OVERHAUL AC SYNCHRONOUS MACHINES

1. SCOPE

1.1 Intent. This standard specification describes the requirements for the Contractor to overhaul (ashore in a suitable repair facility) an alternating current (AC) synchronous generator or motor removed from a Coast Guard vessel.

1.2 Alternate terminology. The term *machine*, when used in this specification, shall imply a propulsion generator or motor.

1.3 Appendices. The following appendices are part of this standard specification:

PROCESS STANDARD	APPENDIX
Remove and Reinstall AC Machine Aboard Vessel	A
Recondition AC Machine	B
Rewind AC Machine	C
Miscellaneous AC Machine Repairs	D

2. REFERENCES

COAST GUARD DRAWINGS

None.

COAST GUARD PUBLICATIONS

Surface Forces Logistics Center Standard Specification 3041 (SFLC Std Spec 3041), 2014, Shipboard Electric Cable Test

Surface Forces Logistics Center Standard Specification 3042 (SFLC Std Spec 3042), 2014, Shipboard Electrical Cable Removal, Relocation, Splice, Repair, and Installation

OTHER REFERENCES

American National Standards Institute (ANSI/EASA) AR100, 2010, Recommended Practice for the Repair of Rotating Electrical Apparatus

International Organization for Standardization (ISO) 1940-1, 2003, Mechanical Vibration – Balance Quality Requirements of Rigid Rotors

American Society for Testing and Materials (ASTM) B177, 2011, Standard Guide for Chromium Electroplating on Steel for Engineering Use

DOD-STD-2188, Apr 1987, Babbitting of Bearing Shells

MIL-D-16791, Jan 1993, Detergents, General Purpose (Liquid Nonionic)

MIL-I-24092/2, Sep 1993, Insulating Varnish, Solvent Containing, Baking, Flexible, for Dip Processing, Grade CB, Class 130 to 180 Thermal Class

MIL-I-24092/5, Sep 1993, Insulating Resin, Solventless, Baking, Flexible, for Dip Processing, Grade SF, Class 130 to 180 Thermal Class

MIL-I-24718/3, Apr 1990, Insulating Resins, Solventless, Vacuum-Pressure-Impregnating Polyester Diallyl Phthalate, Slightly Thixotropic

National Electrical Manufacturers Association (NEMA) MG1, 2010, Motors and Generators

U.S. Department of Energy (DOE/GO) 10099-935, Nov 1999, Model Repair Specifications for Low Voltage Induction Motors

3. REQUIREMENTS

3.1 General. Perform the particular overhaul task(s) specified in the work item, in accordance with this standard specification and the applicable appendix(ces) herein.

3.1.1 Notification and documentation. Abide by the following rules for all inspections, tests, and cleaning operations specified herein.

3.1.1.1 Advance notice. Notify the Coast Guard Inspector at least 24 hours before performing each test, inspection, and cleaning operation. The Coast Guard Inspector shall be present shipboard and in the shop to witness the performance of all tests, inspections, and cleaning operations performed under this specification.

3.1.1.2 Documentation. Submit a CFR after completion of each inspection and test.

3.1.2 Original equipment manufacturer's guidance. Adhere to the requirements, cautions, and warnings stated in the generator or motor manufacturer's instruction book during the performance of this work. Machines originally constructed to NEMA MG1 requirements shall continue to meet such standards after overhaul.

3.1.3 Materials. New material used or installed during work on the machine shall be equal or superior to the material used by the original manufacturer.

3.1.4 Machine overhaul technician. Machine inspection and shop work shall be performed by a firm that is a member of the Electrical Apparatus Service Association (EASA) and that shop shall adhere to the association's standards, including ANSI/EASA AR100.

3.1.5 Machine protection.

3.1.5.1 Particular care shall be taken so that no foreign materials or dust are allowed to lodge on the machine, particularly the collector rings (if so equipped). Ensure that supply air to the compartment is filtered to preclude entry of paint over spray, dust, and industrial grit.

3.1.5.2 For a machine with collector rings, absolutely no silicone or silicone based insulations, cables, paints, varnishes, laminates, tapes, compounds, rubber, greases, or other products shall be used within the air space of the collector rings. Mechanics using protective hand creams containing conductive or

silicone materials shall not handle internal collector space parts, as even small amounts of silicone materials will cause greatly increased brush wear.

3.1.5.3 Take adequate security measures to ensure that foreign objects do not enter a machine at any time, as a small bolt, nut, or other object in the air gap may cause damage that could require weeks to repair. Small, loose objects shall not be permitted in the pockets of workers within the compartment while a machine is uncovered. Account for all tools and fasteners entering and leaving a machine. Protect each open machine with stock or temporary covers during periods when no shipboard work is actively in progress on the internals.

3.1.6 Silicone. Absolutely no silicone or silicone based insulations, cables, paints, varnishes, laminates, tapes, compounds, rubber, greases, or other products shall be used within the interior

3.2 Removal from vessel. When stated in the work item, or if a Change Request has been released and authorized by the KO, remove the designated machine or assembly from the vessel per Section A2.1 of Appendix A and ship to a suitable repair facility.

