



*GE Industrial
Control Systems*

GEEP-164-I

Instructions

Custom 8000[®] Horizontal Induction Motor

Totally Enclosed
Air Over

Antifriction Bearing

These Instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to GE Industrial Control Systems.
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Introduction

General

The purpose of this instruction manual is to provide a description of the product and to provide helpful suggestions for receiving, handling, storing, installing, operating, and maintaining the unit together with useful general information. Although reasonable care has been taken in the preparation of this instruction manual to assure its technical accuracy, no responsibility is assured in any manner by the General Electric Company for any consequences of its use. If further information is required, contact the nearest General Electric office.

This instruction manual should be available to all personnel involved in installing and operating the unit. It should be reviewed before initiating any action on the unit.

Safety Precautions and Warnings

For equipment covered by this instruction manual, it is important to observe safety precautions to protect personnel from possible injury. Among the many considerations, personnel should be instructed to:

- avoid contact with energized circuits or rotating parts.
- avoid by-passing or rendering inoperative any safeguards or protection devices.
- avoid extended exposure in close proximity to machinery with high noise levels.
- use proper care and procedures in handling, lifting, installing, operating, and maintaining the equipment.
- before operating, replace any covers that have been removed for inspection.

Safe maintenance practices with qualified personnel are imperative. Before starting maintenance procedures, be positive that:

- equipment connected to the shaft will not cause mechanical rotation.
- main machine windings and all accessory devices associated with the work the area are de-energized and will remain disconnected from electrical power sources for the duration of the maintenance period.

If high potential insulation testing is required, procedure and precautions outlined in NEMA Standards MG-1 and MG-2 should be followed.

Failure to properly ground the frame of this machine can cause serious injury to personnel. Grounding should be in accordance with the National Electrical Code and consistent with sound local practice.

WARNING: HIGH VOLTAGE AND ROTATING PARTS CAN CAUSE SERIOUS INJURY. THE USE OF ELECTRICAL MACHINERY, LIKE ALL OTHER UTILIZATION OF CONCENTRATED POWER AND ROTATING PARTS, CAN BE HAZARDOUS. INSTALLATION, OPERATION, AND MAINTENANCE OF ELECTRICAL MACHINERY SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. FAMILIARIZATION WITH NEMA PUBLICATION MG-2, SAFETY STANDARD FOR CONSTRUCTION AND GUIDE FOR SELECTION, INSTALLATION AND USE OF ELECTRIC MOTORS AND GENERATORS, THE NATIONAL ELECTRICAL CODE, AND SOUND LOCAL PRACTICES IS RECOMMENDED.



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Reference Publications and Standards

ANSI/NEMA MG-2	Safety Standards for construction and Guide for Selection, installation and Use of Electric Motors and Generators.
ANSI C50.10	General Requirements for Synchronous Machines.
IEEE 1	General Principles for Temperature Limits in Rating of Electrical Equipment.
IEEE 85	Test Procedure for Air-borne Noise Measurements on Rotating Machinery.
IEEE 112	Test Procedure for Polyphase Induction Motors and Generators.
IEEE 115	Test Procedures for Synchronous Machines.

Standards can be obtained by writing to the following:

National Electrical Manufacturers Association
2101 Street, N.W.
Washington, DC 20037

American National Standards Institute
1430 Broadway
New York, NY 10018
Attention: Sales Department

The Institute of Electrical and Electronics Engineers, Inc.
445 Hoes Lane
Piscataway, NJ 08854
Attention: Publication Sales

Warranty considerations

The warranty coverage applicable to the equipment specified under "Identification of Unit" may be found in the corresponding sales contract.

The equipment must be operated in accordance with nameplate specifications, applicable standards and codes, and in accordance with this instruction manual for the warranty to remain in effect during the warranty period.

If a question or circumstance not covered by the instruction manual occurs, or should a problem occur, contact the nearest General Electric Technical Service representative.



Receiving, Handling, and Storage

Receiving

Whenever traffic clearance allows, the machine is shipped from the factory as an assembled unit ready for installation. Sole plates (or slide rails), if ordered, are bolted to machine feet. Occasionally some accessory items are shipped separately. All packing lists should be carefully checked to assure all items have been received. Each unit should be carefully inspected upon arrival. Any damage should be photographed, documented and then reported immediately to the carrier and to the nearest General Electric office.

Handling

The machine should be lifted only by means of the four lifting lugs which have been provided on the frame. If couplings or other attachments unbalance the load, an additional sling should be used to prevent tipping or rotation. Spreaders should be used with the slings attached to the lifting lugs to prevent damage to the top cover while lifting the machine.

