NOTE: MIL-STD-2037 has been redesignated as a Standard Practice. The cover page has been changed for Administrative reasons. There are no other changes to this Document.

INCH-POUND

MIL-STD-2037
26 JULY 1991

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

PROCEDURE TO OBTAIN CERTIFICATION FOR ELECTRIC MOTOR SEALED INSULATION SYSTEMS

AMSC N/A FSC 6105

FOREWORD

1. This military standard is approved for use by all departments and agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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FIGURES

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1. SCOPE

1.1 Scope. This standard applies to random wound, form wound, and salient pole motors.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-S-901 - Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-W-16878 - Wire, Electrical, Insulated, General Specification for.
MIL-W-16878/30 - Wire, Electrical, Silicone Rubber Insulated, 150°C, 1000 Volts.
MIL-W-16878/31 - Wire, Electrical, Silicone Rubber Insulated, 150°C, 1000 Volts, Glass Braid Covering, Abrasion Resistant.
MIL-I-24092 - Insulating Varnish, Electrical, Impregnating, Solvent Containing.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, BLDG. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 677 - Standard Specification for Nonoriented Electrical Steel Fully Processed Types.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

This section is not applicable to this standard.

4. GENERAL REQUIREMENTS

4.1 Certification. In order to provide new or refurbished motors with a sealed insulation system, the facility shall be certified by the Naval Sea Systems Command (NAVSEA). Certification is obtained after the facility demonstrates the ability to produce a motor with a sealed insulation system in accordance with it's NAVSEA approved procedure. After becoming certified, the facility shall be recertified as specified in 4.1.1.

4.1.1 Recertification. Recertification shall be accomplished in accordance with the requirements of 4.2 for certification. Recertification shall be required 3 years after the original certification and every 5 years thereafter. Changes in the sealed insulation system report (see 5.1) require submittal to NAVSEA for acceptance and may require recertification.

4.2 Certification procedure. The certification procedure is a two-part process. The objective of the first part is to obtain NAVSEA acceptance of the facility's sealed insulation system report which is prepared as specified in 5.1. The NAVSEA letter of acceptance, obtained in part one, shall authorize the facility to proceed with part two. A facility becomes certified after obtaining NAVSEA acceptance of part two which consists of the sample motor report (see 5.2) and the large motor test report (see 5.3). Certification is restricted to the range of motor frame sizes determined by the largest frame motor tested in 5.2 and 5.3, and the minimum frame size motor specified in 5.1. Separate certifications are required for motors using random wound, form wound, and salient pole windings. The facility is not required to obtain multiple certifications.

5. DETAILED REQUIREMENTS

5.1 Sealed insulation system report. The facility shall furnish a sealed insulation system report (see 6.3). The sealed insulation system report shall indicate the materials, processes, and test procedures that shall be used in providing electric motors on a production basis. The report shall include the facility's refurbishment procedures as specified in 5.1.2.3. A separate report is required for random wound, form wound, and salient pole motors. The report shall be applicable to the range of motor frame sizes that the facility intends to furnish with sealed insulation.

5.1.1 Format. Any convenient format may be used for the report however, the report shall include specific sections addressing the following items:

(a) Title page.
(b) Reference documents.
(c) Refurbishment.
(d) Materials.
(e) Coil manufacture.
(f) Winding and insulation.
(g) Electrical testing.
(h) Varnishing.
(i) Final testing.
(j) Flow chart.

Pages shall be 8-1/2 by 11 inches with 3-hole left hand binding. Each page shall be numbered and dated with space for revision and notation.

5.1.2 Contents. The contents of the report shall include but not be limited to the following information.

5.1.2.1 Title page. The title page shall contain the name and street address of the facility, the number assigned to the report, the report's date of issue, and a description of the motors covered by the report including the range of frame sizes and types.

5.1.2.2 Referenced documents. The report shall contain a list of all referenced documents.

5.1.2.3 Refurbishment. The report shall include the facility's refurbishment procedures. This information shall be provided regardless of whether the primary business of the facility is original equipment manufacture or refurbishment.

5.1.2.3.1 Incoming inspection. Details of the facility's visual, electrical, and mechanical incoming inspection procedures shall be included in the report. Inspection recording documents shall be included in the report (see figures 5 through 7 for sample forms). The description of the electrical inspection should include the testing that shall verify the winding integrity such as insulation resistance, winding resistance, and high potential testing. The descriptions of the mechanical and visual inspections should address the following items as applicable:

(a) Dimensions of mounting surfaces and shaft bearing diameters.
(b) Presence of deformation, corrosion, or other damage to the bearing seats and shoulders, shaft keyways and threads, mounting surfaces, commutators, and brush riggings.
(c) Presence of cracks, looseness, or signs of overheating in the rotor, armature, or commutator.
(d) Presence of corrosion or other damage to the frame, end bells, and laminations.

5.1.2.3.2 Stripping and cleaning. The report shall contain the procedures for stripping and cleaning of wound assemblies such as stators, armatures, and salient pole fields, as applicable. These procedures should address the following issues:

(a) Winding information and end turn dimensions and clearances should be determined during the stripping process.
(b) Open flames or torches shall not be used on laminated iron surfaces.
(c) If solvent stripping other than vapor degreaser is used, solvent shall not be retained or trapped between laminations and the solvent shall not damage the core plate.
(d) The surface temperature of the laminated iron surface shall be determined by thermocouple and shall not exceed 370 degrees Celsius (°C) (698 degrees Fahrenheit (°F)).
(e) Grit or sand blasting materials shall not be used to clean laminated iron surfaces.
(f) Varnish and insulating material shall be removed from the slots. Air passages, vents, holes, and so forth, shall be clean and free of old varnish or other material.
(g) Repair or replace any defective lamination. Clean the core by solvent (noncorrosive type) immersion and, after drying, impregnate core with epoxy solvent type or solventless varnish and cure. The purpose of this treatment is to provide corrosion protection to the iron.