3.3 Initial inspection. Prior to performing the shop work specified by the work item, the machine repair facility shall accomplish the following:

3.3.1 Access cover removal. Remove, clean, and retain all machine access covers and fasteners.

3.3.2 Disassembly and inspections. Unpack the machine assembly removed from the vessel. Disassemble the machine and remove the rotor. Accomplish the following machine inspections:

3.3.2.1 Visual inspections. Perform a visual inspection of the machine components for the presence of contamination by dust, dirt, moisture, oil, and other foreign matter. Attempt to determine the origin, such as leaking seals, or any unusual conditions prior to the start of cleaning. Note all abnormal conditions on the stator, rotor, windings, and risers, and if installed, collector rings, brush holders, brushes, and brush holder springs. Carefully examine the interior of the machine for loose objects such as, nuts and bolts; remove all such items. Inspect all electrical connections for tightness. Check all wedges, bands, and soldered connections and correct any minor deficiencies. Check for evidence of overheating, both general and localized. Identify any mechanical deficiencies, including non-conformance with Section 2 of ANSI/EASA AR100. Inspect insulation condition in accordance with Section 1.5.1 of ANSI/EASA AR100. Record all findings, including the types of contaminants (oil, water, carbon, dirt, etc.) found.

3.3.2.2 Brush removal. If installed, remove and inspect all brushes, brush rigging insulators, brush holders, and brush holder springs. Dispose of the removed brushes. Clean and retain the remaining components.

3.3.2.3 Collector ring wear and concentricity. For a machine with slip rings, measure and record the collector ring wear and concentricity. Note any corrosion or abnormal wear patterns. Also record the manufacturer's acceptable collector ring runout. Note locations (relative to a reference point) on the collector ring where runout is excessive.

3.3.2.4 Accessories. Inspect any machine accessories, such as temperature sensor or space heater, and the associated internal wiring. Test accessory operation and submit a CFR with recommendations for repair or renewal.

3.3.3 Initial winding tests. Assess winding conditions per Section 4.3 of ANSI/EASA AR100:

3.3.3.1 Insulation resistance test. Measure and record the insulation resistance of each circuit listed in Table 1A through 1D below, as applicable. Apply a test voltage of 500 VDC for all circuits except the stator circuit on 2320, 4160 or 6600 VAC machines, which shall be tested at 1000, 2500 or 5000 VDC, respectively. Test six phase stators as two independent three-phase windings. Temperature correct all insulation resistance readings to 25°C using the nomograph of Figure 1. Record uncorrected insulation resistance reading, winding temperature, and corrected insulation resistance for each measurement taken. The following formula can be used as a cross check on the nomograph temperature correction:

$$R_{25} = R_T \, 10^{0.0305(T-25)}$$

where	R_{25}	is the corrected insulation resistance
	R_T	is the uncorrected insulation resistance
	T	is the winding temperature (°C)

3.3.3.2 Insulation resistance polarization index (PI) test. Measure and record the PI tests as follows:

3.3.3.2.1 Measure and record the insulation resistances of the windings after applying the test voltage specified in paragraph 3.3.3.1 above for one minute. Separately test the main field and stator windings. Apply rotor voltage between the copper conductors and the rotor structure to eliminate the insulating effect of the bearing lubrication film.

3.3.3.2.2 If the value of the one minute insulation resistance is between the values shown in Table 1A through 1E below, as applicable, continue applying test voltage until a steady state value is reached. Measure and record the insulation resistance each minute during the test and more frequently when results are changing quickly. Plot the insulation resistance as a function of time on log-log paper for each winding tested. A PI value of less than 2.0 indicates that the windings are moist or dirty.