WARNING: LIFTING LUGS ON THE FRAME ARE DESIGNED FOR LIFTING THE MACHINE ONLY. DO NOT USE FOR LIFTING COUPLED EQUIPMENT SUCH AS PUMPS, COMPRESSORS, GEARS OR OTHER EQUIPMENT. DO NOT USE MACHINE LIFTING LUGS FOR LIFTING EQUIPMENT ON A COMMON BASE. LIFT THE ASSEMBLY WITH A SLING AROUND THE BASE OR BY OTHER LIFTING MEANS PROVIDED ON THE BASE. FOR UNBALANCED LOADS (SUCH AS COUPLINGS OR OTHER ATTACHMENTS), ADDITIONAL SLINGS OR OTHER EFFECTIVE MEANS SHOULD BE USED TO PREVENT TIPPING.

DO NOT ATTEMPT TO LIFT THE ENTIRE MACHINE USING EYEBOLTS IN THE HOLES IN THE TOP COVER.

FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN DAMAGE TO THE EQUIPMENT, INJURY TO PERSONNEL, OR BOTH.

WARNING: THE MOTOR SHOULD NEVER BE LIFTED BY THE CAST LUGS IF THE AMBIENT TEMPERATURE IS LOWER THAN -18°C .

Always lift or move the unit with all assembly bolts, screws and studs in place, secured with the shaft clamp in position when supplied (supplied on machines with sleeve bearings only). Machines with oil-lubricated bearings are shipped without oil.

Storage

If, at the time of purchase, it was specified that the motor be packaged for long-term storage, the package should be left intact during the period of storage.

If the machine is not put in service immediately, adequate precautions must be taken to protect it while in storage. The following instructions are provided as a guide for storage. Full compliance with these instructions is required to maintain the warranty.

During manufacturing, testing, and preparation for shipment basic precautions are taken by the factory to guard against corrosion of the bearing journals and shaft extension. The shaft extension is treated with a heavy coating of rust inhibitor. All machines with oil-lubricated bearings are operated and tested at the factory with a rust-inhibiting oil in the lubrication system. Although the machines are shipped without oil, a rust-inhibiting film remains on the critical bearing surfaces during transit and for up to three months of normal storage. Nevertheless, when the machine is received, the bearing oil reservoirs should be filled to the proper oil level with a good grade of rust-inhibiting oil. (See section entitled Lube Oil Recommendation on page 24).

Grease-lubricated machines have the bearings packed at the factory and no further preventive maintenance is required on the bearings during storage.

For clean, dry, indoor storage locations, rotate the shaft of all two-bearing machines at three-month intervals so as to thoroughly coat journals with a fresh oil film.

Machines equipped with brushes should have the brushes lifted in the brush holders so they are not in



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contact with the collectors.

Outdoor storage is not recommended. Aside from all the possibilities of external weather conditions, erection conditions, environmental conditions etc., which can affect an idle machine, variations in temperature and humidity can cause condensation throughout the unit, producing rust and corrosion on metal parts as well as deterioration of the electrical insulation. If outdoor storage cannot be avoided, contact the factory through the nearest General Electric office giving full information on the circumstances and explaining steps to be taken to protect the machine. Failure to protect the machine may invalidate the warranty.

The storage facility must provide protection from contact with rain, hail, snow, blowing sand or dirt, accumulations of ground water, corrosive fumes and infestation by vermin or insects. Continuous or severe intermittent floor vibration should be avoided. Electrical service for space heater and illumination should be provided. There should be fire detection and a fire fighting plan. The machines must not be stored where they are liable to accidental damage or exposed to weld spatter, exhaust fumes or dirt. If necessary, erect suitable guards or separating walls to provide adequate protection. Avoid storage in a atmosphere containing corrosive gases, particularly chlorine, sulphur dioxide and nitrous oxides.

The machine in storage must be protected from moisture condensation on the windings and other critical parts. To prevent condensation, energize the machine's space heaters to keep the machine temperature above the room temperature by at least 3C. During the periods of extreme cold or rapid temperature decrease, the space heaters may not be adequate to maintain this temperature differential. Therefore, safe supplementary space heating may be required.

The machine in storage should be inspected periodically and inspection records maintained. The following tests and inspections are designed to reveal deterioration or failure of protective systems (shelter, coatings and temperature control), of the machine without delay. Inspect the storage area for compliance to the above criteria and inspect the stored machine for the following:

1. Physical damage.
2. Cleanliness.
3. Signs of condensation.
4. Integrity of protective coatings.
5. Condition of paint - discoloration.
6. Signs of vermin or insect activity.
7. Satisfactory space heater operation. It is recommended that an alarm system be in place to operate on interruption of power to the space heaters. Alarms should be responded to immediately.
8. Record the ambient temperature and relative humidity adjacent to the machine, the winding temperature (utilizing the RTD's), the insulation resistance and the polarization index. Refer to the section entitled Insulation Resistance on page 15 for information on determining the insulation resistance and polarization index.