5.1.2.3.3 Core testing. The report shall contain the procedures for core testing. A core tester, such as a LEXSECO 1081 or equivalent, may be used. If a core tester is not available, the following tests may be conducted to determine armature and stator core acceptability:

(a) AC stator core:

(1) Measure the stator core length (CL), core depth (CD), core inner diameter (CID), and slot depth (SD) in inches.
(2) Effective stator core length (CL) is obtained as follows:

CL = Measured core length × 0.80.

(3) To determine the stator core depth (CD), measure from the bottom of the coil slot to the core's outer circumference.
(4) Effective core cross section area = (CL) × (CD).
(5) Estimated voltage per turn = 0.26 × core area.
(6) The number of cable turns to be placed through the stator core = supply voltage/estimated volts per turn.
(7) Effective stator core diameter (ECD) = CID + (2SD) + CD.
(8) Ampere turns (AT) = 45 × ECD.
(9) Current required = AT/Turns.
(10) Select a cable size that has a current rating not less than that required to conduct the test as calculated in step 9, above.

(11) Wrap the required number of turns of insulated cable (calculated in step 6) around the stator axially (that is, each cable loop or turn should be passed through the ID of the stator and then looped back over the OD of the stator).
(12) Energize the cable to the supply voltage value and measure the current.
(13) After 1 or 2 minutes with the cable energized, feel the surface of the core, identify one or two of the hottest areas, mark with chalk, and designate them as "hot spots". Determine also, and mark, an area which is closest to room temperature. Designate this as a "cold spot". De-energize the coil.
(14) Attach thermocouples to the areas designated as "hot spots" and "cold spots" and cover the thermocouples with plastic sealer (Dux seal).
(15) Re-energize the coil at the supply voltage value and record the current and temperature of the "hot" and "cold" spots at 10-minute intervals for a period of 1 hour unless severe overheating occurs. During testing, a nominal core temperature of 10 to 15°C above room ambient indicates sufficient flux to produce hot spots. Changing the number of cable turns may be required to maintain the core in the desired temperature range. If the temperature is less than desired, remove turns (two at a time) and observe the temperature.
(16) If, after 1 hour, either the difference in temperature between the "hot spots" and "cold spots" exceeds 15°C or 27°F or the temperature of the "hot spot" exceeds 85°C (185°F) at any time during the test, the laminations must be replaced in the high temperature area. Replacement laminations shall have C-5 or equivalent core plate in accordance with ASTM A 677.

(b) DC armature core.

(1) Measure the armature core length (CL), core depth (CD), core inner diameter (CID), and slot depth (SD) in inches.
(2) Effective armature core length (CL) is obtained as follows:

CL = Measured core length × 0.80.

(3) To determine the armature core depth (CD), measure from the bottom of the coil slot to the inner diameter of the laminated core.
(4) Effective core cross section is (CL) × (CD).
(5) Estimated voltage per turn = 0.26 × core area.
(6) The number of cable turns to be placed through the armature core = supply voltage divided by the estimated volts per turn.
(7) Effective armature core diameter (ECD) = CID + (2SD) + CD.
(8) Ampere turns (AT) = 45 × ECD.
(9) Current required = AT/Turns.

(10) Select a cable size that has a current rating not less than the current required to conduct the test as calculated in step 9, above.

(11) Wrap the required number of turns of insulated cable (cable turns calculated in step 6) around the armature axially (that is, each cable loop or turn should be passed through the spider of the armature and then looped back over the OD of the armature).

NOTES: In the event that the armature core does not have a spider or physically does not have adequate space to wrap the required turns, use a single series loop with the following guidelines:

(a) The single turn series loop is limited to the ac current source available within the rewind facility. In most cases this will be 1000 amperes.

(b) The single turn series loop consists of a shaft clamp at each end of the rotor shaft and the associated current carrying cable connected to a controlled current source to form a series loop.

(c) If space and current carrying capacity dictates, the series loop may be configured with two parallel shaft clamps and associated current carrying cables at each end of the rotor shaft.

(d) The controlled ac current source may be any source available within the rewind facility including an ac welding set.

(e) If the current requirements exceed 1000 amperes, then the rotor core test should be performed by using a motor core tester, such as LEXSECO Model 1081; Adwell Industries Ltd. "EL-CID"; or equal.

(f) A standard GROWLER test may also be used to help identify a damaged rotor core.

(12) Repeat steps 12 through 16 of the ac stator core test, as specified in 5.1.2.3.3(a), using the same pass-fail criteria.

5.1.2.4 Materials. The report shall identify the materials to be used in the sealed insulation system. The identifications shall include the material's name, manufacturer, size, thickness, quantity, and designated use, as applicable. The designated uses include but are not limited to:

Slot wedge	Magnet wire
Slot cell	Lead wire
Phase insulation	Sleeving
Coil insulation	Epoxy compounds
Tapes	Adhesives and sealing compounds
Tie cords and ropes	Varnishes
Banding material	Pole insulation

5.1.2.4.1 Auxiliary materials. The report shall identify the auxiliary materials to be used in the sealed insulation system such as temporary tapes, masking compounds, release agents, and so forth. Identify these materials by use, material designation, and manufacturer.

5.1.2.4.2 Asbestos. Asbestos and asbestos containing materials shall not be used.

5.1.2.4.3 Varnish and resin. The report shall identify the material designation, manufacturer, and manufacturer's designation for solvent type varnishes, solventless epoxy resins, and sealing compounds used in the sealed insulation system.

(a) Solvent type varnishes shall be in accordance with MIL-I-24092 class 155, grade CB or CBH. Class 180 non-silicone type varnishes may also be used.
(b) Solventless epoxy resins shall be rated class F (155°C), the following data shall be submitted:

(1) Descriptive characteristics of resins.
(2) Data sheet showing viscosity, film build, gel time, storage life, cure cycle, hardness, tensile strength, and elongation.
(3) Method of application listing temperature limits for best viscosity conditions.