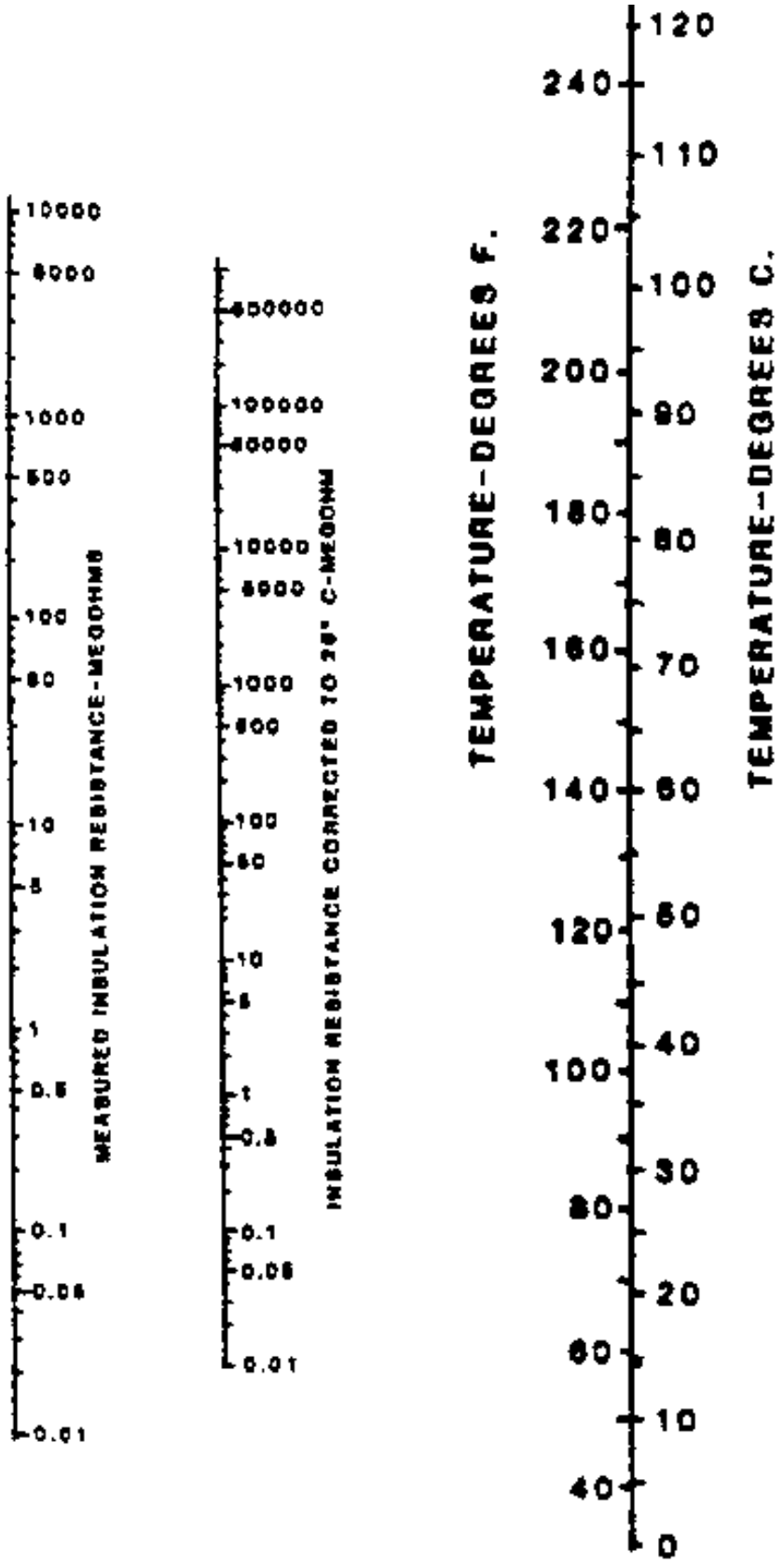

Figure 1 – Insulation Resistance Temperature Correction Nomograph

TABLE 1A – POLARIZATION INDEX APPLICABILITY FOR 450 VAC GENERATORS

Windings	Minimum Resistance	Maximum Resistance
Stator	0.2 MΩ	125 MΩ
Field	0.4 MΩ	125 MΩ

TABLE 1B – POLARIZATION INDEX APPLICABILITY FOR 700 VAC MAIN PROPULSION GENERATORS (POLAR)

Windings	Minimum Resistance	Maximum Resistance
Stator	0.3 MΩ	102 MΩ
Field	0.4 MΩ	150 MΩ

TABLE 1C – POLARIZATION INDEX APPLICABILITY FOR 2320 VAC MAIN PROPULSION MOTORS (HEALY)

Windings	Minimum Resistance	Maximum Resistance
Stator	0.8 MΩ	313 MΩ
Field	0.4 MΩ	150 MΩ

TABLE 1D – POLARIZATION INDEX APPLICABILITY FOR 4160 VAC CENTRAL POWER PLANT GENERATORS (MACKINAW)

Windings	Minimum Resistance	Maximum Resistance
Stator	1.6 MΩ	605 MΩ
Field	0.4 MΩ	150 MΩ

TABLE 1E – POLARIZATION INDEX APPLICABILITY FOR 6600 VAC CENTRAL POWER PLANT GENERATORS (HEALY)

Windings	Minimum Resistance	Maximum Resistance
Stator	2.5 MΩ	924 MΩ
Field	0.4 MΩ	150 MΩ

3.3.3.3 Bearing insulation resistance test. Measure and record bearing insulation resistance per Section 4.2.8 of ANSI/EASA AR100.

3.3.3.4 Additional tests. Perform remaining tests as needed to fully assess winding condition.

3.4 Shop work. Perform the following work at the machine repair facility:

3.4.1 Reconditioning. When stated in the work item, or if a Change Request has been released and authorized by the KO, recondition the designated machine or assembly per Appendix B.

3.4.2 Rewinding. When stated in the work item, or if a Change Request has been released and authorized by the KO, rewind the designated machine or assembly per Appendix C.

