by employees of that entity in addition to repair(s) made at a shop operated by or under the supervision of that entity.

3.8 user: The owner of the motor or an authorized agent of the owner.

4. Prerepair activity and responsibility

Several items should be considered and documented prior to repairs. Indeed, some prequalification activities should be finished prior to failure or shipment to a repair facility. Some of these activities are the responsibility of the user, while others are assigned to the repair facility.

4.1 User responsibility

In order for the repair operation to be high quality and cost-effective, the user should make advance preparation.

4.1.1 Records

Obviously, the more information the owner can furnish to the repair shop, the better the repair will be. For example, at times the nameplate will not be readily readable after several years in service, and pertinent data must be obtained largely by measurements. It would be ideal if the owner would keep a record of the nameplate and other motor information in a file along with any data such as failure history, bearing replacement, and other problems and repairs. This record would then be furnished to the repair facility.