(c) Resin and varnish should be selected to provide adequate plasticity to prevent the formation and propagation of cracks in the cured winding. These cracks, while difficult to detect visually, may cause reductions in insulation resistance during submergence testing.

5.1.2.4.4 Insulation. Insulating materials shall have a minimum temperature rating of class F and shall be selected to facilitate varnish penetration and wetting of the winding and insulation. Calendared material and material with sizing should be avoided.

5.1.2.4.5 Lead wire. Nonventilated motors using commutators or slip rings shall not use silicone lead wire. Other motors may use silicone lead wire in accordance with MIL-W-16878 and MIL-W-16878/30 or MIL-W-16878/31.

5.1.2.4.6 Material usage. The report shall identify the frame sizes applicable to materials whose use is restricted to less than the full range of motor frame sizes covered by the report.

5.1.2.4.7 Material quality. The report shall describe storage and quality assurance procedures used to ensure that Navy approved materials are kept segregated from non-approved materials and that only Navy approved materials are used on Navy motors.

5.1.2.5 Coil manufacture. The report shall include a description of the coil winding procedures.

5.1.2.6 Winding and insulation. Step-by-step winding procedures shall be included in the report. The procedures shall address the facility's methods of compliance with the following winding requirements.

(a) Individual stator coils shall be continuously taped in the end turn regions, iron-to-iron. The taping shall extend into the slots a minimum of 1/2 inch.
(b) The slot insulation shall extend a minimum of 3/8 inch beyond each end of the core.
(c) Slot liners shall be folded under the wedges.
(d) Phase insulation and slot fillers should be used as required.
(e) Varnish shall be excluded from the strands of lead wire to ensure lead flexibility. Lead wire to coil connections shall be sealed and insulated prior to vacuum pressure impregnation (VPI).
(f) Felt or mat type materials shall not be used on exposed surfaces since a rough surface finish after varnishing collects contaminants and is virtually impossible to clean.

5.1.2.7 Electrical test after winding. The report shall describe the electrical tests performed on the wound assembly prior to varnishing. The following tests shall be included and shall be performed as specified in 5.1.2.11. The test results shall be recorded.

(a) Insulation resistance at 500 volts direct current (Vdc): With the winding dry and clean, insulation resistance is a measure of insulation integrity in proximity to the core (ground). The end turn areas are insulated from ground by the surrounding air. The minimum acceptable insulation resistance for finished motor windings dry, after submergence is 1000 megohms corrected to 25°C. It is recommended that the insulation resistance, measured prior to varnishing be equal to or greater than 1000 megohms.
(b) DC high potential proof test at 1.6 × (2E + 1000) VOLTS, where E is the rated motor voltage.
(c) Surge comparison test at 5000 volts.
(d) Repeat insulation resistance at 500 Vdc.

5.1.2.8 Varnish treatments. The report shall describe the varnish treatment procedures. The description shall include the following:

(a) Varnish treatment shall be accomplished using a solventless varnish and the VPI process. The number of VPI cycles should be included in the report. The complete treatment using one VPI cycle is preferable, however, the use of more than one cycle is acceptable. After VPI, a solvent-type varnish overcoat is acceptable and can be applied using a dip process.
(b) The weight of the wound assembly shall be recorded before varnishing and after the final bake.
(c) The schedule and procedure for verifying the properties of the varnish including the thixotropic index, percent solids, and viscosity shall be included in the report.
(d) Details of the VPI process along with any variations due to motor frame size or complexity shall be described in the report. The description should include:

(1) Preheat temperature and duration prior to placing the wound assembly in the VPI tank.
(2) The vacuum shall be 3 mm of mercury (Hg) or lower. The report should include the vacuum pressure and duration of the vacuum cycle. Prior to introduction of resin, the preheat and vacuum cycles can effectively minimize the moisture content in the wound assembly.
(3) Resin should be introduced while maintaining a vacuum on the wound assembly. The time interval between the start of the vacuum cycle and the introduction of resin should be included in the report.
(4) The minimum pressure and duration of the pressure cycle should be included in the report. The minimum pressure shall be 90 pounds per square inch (lb/in^2) gauge or greater.

(e) The report shall identify the general characteristics of the VPI tank, resin storage tank, and the associated auxiliary equipment.
(f) The varnish curing procedure shall be included in the report. The description should include the curing temperature and duration and any rotation of the wound assembly during curing. Baking time starts from the time the iron reaches the specified temperature. A temperature detector attached to the iron shall be used.
(g) The report shall include details of the solvent-type varnish overcoat procedure as applicable. The description should include details of the preheat, drain time, and the curing temperature and duration.

5.1.2.9 Electrical test after varnishing. The report shall describe the electrical tests performed on the wound assembly after varnishing. The following tests shall be included and performed as specified in 5.1.2.11. The tests results shall be recorded.

(a) Submerged insulation resistance shall be not less than 100 megohms, corrected to 25°C, after submergence in fresh water for 24 hours. With the wound assembly submerged, insulation resistance is a measure of insulation integrity in the slot and end turn areas.
(b) After submerged insulation resistance testing, the final testing should be performed and shall include:

(1) Insulation resistance at 500 Vdc, with the winding dry and clean insulation resistance shall be not less than 1000 megohms, adjusted to 25°C.
(2) AC high potential test at 2E + 1000 volts, where E is the rated motor voltage.
(3) Surge comparison test at 5000 volts.
(4) Repeat insulation resistance dry, at 500 Vdc.

5.1.2.10 Test equipment. The report shall identify the manufacturer and model number of the test equipment used to provide motors with a sealed insulation system.