3.4.3 Miscellaneous repairs. When stated in the work item, or if a Change Request has been released and authorized by the KO, repair the designated machine or assembly per the applicable paragraph of Appendix D shown in Table 2 below.

TABLE 2 – MISCELLANEOUS REPAIRS MATRIX

Repair	Appendix D Paragraph
Shafting	D2.1
Slip rings	D2.2
Frame and bearing housings	D2.3
Bearings	D2.4
Journals	D2.5
Temperature sensors	D2.6
Leads	D2.7
Space heater	D2.8

3.4.4 Balancing. Dynamically balance the rotor assembly per the manufacturer's specifications and the following:

3.4.4.1 In the absence of manufacturer's specifications, balance per ISO 1940/1 to quality grade G as follows:

3.4.4.1.1 Rotors with 4 or more poles shall meet Tolerance G2.5.

3.4.4.1.2 Two pole rotors shall meet Tolerance G1.0.

3.4.5 Reassembly. Reassemble the machine and reinstall all access covers and fasteners, except those at the terminal box.

3.4.5.1 Renew all disturbed seals and gaskets.

3.4.5.2 Clean bearing grease passages and lubricate in accordance with Section 2.3 of ANSI/EASA AR100.

3.4.5.3 If equipped with slip rings, reinstall the brush rigging and renew the brushes with the same size, type, and hardness as originally installed. Adjust the brush rigging and seat each brush to fit the slip ring curvature per Sections 2.9 and 2.10 of ANSI/EASA AR100.

3.5 Shop acceptance testing. Perform the following shop acceptance tests:

3.5.1 Final shop insulation resistance tests. Assess insulation system conditions in accordance with Section 4.2 of ANSI/EASA AR100. At a minimum, the following shall be performed:

3.5.1.1 Insulation resistance test. Measure and record the insulation resistance of the main field and stator circuits (see paragraph 3.3.3.1 above). If the insulation resistance on any circuit, adjusted to 25°C, is below the value shown in Tables 3A through 3D below, as applicable, submit a CFR along with proposed corrective action.

TABLE 3A – MINIMUM INSULATION RESISTANCE FOR OPERATION

Windings	Minimum Insulation Resistance (MΩ) for Generator or Motor of Rated Voltage (VAC)				
	450	**700**	**2320**	**4160**	**6600**
Stator	0.2	0.3	0.8	1.6	2.5
Field	0.4	0.4	0.4	0.4	0.4

TABLE 3B – MINIMUM INSULATION RESISTANCE AFTER CLEANING & DRYING

Windings	Minimum Insulation Resistance (MΩ) for Generator or Motor of Rated Voltage (VAC)				
	450	**700**	**2320**	**4160**	**6600**
Stator	1.0	1.4	4.2	8.1	12.3
Field	2.0	2.0	2.0	2.0	2.0

TABLE 3C – MINIMUM INSULATION RESISTANCE AFTER RECONDITIONING

Windings	Minimum Insulation Resistance (MΩ) for Generator or Motor of Rated Voltage (VAC)				
	450	**700**	**2320**	**4160**	**6600**
Stator	25.0	27.3	83.5	161	246
Field	25.0	40.0	40.0	40.0	40.0

TABLE 3D – MINIMUM INSULATION RESISTANCE AFTER REWINDING

Windings	Minimum Insulation Resistance (MΩ) for Generator or Motor of Rated Voltage (VAC)				
	450	**700**	**2320**	**4160**	**6600**
Stator	200	68.3	209	403	616
Field	400	273	835	1610	2460

3.5.1.2 Insulation resistance polarization index (PI) test. Repeat the insulation resistance PI tests of Section 3.3.3.2 above. If the PI is less than 2.0 (3.0 after reconditioning or rewinding), submit a CFR along with proposed corrective action.

3.5.1.3 Bearing insulation resistance test. Measure and record bearing insulation resistance per Section 4.2.8 of ANSI/EASA AR100. If the bearing insulation resistance is less than 1 megohm, submit a CFR along with proposed corrective action.

3.5.2 High potential tests. For windings that have been reconditioned or rewound, perform high potential tests in accordance with Section 4.4 of ANSI/EASA AR100.

3.5.3 Accessory tests. Test accessories in accordance with Section 4.4.2 of ANSI/EASA AR100.

3.6 Final assembly. Complete the remaining tasks in Section 1 of ANSI/EASA AR100. Reinstall the terminal box cover plate with new gasket.

3.7 Packaging. Package the machine assembly for transport back to the vessel. If the machine will not be promptly reinstalled, store the packing crate in a climate-controlled environment or pack the container with desiccant and shrink-wrap it with heavy plastic film.

3.8 Reinstallation aboard vessel. When stated in the work item, or if a Change Request has been released and authorized by the KO, transport the designated machine to the vessel, reinstall per Section A2.2 of Appendix A, and test per Section A2.3 of Appendix A.