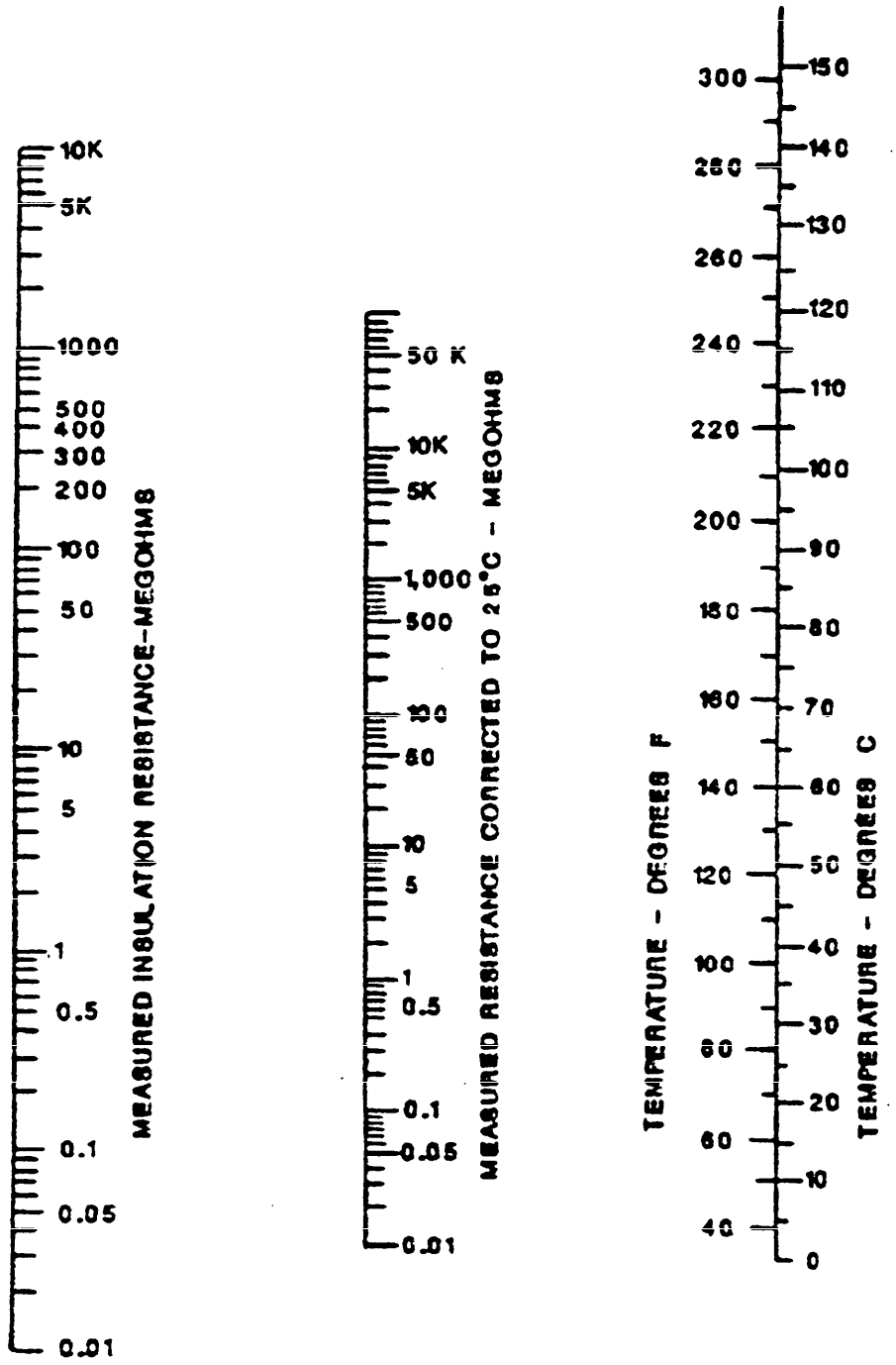
5.1.2.11 Electrical test methods. The report shall describe the electrical test methods used in providing motors with sealed insulation systems. The following test methods shall be included.

(a) Insulation resistance test. Apply a test potential of 500 Vdc until a stable reading is obtained, but not less than 1 minute. Record the insulation resistance reading and the average winding temperature at the time of the test. If the winding is at ambient temperature, a measurement of the ambient temperature may be substituted for that of the winding temperature. A megohm bridge or meter shall be used with a range of 0.1 to 1,000,000 megohms. Insulation resistance measurements shall be corrected to 25°C using figure 1 and recorded.

(b) Submerged insulation resistance test. Each wound assembly including lead connections shall be submerged for 24 hours in fresh water with a minimum conductivity of 500 micromhos/cm and a maximum surface tension of 31 dynes/cm at 25°C. Wound assemblies with commutators or slip rings should be submerged to a point where the water level is as close as possible to the uninsulated areas.

(1) The conductivity of the fresh water may be increased by adding bicarbonate of soda to the water (salts are not used due to corrosive effects). The surface tension may be adjusted by addition of a wetting agent such as Triton X-100 (manufactured by Rohm and Haas, Philadelphia, PA), or equivalent.

(2) The insulation resistance should be verified to be acceptable prior to submergence. During submergence the insulation resistance shall be not less than 100 megohms, corrected to 25°C, using figure 1. While submerged, as a minimum, the insulation resistance shall be measured as specified in 5.1.2.11(a) and recorded after 1 minute, 10 minutes, 1 hour, and 24 hours. Insulation resistance shall also be measured and recorded immediately after removal from submergence, and 1 hour after removal from submergence.



This nomograph is based on insulation resistance decreasing by one-half for each 15°C increase in temperature.

FIGURE 1. Insulation resistance - temperature nomograph.

(c) DC high potential proof test. With the motor leads connected together, connect the positive terminal of a dc high potential tester to the motor leads and the negative terminal to the iron (ground). The tester shall have an output capacity of not less than 5000 volts and 2500 microamperes and shall have a protective relay for excessive current draw. Slowly increase the applied voltage to the proof test value and monitor the leakage current for sharp increases not proportional to voltage. After maintaining the proof test value for 1 minute, record the leakage current. Proof test voltage = 1.6×(2E + 1000) volts dc, where E is the rated motor voltage.

(d) Surge comparison test. Connect a comparison tester of adequate capacity to the stator windings in accordance with figure 2.

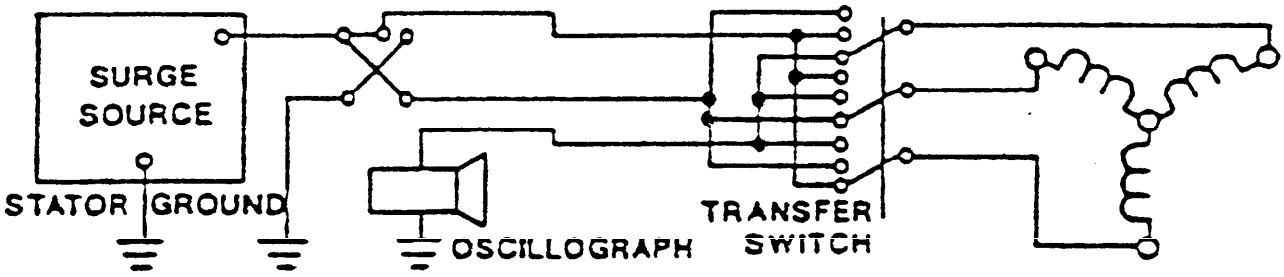


FIGURE 2. Surge comparison test diagrams.

Adjust the tester for a surge voltage of 5000 volts and conduct the test in accordance with the tester instruction manual. Repeat the test for each phase and compare waveshapes. Indicate satisfactory results on the data sheets. Safety precautions, calibration procedures, and operating instructions shall be followed in detail for safe, proper operation.

(e) AC high potential proof test: The ac high potential test equipment shall have a capacity of not less than 1 kilovoltampere (kVA) and shall apply a sinusoidal, 60-cycle, proof voltage between the motor windings and ground. The proof voltage shall be equal to the sum of twice the motor's rated voltage plus 1000 volts. With the motor leads connected together, the test voltage shall be applied between the leads and ground. The measurement of the voltage used in dielectric tests shall be made by the voltmeter method whereby the instrument derives its voltage from high-volt circuit either directly or by means of a voltmeter coil placed in the testing transformer, or through an auxiliary ratio transformer. In performing the test, the voltage shall be increased as rapidly as possible consistent with maintaining an accurate meter reading. The proof voltage shall be applied for 1 minute. After the test, the voltage shall be reduced smoothly at approximately 100 volts per second to zero.

5.1.2.12 Squirrel cage rotor treatment. The report shall describe the rotor VPI treatment required to protect against corrosion.

5.1.2.13 Inspection system. The report shall identify quality assurance and inspection systems used to substantiate product conformance to the procedures prepared as specified herein. Add inspection checkoff points to procedure steps.

5.1.2.14 Flow chart. A flow chart shall be provided identifying the step-by-step progression through the procedures of the facility's sealed insulation system. In addition to identifying the specific step of the procedure, each flow chart element shall contain a reference to the applicable paragraph of the facility's procedure.

5.1.3 Sealed insulation - quality assurance report. A quality assurance report containing a record of the work and tests on each production motor shall be prepared (see 6.3). The report shall be available for inspection by Government representatives for a period of 4 years after final delivery.

5.1.4 Information plate. An information plate shall be provided for installation on the exterior of the motor. This information plate shall be in accordance with MIL-P-15024. The code shall be legibly engraved or stamped on the plate with letters approximately 1/8 inch high and not less than 0.003 inch deep. The plate shall contain the statements: "STATOR WINDINGS INSULATED TO PROVIDE A SEALED INSULATION SYSTEM. CAUTION: WHEN STRIPPING, OVEN TEMPERATURE NOT TO EXCEED 370 DEGREES CENTIGRADE, MEASURED ON CORE".

5.2 Sample motor report. The facility shall furnish a sample motor report (see 6.3). A separate report shall be furnished for random wound, form wound, and salient pole motors to coincide with each sealed insulation system report furnished as specified in 5.1. Acceptance of the report certifies motors up to the frame size of the sample motor tested. Refer to 5.3 for extension of certification of motors through the largest frame size indicated in the sealed insulation system report (see 5.1).

5.2.1 Format. The report may have any convenient format. The pages shall be 8-1/2 by 11 inches with 3-hole left hand binding. Each page shall be numbered and dated with a space for revisions and notations. The report shall contain specific sections as follows:

Title page.
Reference documents.
Motor data.
Test procedures.
Test data.
Photographs of VPI equipment.
Photographs of winding before and after VPI.
Recording instrument charts.

5.2.2 Contents. The contents of the report shall include but not be limited to the following information.

5.2.2.1 Title page. The title page shall contain the name and street address of the facility, the number assigned to the report, the report's date of issue, and a description of the motors covered by the report including the range of frame sizes and types.

5.2.2.2 Referenced documents. The report shall contain a list of all referenced documents.

5.2.2.3 Motor data. The report shall contain motor data for each sample motor tested. The data shall include the following:

(a) Motor identification number.
(b) Date of manufacture or refurbishment.
(c) Frame size.
(d) Horsepower (HP) rating.
(e) Synchronous speed.
(f) Volts/phase/frequency.

5.2.2.4 Test procedures. The report shall include the test procedures used in performing the tests specified in 5.2.5.

5.2.2.5 Test data. The report shall include test data as specified in 5.2.5. The test data shall include but not be limited to the following:

(a) Photographs of test fixtures.
(b) Photographs of sample motors assembled with test fixture.
(c) Photographs and descriptions of test equipment.
(d) Test results (see 5.2.5).
(e) Cured resin sample (see 5.2.2.5.1).
(f) Coil and lead cable sections (see 5.2.2.5.2).

5.2.2.5.1 Cured resin sample. A sample of the cured resin shall be provided. The size shall be 1 inch wide, 3 inches long and 1/8 inch thick (approximate dimensions). Hardness data shall be submitted with the resin sample and shall be shore D values at 25°C with additional values at 100 and 150°C.