4. NOTES

4.1 Section 4.3 of ANSI/EASA AR100 lists additional shop acceptance tests that could be performed. If such testing is justified by the particular condition or operating history of the machine, the performance of such additional tests and the associated acceptance values will be specified in the work item.

APPENDIX A

REMOVE AND REINSTALL AC MACHINE ABOARD VESSEL

A1. SCOPE

A1.1 Intent. This appendix describes the requirements for removing and reinstalling an alternating current (AC) generator or motor aboard a vessel. As directed by the work item, the removed machine may be sent to a suitable repair facility for overhaul or replaced by a new machine.

A2. REQUIREMENTS

A2.1 Removal from vessel. Perform the following to remove the machine from the vessel:

A2.1.1 Lock out. For a medium voltage (greater than 1000 volts) machine, the associated circuit breaker or disconnect switch shall be locked out or removed from the switchboard in addition to being danger tagged. Padlocks shall be installed to physically prevent closure or reinstallation of the disconnecting means and for generators, the starting of the prime mover. Also ensure that appropriate grounding straps are installed.

A2.1.2 Secondary power sources. Ensure that secondary power sources, such as off-line electronic insulation fault monitors, space heaters, resistance temperature detectors, and internal inspection lights, are secured prior to commencing work.

A2.1.3 Preliminary measurements. Accomplish the following, prior to removal of the rotor or assembled machine:

A2.1.3.1 Measure and record the coupling and alignment clearances; match mark each coupling prior to disassembly for later reconnection.

A2.1.3.2 Measure and record air gaps.

A2.1.4 Cable. As needed to perform the work, disconnect the machine stator power cable, field power cable, and any accessory (e.g., temperature sensor or space heater) wiring in accordance with SFLC Std Spec 3042.

CAUTION!

For a Caterpillar SR4 series generator, the permanent magnet pilot exciter armature stator must be removed prior to rigging out the rotor. Observe the removal and reinstallation instructions in Caterpillar form SENR3985, typically included in the manufacturer's instruction book.

A2.1.5 Ventilation. As needed to perform the work, remove blower(s) and duct sections to separate the machine from its ventilation system. Clean air stream surfaces of the removed components and the first 3 feet of ductwork in each direction from each break.

A2.1.6 Sea water. For a machine with a salt water to air heat exchanger, establish two barriers (e.g., two shut valves, preferably with a telltale drain between them to warn if the upstream pressure barrier is leaking) between the sea water joints to be broken and the surrounding waters. If two barrier protection is not possible due to system design, then permission of the cutter's Commanding Officer is required to use single barrier protection and that barrier shall be locked in the secured position (e.g., lockwire the valve handwheel). Single barrier isolation is also acceptable if the vessel will not be waterborne, the barrier is a blank flange capable of withstanding normal system operating pressure, or the piping to be disconnected is supplied by a depressurized header and is located at an elevation above the highest expected waterline for the duration of the work. As needed to perform the work, drain, disconnect, and blank sea water piping to separate the air cooler from ship's piping.

A2.1.7 Lubricating oil. For a machine with oil lubricated bearings, drain, disconnect, and blank lube oil piping as needed to separate the bearings from ship's piping.

A2.1.8 Brushes. For a machine with slip rings, remove and inspect all brushes. Also remove brush rigging insulators, brush holders, and brush holder springs as needed for rotor removal.

A2.1.9 Coupling disassembly. Disassemble the coupling and retain for reuse, accomplishing the following as applicable:

A2.1.9.1 When design, rigging, access, or space constraints preclude removing the fully assembled machine from the vessel, remove the rotor in accordance with the machine manufacturer's recommended rigging procedure, including removal of the brushless exciter (if so equipped).

A2.1.9.2 If the machine is of single bearing design and is to remain fully assembled during off load, install appropriate blocking to support the driven end.

A2.1.10 Removal. Remove the machine to be overhauled from the vessel, retaining all shims, fasteners, and other hardware for reinstallation:

A2.1.11 Disposition. Perform the following on each designated component or assembly as directed by the work item:

A2.1.11.1 Package the removed windings or assembly for transport to a suitable machine repair facility. If the rotor and stator were off loaded separately, they may be reassembled before crating or individually packaged. Support the rotor so that its windings cannot make physical contact with unprotected adjacent surfaces during the transit.

A2.1.11.2 Scrap items that will not be reinstalled.

A2.1.11.3 Retain the remaining items for future reinstallation and store in a protected location.

A2.1.12 Clean, inspect, and paint the vacated foundation while the machine is not installed.

A2.2 Reinstallation aboard the vessel. Unpack the machine assembly and visually inspect for shipping damage. Reinstall the removed components using shims, fasteners, and other hardware retained in paragraph A2.1 above.

A2.2.1 Shaft coupling. Remake the coupling, remove blocking, and realign the generator with the prime mover or the motor with the driven load. Measure angular and parallel misalignment, adjusting, as

necessary, to within manufacturer's tolerances. If no manufacturer's data is available, angular misalignment shall not exceed 0.005 inch and parallel misalignment shall be no greater than 0.002 inch.