5.2.2.5.2 Coil and lead cable sections. The tested stator shall be cleaned and dried and cut up to provide the following sample sections:

(a) A cross-section of the stator slot cut 1/2 inch back from the stator lamination face. The sample shall have one slot intact with both top and bottom coils and 2 inches of end turn. The cut face shall be ground smooth to show the conductors and insulating components.
(b) A longitudinal section of a stator slot cut as near the center of the coil as possible so as to show the penetration and film build along the length of the coil in the slot.
(c) An end turn section of coils cut as close to the laminations as possible and traversing several slots and including a lead wire-to-coil connection joint.
(d) For form-wound coils, a sample shall be furnished consisting of top and bottom coils removed from a slot without cutting the core.

(e) For form-wound coils, a knuckle section shall be furnished
(f) The separate lead wire section.

5.2.3 Sample motor. Sample motors shall be provided in accordance with the applicable NAVSEA approved sealed insulation systems report with the following exception. The electrical testing after varnishing, as specified in 5.1.2.9, should be limited by the facility to the minimum necessary to ensure the winding integrity of the sample motor. Dielectric and submergence testing shall be performed as part of the sample motor testing specified in 5.2.5.

5.2.3.1 Multiple motor testing. If more than one sample motor is to be simultaneously tested, one of the motors shall be designated the sample motor. If the sample motor is damaged during handling, one of the remaining motors may be designated the sample motor and the test shall proceed from that point. If the sample motor fails a test, all motors shall be considered as failed.

5.2.3.2 Sample motor size and number. The minimum number of sample motors furnished and their frame size shall be determined as specified in table I.

TABLE I. Sample motor size and number.

Motor type	Sample motor frame size	
	Large motor test 1/	Other tests 2/
Fractional hp, induction & synchronous	1	48 frame
Integral hp, induction & synchronous	1	215 frame or larger
Integral hp, dc	1	224 frame or larger

1/ The large motor test (see 5.3) shall be performed to extend certification to motors with a frame size larger than that for which the facility has been certified. Certification may be extended to include the largest frame size motor applicable to 5.1. The large motor test may be performed using a production motor.
2/ Other tests consist of standardization, submergence and shock testing. The standardization test shall be the initial test performed on sample motors. Shock and salt water submergence testing may be performed on separate sample motors. If performed on the same motor, shock testing shall precede salt water submergence testing.

5.2.4 Sample motor electrical test requirements. Electrical test requirements shall be as follows:

(a) AC-high potential. An ac potential of twice rated voltage plus 1000 volts shall be applied for a period of 1 minute between isolated circuits to test their insulation, and shall also be applied between each circuit and ground. Testing shall be performed as specified in 5.1.2.11(e).

(b) Insulation resistance. Insulation resistance measurement shall be made using a direct potential of 500 volts. Insulation resistance between each circuit and ground and between isolated circuits shall be measured and recorded. Temperature of the windings shall be recorded. Insulation resistance values shall be corrected to 25°C using figure 1 and recorded. Testing shall be performed as specified in 5.1.2.11(a).

(c) Surge comparison. Surge comparison testing shall be performed at 5000 volts as specified in 5.1.2.11(d).

5.2.5 Test procedures. Sample motors shall be tested as specified in the following procedures.

5.2.5.1 Standardization test. Wound assemblies of each sample motor shall undergo the following tests. The test results shall be recorded.

(a) Insulation resistance (see 5.2.4).
(b) AC high potential (see 5.2.4).
(c) Surge (see 5.2.4).
(d) Insulation resistance (see 5.2.4). Following the dielectric testing, the wound assembly shall be placed in a thermostatically controlled oven and heated to 130°C for 24 hours. At the completion of the 24-hour period with the wound assembly at 130°C, measure and record the insulation resistance. After the wound assembly has cooled to room temperature, measure and record the insulation resistance and room temperature.

5.2.5.1.1 Acceptance criteria. The insulation resistance of the wound assembly shall be not less than 2 megohms at 130°C.

5.2.5.2 Submergence test. The wound assembly shall be submerged in 4-percent salt water for 150 hours. Wound assemblies with commutators or slip rings should be submerged to a point where the water level is as close as possible to the uninsulated areas. Wound assemblies without commutators or slip rings shall be completely submerged. While submerged, the wound assembly shall be energized as specified in 5.2.5.2.2. During submergence the insulation resistance shall be measured and recorded every 50 hours. Squirrel cage rotors shall be submerged for 150 hours in 4-percent salt water.

5.2.5.2.1 Acceptance criteria. The insulation resistance of the wound assembly, while submerged in salt water, shall be not less than 2 megohms corrected to 25°C using figure 1. Squirrel cage rotors shall be free of excessive corrosion after the 150-hour submergence.

5.2.5.2.2 Wound assembly energization. Wound assemblies that do not rotate when operating as a motor shall be energized while submerged. Wound assemblies that rotate during normal operation, such as, dc armatures and wound rotors, shall not be energized during submergence. Assemblies that require energizing shall have sufficient voltage applied to produce no load current while submerged.

5.2.5.2.3 Preparation for submergence. Wound assemblies shall be assembled for testing in accordance with either of the following procedures.

(a) Assembly as a complete motor, with the components necessary for rotation but without cooling fans.
(b) Assembly as a motor part into a fixture that will protect the winding and support the wound assembly while submerged. For squirrel cage induction motors, selection of this procedure requires concurrent submergence of the rotor.

5.2.5.3 Shock test. A sample motor shall be shock tested. Shock testing may be performed on a sample motor separate from the one used for salt water submergence testing. If a separate sample motor is used, it shall undergo a standardization test prior to shock testing. The sample motor may be a completely assembled motor or a wound assembly in a test fixture. The test fixture, if used, must support the stator assembly on the anvil plate and be capable of withstanding high impact (HI) shock. The test procedure for shock testing is as follows:

(a) With the sample motor dry, at room temperature, measure and record the insulation resistance and the room temperature.
(b) Prior to exposure to HI shock, submerge the sample motor for 24 hours in fresh water with the conductivity and surface tension adjusted as specified in 5.1.2.11(b). Measure and record the insulation resistance at appropriate intervals. The insulation resistance while submerged shall be not less than 100 megohms, corrected to 25°C.
(c) Prior to and after HI shock testing with the sample motor dry, at the shock test facility and at room temperature, measure and record the insulation resistance and room temperature. The HI shock testing and apparatus shall be in accordance with MIL-S-901. The testing shall consist of three blows, one in each principal axes. The hammer drop distance shall be 5 feet. The wound assembly should not be energized during HI shock testing.
(d) After HI shock, with the sample motor dry, at room temperature, and at the water submergence test facility, measure and record the insulation resistance and the room temperature. The insulation resistance should be not less than 2 megohms, corrected to 25°C.
(e) Repeat the fresh water submergence test specified in 5.1.2.11(b) with the exception that while submerged the insulation resistance shall be not less than 2 megohms, corrected to 25°C.

5.3 Large motor test. A wound assembly of frame size larger than that certified by the sample motor report (see 5.2) shall be tested as specified in 5.1.2.11(b). The wound assembly shall be as specified in 5.1 and may be a production motor. A large motor test report consisting of test data and motor identification, including frame size, shall be forwarded to NAVSEA for acceptance (see 6.3). The report may be forwarded after submittal of the sample motor report (see 5.2). Initial large motor testing may be accomplished with motors of frame sizes intermediate to the largest frame specified in 5.1. Certification of the entire range of frame sizes applicable to 5.1 requires testing of the largest frame size motor.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This standard is intended to assist activities in the preparation of a step-by-step procedure to obtain certification for providing electric motors with a sealed insulation system.

6.2 Issue of DODISS. When this standard is used in acquisition, the applicable issue of the DODISS must be cited in the solicitation (see 2.1.1, and 2.2).

6.3 Data requirements. The following Data Item Descriptions (DID's) must be listed, as applicable, on the Contract Data Requirements List (DD Form 1423) when this standard is applied on a contract, in order to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
5.1	DI-MISC-80652	Technical information report	----
5.1.3, 5.2, and 5.3	DI-T-2072	Reports, test	10.1.b

The above DID's were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 Subject term (key word) listing.

Dip-and-bake treatment
Form wound
Integral horsepower
Random wound
Salient pole
Squirrel cage induction
Vacuum pressure impregnation

Preparing activity:
Navy - SH
(Project 6105-0158)

ATTACHMENT (1)

Quality Assurance Report
Sealed Insulation System Motor
Record of Contractor Work and Test

Performed For: _____

Contractor: _____

Navy Contract No.: _____

Contractor Job No.: _____

Motor Serial No.: _____

Work Performed as Follows:

Repaired Laminations Stator Core _____

Rewound Stator with Sealed Insulation System _____

Replated Shaft Bearing Seat _____

Submitted By:

_____ _____
Q.A. Administrator DCAS Inspector

_____ _____
Date Date

FIGURE 3. Sample quality assurance report.

INCOMING INSPECTION

Nameplate Data:

Type _____	Frame _____	Class _____	Form _____
RPM _____	Duty HP _____	Cont HP _____	
Volts _____	AMPS _____	Freq _____	AMB _____
Phase _____	Duty _____	Serial No. _____	
Ins Class _____	Mfg Dwg No. _____		
Date Mfd _____	Inspected _____		

1. Inspect stator core, frame, rotor, shaft, end bells, terminal box and mounting feet for visible damage.

RECORD COMMENTS: _____

2. Inspect shaft keyways, threads and component mounting surfaces for nicks, dents and deformation.

RECORD COMMENTS: _____

3. Inspect bearing seats and shoulders for nicks, dents, corrosion, scoring and any other damage or deterioration.

RECORD COMMENTS: _____

4. Inspect rotor bars and end rings for cracks, looseness, or evidence of overheating.

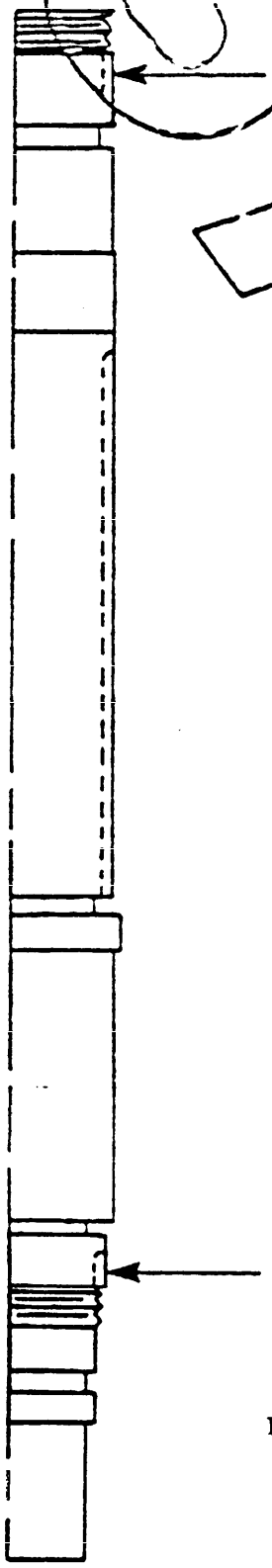
RECORD COMMENTS: _____

FIGURE 4. Sample incoming inspection report.

Work performed by: _____ Q.A. Inspector _____

Date _____ Date _____

5. Shaft Bearing Surface Diameters



Dia. 1 _____ Dia. 2 _____ Dia. 3 _____ T.I.R. _____

☐ As Received

☐ Final

Work Done _____

Meaured by: _____

Date _____

Q.A. Inspector _____

Date _____

Dia. 1 _____ Dia. 2 _____ Dia. 3 _____ T.I.R. _____

FIGURE 4. Sample incoming inspection report - Continued.