A2.2.2 Alignment. Measure and record air gaps. Adjust alignment so that air gaps are uniform and within machine manufacturer's specifications.

A2.2.3 Brush holders. If removed, reinstall and align the brush rigging insulators, brush holders, and brush holder springs per machine manufacturer's instructions.

A2.2.4 Brushes. Install retained or replacement brushes into the brush holders. After the brushes have been installed, check and ensure the following:

- Brushes are free to move in the brush holder without sticking.
- Brush tension is adjusted in accordance with manufacturer's recommendations. If no data is available, adjust brush tension to achieve a pressure of 2½ pounds per square inch of brush cross sectional area.
- The shunt terminals are firmly attached to the brush holders.

A2.2.5 Ventilation. Reinstall blower(s) and duct sections removed in paragraph A2.1.5 above.

A2.2.6 Cables. Perform insulation resistance tests and reconnect cables lifted in paragraph A2.1.4 above in accordance with SFLC Std Spec 3042 using retained hook-up data.

A2.2.7 Sea water. Using new gaskets, reinstall and reconnect salt water to air heat exchangers that were removed in paragraph A2.1.6 above.

A2.2.8 Lubrication. Ensure that machine bearings are properly lubricated. Using new gaskets, reconnect any lube oil piping that was removed in paragraph A2.1.7 above; refill drained piping with fresh oil and purge any trapped air. Slowly rotate the assembled machine using the barring gear or turning motor if installed. Verify that air gap is adequate to prevent mechanical contact of the rotor windings with the stator coils through at least one complete revolution.

A2.2.9 Covers. Reinstall the cleaned machine access covers and any other removed equipment. Reuse retained fasteners.

A2.2.10 Space heater. Energize the machine space heating system to exclude moisture whenever the unit is not in operation.

A2.3 Final acceptance testing. Perform the following final acceptance tests:

A2.3.1 Measure and record the insulation resistance of the stator circuit to ground in accordance with SFLC Std Spec 3041.

A2.3.2 Operational test. Ship's force will operate all machinery during operational tests. Prior to testing, remove locks and grounding straps that were installed in paragraph A2.1.1 above.

NOTICE!

In order to run the machine during the next tests, the associated mechanical systems may need to be refilled and vented prior to operation. Prime mover air intakes and exhaust systems must be clear and ready for operation. Ensure that fire suppression, fuel oil, compressed air, sea water cooling, and lube oil system valve lineups support machine operation before commencing electrical tests.

A2.3.2.1 For a three-phase generator, perform a phase rotation test prior to paralleling with any other power source. Correct any generator or motor reverse phase rotation problems.

NOTICE!

Coordinate machine operational testing with mechanical system retests. Inspect disturbed mechanical joints in fluid systems for leakage as the system is pressurized for the first time.

A2.3.2.2 Perform an operational test of the overhauled machine at maximum power, not to exceed the machine's continuous power rating, for no less than one hour using on board loads. A generator may be tested using a load bank. Correct any excessive vibration, unusual noise, or overheating conditions. Verify that all machine accessories (e.g., temperature sensors and space heater) are operating properly.

A3. NOTES

A3.1 For instances where the Contractor is not tasked with removal or reinstallation of the machine, Ship's Force should perform the related steps of this Appendix instead.

APPENDIX B

RECONDITION AC MACHINE

B1. SCOPE

B1.1 Intent. This appendix describes the requirements for reconditioning the windings of an alternating current (AC) generator or motor at a suitable repair facility.

B2. REQUIREMENTS

B2.1 Cleaning. Clean the rotor and stator windings as follows:

B2.1.1 Suction. Use suction to remove abrasive particles such as loose grit, iron dust, carbon and copper particles. If slip rings are installed, clean them using a canvas cloth while turning the rotor.

B2.1.2 Compressed air. Use compressed air with suction such that material dislodged by the air stream will be captured and exhausted. Remove dry loose dust and foreign particles, particularly from inaccessible locations such as air vents in the rotor punchings. Ensure the following:

- The compressed air is clean (oil free with the use of an oil filter) and dry.
- The air pressure does not exceed 30 pounds per square inch.
- The machine is opened from both ends, to allow a path of escape for air and dust.
- Extreme caution is used when using compressed air, particularly if abrasive particles are present.

B2.1.3 Cleaning solution. All cleaning solutions shall be water based. Dry ice, citrus terpenes, or other waterless organic solvents shall not be used. Prepare one of the following solutions for cleaning:

- Liquid non-ionic water-soluble general-purpose detergent, meeting the requirements of MIL-D-16791, mixed in a proportion of 1 ounce of concentrate to 1 gallon of fresh water. If the cleaning solution is batch prepared, heated the mixing water to 130°F to 150°F prior to dissolving the detergent.
- Steam cleaner, typically in the proportions of 15 to 20 pounds of steam cleaning compound and 1 quart of butyl alcohol to 1,000-gallons of water.

B2.1.4 Cleaning method. After removal of loose materials above, clean the coils, windings, and structural members until all carbon dust, oil, grease, and foreign deposits are removed. Cleaning and rinse solution temperature shall be no less than 140°F and shall not exceed 194°F. Use clean lint-free cloths to check for cleaning effectiveness.

B2.1.4.1 For tank cleaning, place the rotor in the solution with its axis vertical and the slip ring end up. Hold the solution at a constant temperature of 88°C (190°F) and circulate it through the windings with an air agitator or other means.

B2.1.4.2 For steam cleaning or pressure washer applications, ensure that all surfaces are thoroughly wetted. Set the sprayer controls to avoid damaging the insulation by limiting winding impingement pressure to 30 psig. Avoid striking varnished surfaces with the cleaning nozzle or wand.

B2.1.5 Rinse. At the conclusion of a wash cycle, rinse the windings using hot fresh water. Do not let cleaning solution dry on machine surfaces. Continue wash and rinse cycles until the machine is clean. The final rinse of the work day shall include all machine internals to ensure that any overspray is completely removed from all surfaces. Wipe off accessible wetted surfaces and blow dry or wet vacuum any remaining surface water.

B2.1.6 Drying. Immediately after cleaning, rinsing and hand drying, bake the windings in an oven until completely dry. Do not allow winding temperature to exceed 230ºF and maintain oven temperature below 300ºF. Do not exceed manufacturer's temperature limits. Take insulation resistance readings per Section 4.2.1 of ANSI/EASA AR100 when the drying is started and at regular intervals thereafter. Plot the data on semi-logarithmic paper with the logarithm of temperature corrected insulation resistance as ordinate and time as abscissa. Continue drying until either:

- The temperature corrected insulation resistance readings show no abrupt changes and do not increase more than 5% over a 12-hour period.
- The polarization index is greater than 3.0.

B2.2 Evaluation. A shop cleaned and dried machine should have an insulation resistance of no less than the applicable value shown in Table 3B above in order to proceed with insulation treatment. If insulation resistance is less than this value after two clean and dry cycles, submit a CFR. If a Change Request is released and authorized by the KO as a result of this CFR, discontinue further work on the affected circuit(s) under this appendix and rewind per Appendix C.

B2.3 Insulation treatment. Upon satisfactory completion of cleaning, drying, and any other authorized repairs, accomplish insulation treatment of the rotor and stator windings per Section 3.4 of ANSI/EASA AR100 using one of the methods below, except that a machine constructed with sealed insulation systems shall only be vacuum pressure impregnated (VPI). The work item may further restrict the choice of materials or methods. The temperature class of the applied treatment shall be no less than that of the existing insulation system.

B2.3.1 Solvent-varnish dip and bake. Varnish shall be of Grade CB per MIL-I-24092/2 when required by the work item; an industrial electrical grade polyester solvent-varnish compatible with the original varnish may be used otherwise.

B2.3.2 Solventless resin dip and bake. Resin shall be of Grade SF per MIL-I-24092/5 when required by the work item; an industrial electrical grade solventless resin compatible with the original varnish may be used otherwise.

B2.3.3 Vacuum-pressure impregnation. Resin shall meet MIL-I-24718/3 when required by the work item; an industrial electrical grade resin compatible with the original insulation may be used otherwise.

B2.4 Curing. Cure the treated windings in accordance with the varnish manufacturer's recommendations.

B3. NOTES

B3.1 Solventless varnish. In recent years epoxy-type 100% solid (solventless) varnishes have been used in geographical areas that regulate industrial facility volatile organic air emissions. Such treatment may be applied by the traditional dipping and baking approach or by the VPI method.

B3.2 Vacuum-pressure impregnation. A VPI resin may be successfully applied over windings that were previously varnish dipped and baked. Many machine repair shops now have automated VPI equipment, reducing the cost of such treatment to near that of the traditional dip and bake method. Unless the cost is significantly greater, the windings of a machine constantly exposed to moist salt air should be reconditioned using the VPI method.

APPENDIX C

REWIND AC MACHINE

C1. SCOPE

C1.1 Intent. This appendix describes the requirements for rewinding an alternating current (AC) generator or motor at a suitable repair facility.

C2. REQUIREMENTS

C2.1 Core loss test. If not previously accomplished in Section 3.3.3.4 above, perform an interlaminar insulation resistance test in accordance with Section 4.2.7 of ANSI/EASA AR100 and Section 2.5.3 of DOE/GO 10099-935.

C2.2 Rewinding. Strip, clean, test, and rewind the machine per Section 3 of ANSI/EASA AR100, observing the following:

C2.2.1 Burn out. Strip the old windings in accordance with Section 3.3 of ANSI/EASA AR100 and Section 2.5.4 of DOE/GO 10099-935.

C2.2.2 Cleaning. Clean and dry each core in accordance with Section 2.6.1 of DOE/GO 10099-935.