INITIAL TESTS

1. Insulation Resistance

Megohms	Measured	Corrected
Stator		
Stator Temp.	°C	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

2. Winding Resistance

Stator	Ohms
T1-T2	
T2-T3	
T3-T1	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

3. AC High Potential Test

1900 Volts	Stator	

(if SAT check)

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

FIGURE 5. Sample initial tests report

4. Loop test on stator core after stripping.

TIME	Voltage	Current	Temperature °C		
			No. 1 Spot	No. 2 Spot	Cold Spot

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

FIGURE 5. Sample initial tests report - Continued.

Refurbishment

1. Stator core stripping: Q.A. Check Point (Initials & date) _____

Reclaim oven temperature setting _____°C, Core temp _____ °C

Winding Data: Magnet Wire Size _____
Coil type _____
End turn length _____ in.
Clearance to frame _____ in.

Laminations repaired _____ replace _____ _____
C5 core plate ____ _____

Core sovlent cleaned and dried
_____ hrs at _____ °C _____
Core imprenated with epoxy No _____ and
baked _____ hrs at _____ °C _____

2. Rewinding of stator core:

Materials and processing same as certified motor _____
Deviations approved by SEA ltr Ser _____
and date _____ as follows:

_____ _____
_____ _____
Connections and joints sealed

Work performed by: _____ Q.A. Inspector _____
Date completed: _____ Date: _____

FIGURE 6. Sample refurbishment report

Electrical Tests
(After Winding)

1. Insulation Resistance

Megohms	Before HiPot		After HiPot		Acceptance Criterion
	Measured	Corrected	Measured	Corrected	
Stator					1000 Megohms
Temp		---		---	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

2. High Potential Test

1900 Volts AC	Check If SAT
HiPot to GRND	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

3. DC High Potential Test (Alternate)

3000 Volts DC	Microamperes
Leakage Current	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

FIGURE 7. Sample electrical tests (after winding) report.

4. Surge Comparison Test

	5000 Volts	Check IF SAT
	T1 - T2	
	T2 - T3	
	T3 - T1	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

FIGURE 7. Sample electrical tests (after winding) report - Continued.

Varnish Treaments

1. Vacuum-Pressure Impregnation

First VPI Treatment	Stator
Resin Designation	
Thixotropy Index	
Viscosity	
Percent Solids	
Stator Temp °C	

Second VPI Treatment	Stator
Resin Designation	
Thixotropy Index	
Viscosity	
Percent Solids	
Stator Temp °C	

Materials and processing same as certified motor

Q.A. Check Point _____

Deviations approved by NAVSEA ltr Ser _____
and date _____ as follows:

_____
_____

Work performed by: _____ Q.A. Inspector _____
Date completed: _____ Date: _____

FIGURE 8. Sample varnish treatments report.

2. Dipping Varnish

First Dip & Bake Treatment	Stator
Resin Designation	
Viscosity	
Percent Solids	
Stator Temp °C	

Second Dip & Bake Treatment	Stator
Resin Designation	
Viscosity	
Percent Solids	
Stator Temp °C	

Materials and processing same as certified motor

Q.A. Check Point _____

Deviations approved by NAVSEA ltr Ser _____ and date _____ as follows:

_____

_____

Work performed by: _____

Date completed: _____

Stator Weight	Before VPI and D&B Treatments	After
lbs.		

FIGURE 8. Sample varnish treatments report - Continued.

3. If additional VPI treatments or varnish treatments are required by the certified sealed insulation system motor; then, attach additional data sheets as above for the production motor report herein.

4. Treatment of rotor for corrosion protection.

Rotor cleaned and dried
_____ hrs at _____
Rotor impregnated with epoxy # _____ and
baked _____ hrs at _____ °C

Work performed by: _____ Q.A. Inspector _____
Date completed: _____ Date: _____

FIGURE 8. Sample varnish treatments report - Continued.

Submergence Test

1. Insulation resistance - stator core - 100 Megohms Minimum (25°C).

Time Minutes	Megohms
1	
10	

Time Hours	Megohms
1	
24	
After Removal	
1 Hr After	

Water Conductivity	500 Micromhos/cm., min.
Before Test	
After Test	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

FIGURE 9. Sample submergence test report.

1. Insulation resistance - 1000 Megohms Minimum (25°C)

Megohms	Before HiPot		After HiPot	
	Measured	Corrected	Measured	Corrected
Stator				
Temp°C		---		---

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

2. Winding resistance - ± 5%

Stator	Ohms
T1 - T2	
T2 - T3	
T3 - T1	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

3. High Potential Test

1900 Volts AC	Check If SAT
HiPot to GRND	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

FIGURE 10. Sample final electrical tests report.

4. Surge Comparison test -

5000 Volts	Check If SAT
T1 - T2	
T2 - T3	
T3 - T1	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

5. Phase sequence and phase rotation test

Voltage	*Check If SAT
Phase Rotation	
Phase Sequence	

Tested by: _____ Q.A. Inspector _____
Date: _____ Date: _____

* Same as incoming motor

FIGURE 10. Sample final electrical tests report - Continued.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-STD-2037	26 JULY 1991

3. DOCUMENT TITLE
PROCEDURE TO OBTAIN CERTIFICATION FOR ELECTRIC MOTOR SEALED INSULATION SYSTEMS

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code)	
Technical Point of Contact (TPOC): Mr. John Anderson (SEA 56Z21) PLEASE ADDRESS ALL CORRESPONDENCE AS FOLLOWS:	(1) Commercial TPOC: 703-602-3475	(2) AUTOVON 8-332-3475
ADDRESS (Include Zip Code) Commander, Naval Sea Systems Command Department of the Navy (SEA 55Z3) Washington, DC 20362-5101	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	