C2.2.3 Core inspection. Reperform the test of paragraph C2.1 above on the bare core. If results are unsatisfactory or there is visual evidence of damage, submit a CFR with the recommended repair course of action. Reperform the core loss test after any iron restacking or interlaminar insulation repairs.

C2.2.4 Core preparation. Prepare the bare core for winding, touching up the interlaminar insulation, varnishing the iron, and installing ground wall insulation, as necessary, to restore machine to a like new condition.

C2.2.5 Windings. Wind coils in accordance with Sections 3.6 through 3.12 of ANSI/EASA AR100 and Sections 2.7.1 through 2.7.7 of DOE/GO 10099-935.

C2.2.6 Banding. Apply banding in accordance with Section 3.13 of ANSI/EASA AR100. Use the same type of wire or glass banding that was installed by the original manufacturer. Do not substitute one for the other, nor replace magnetic banding wire with non-magnetic or vice versa.

C2.2.7 Quality assurance. Visually inspect and test the windings per Section 2.7.8 of DOE/GO 10099-935 prior to impregnation to ensure that there are no improper connections or shorted turns. Measure and record the resistance of each phase winding with a precision resistance bridge or micro-ohmmeter. Measured resistances shall be within 2.5% of the original manufacturer's specification, temperature corrected as necessary. In the absence of manufacturer’s specifications, the measured resistance of each phase winding shall be within 2.5% of the average.

C2.3 Vacuum-pressure impregnation. Upon satisfactory completion of rewinding and any other authorized repairs, accomplish insulation treatment of the rotor and stator windings per Section 3.4 of ANSI/EASA AR100 using the *vacuum pressure impregnation method*. The temperature class of the applied treatment shall be Class F or better and no less than that originally applied by the machine manufacturer. Resin shall meet MIL-I-24718/3 when required by the work item; an industrial electrical grade resin may be used otherwise. Cure the treated windings in accordance with the varnish manufacturer's recommendations.

C3. NOTES

C3.1 Vacuum-pressure impregnation. Many machine repair shops now have automated VPI equipment, reducing the cost of such treatment to near that of the traditional dip and bake method. Unless the cost is significantly greater, the windings of a machine afloat should be rewound with a sealed insulation system using the VPI method.

APPENDIX D

MISCELLANEOUS AC MACHINE REPAIRS

D1. SCOPE

D1.1 Intent. This appendix describes the requirements for miscellaneous repairs to an alternating current (AC) generator or motor at a suitable repair facility.

D2. REQUIREMENTS

D2.1 Shafting. Correct machine shafting deficiencies in accordance with Section 2.1 of ANSI/EASA AR100 and Section 2.10 of DOE/GO 10099-935. Renew cracked or bent shafts; do not attempt weld repair or straightening unless specifically authorized by the work item or Change Request.

D2.2 Slip rings. True and resurface the collector rings in accordance with Section 2.7 of ANSI/EASA AR100. If insufficient material remains to accomplish such work without reducing the collector ring diameter below the manufacturer's minimum allowable, submit a CFR and do not proceed without COTR concurrence.

D2.3 Frame and bearing housings. Repair the frame and bearing housings in accordance with Section 2.4 of ANSI/EASA AR100 and Section 2.12 of DOE/GO 10099-935.

D2.4 Bearings. Inspect and measure all bearings in accordance with Section 2.2 of ANSI/EASA AR100 and Section 2.11 of DOE/GO 10099-935. Renew bearing insulation if resistance measured in paragraph 3.3.3.1 above is less than 10 megohms. As directed by the work item, renew worn bearings or rebabbit bearing shells in accordance with the manufacturer's instruction book or DOD-STD-2188 if no guidance is given; measure and record new bearing clearances.

D2.5 Journals. Restore the bearing journal(s) to their original diameter as follows:

D2.5.1 Chrome-plate the bearing journals in accordance with ASTM B177.

D2.5.2 Record the depth of metal machined from the journal diameter before buildup. Advise the Coast Guard Inspector before proceeding if machining deeper than 0.025 inches.

D2.5.3 Apply the buildup metal so that it will not flake or crack under normal operating conditions.

D2.5.4 Polish all journal areas after completing buildup metal process.

D2.6 Temperature sensors. Renew temperature sensors in accordance with Section 3.9 of ANSI/EASA AR100 and Section 2.13.2 of DOE/GO 10099-935.

D2.7 Leads. Renew the machine leads in accordance with Section 2.13.3 of DOE/GO 10099-935.

D2.8 Space heater. Renew the machine space heater and its internal wiring in accordance with Section 2.13.5 of DOE/GO 10099-935.

D3. NOTES

D3.1 Common repairs. The above are the most common miscellaneous machine repairs. Requirements for correcting other deficiencies shall be defined in the work item.

D3.2 Brushes. To minimize potential delays for long lead time material and obtain higher quantity discounts, it may be advisable to furnish replacement brushes from on board spares rather than task ordering by the Contractor.