Experience has shown that adequate precautions during storage will avoid costly deterioration of parts and lengthy maintenance procedures at installation and start-up



Installation

Location

The location of the connected equipment determines the general location of the machine. Motors and generators, however require large volumes of clean air for cooling and these machines have environment requirements which must be considered. They are:

1. A clean, well-ventilated location.
2. The machine enclosure should be consistent with the location, environment and ambient conditions.
3. If the location is not relatively free of dust and particles, the machine should have air filters or, in more severe cases, the machine should be enclosed.
4. Other equipment, walls, buildings, etc. should not restrict machine ventilation or allow ventilating air to recirculate.
5. Adequate space around the machine for normal maintenance
6. Adequate overhead space for removal of the top cover.
7. An environment free of corrosive gases and liquids (both acids and bases).

WARNING: *INSTALLATION OF THE MACHINE WHERE HAZARDOUS FLAMMABLE OR COMBUSTIBLE VAPORS AND/OR DUSTS PRESENT A POSSIBILITY OF EXPLOSION OR FIRE SHOULD BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE, ARTICLES 500-503, AND CONSISTENT WITH SOUND LOCAL PRACTICES. EXTREME CARE IS REQUIRED FOR MACHINES SUPPLIED WITH A DUST-IGNITION-PROOF COLLECTOR-RING HOUSING, ACCESSORY DEVICE, OR CONDUIT BOX SINCE ANY NICKS OR BURRS DURING DISASSEMBLY AND REASSEMBLY MAY DESTROY THE EXPLOSION-PROOF OR DUST-IGNITION-PROOF FEATURES. IF IGNITABLE DUST OR LINT IS PRESENT, THE SURFACE TEMPERATURE OF SPACE*

HEATERS, IF SUPPLIED, SHOULD NOT EXCEED 80 PERCENT OF THE IGNITION TEMPERATURE. REFER TO FACTORY FOR INFORMATION ON SURFACE TEMPERATURE. DUST AND/OR LINT SHOULD NOT BE ALLOWED TO BUILD UP AROUND THE SURFACE OF THE SPACE HEATERS.

FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN DAMAGE TO EQUIPMENT, INJURY TO PERSONNEL, OR BOTH.

Foundation

The mounting dimensions of the machine and the minimum foundation stiffness required to adequately support the machine are supplied on the outline. A certified outline drawing is supplied by the factory soon after receipt of the order, and the above information is essential for planning and constructing the foundation.

A properly constructed foundation is essential to insure the correct horizontal and vertical alignment of the driving and the driven equipment, to carry the weight, to resist the reaction torque, to absorb any cyclical or dynamical forces generated by the driven equipment and to prevent vibration amplification. Since a suitable foundation is a basic requirement for satisfactory operation, it is recommended that a person technically competent in foundation design be consulted.

Although adequacy of the foundation is the responsibility of the owner, the following suggestions are provided as a guide. A concrete foundation is preferable to any other type of foundation. It should be reinforced as required and should extend downward to have a firm footing. The top of the foundation should be approximately one inch short of the bottom allow for grout.

If the machine must be located on structural steel or on a building floor, the weight and minimum stiffness requirements stated on the outline drawing must be met. Also, the dynamics of the entire structural system from the machine to the structure footing must be considered.

Mounting

The machine has two full-length mounting feet, one on each side, consisting of machined steel bars



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integral with the frame. When foundation caps or sole plates are used, their function is to act as spacers between the actual foundation and the unit. They are to be a part of the foundation. Accordingly, if they are used, it is important that they be firmly attached to the foundation to withstand the applied torques and normal vibration forces. It is also imperative that they be supported evenly on the foundation and be located in a level plane.

Place the machine on the foundation (sole plates, if used) with its shaft approximately in line with and at proper distance from the shaft of the machine to be coupled. Use shims under the feet to adjust for the correct shaft height. Refer to the outline drawing for information covering the shim location and required shim and depth. When this preliminary alignment is complete, install the holdown bolts but do not tight them until final alignment has been made.



Alignment and Coupling

General

Machines with antifriction bearings are designed to have the outer race of the opposite drive end axially held by the end shield and to allow the outer race of the other bearing to move axially to allow for the thermal expansion and contraction of the rotor relative to the stator. Because one bearing is held, the machine does not have any end play designed into the rotor shaft. The shaft cannot carry any external thrust unless specified at the design state and designed into the bearing system. A coupling which allows independent axial movement of the driven equipment shaft relative to the motor shaft, such as a splined type (or other axially independent type) coupling, is recommended for all units with antifriction bearings.

Parallel and Angular Alignment for Flexible Couplings

Flexible couplings should not be used to compensate for inadequate initial alignment of the two coupling halves. Refer to the instructions supplied by the flexible coupling manufacturer. Coupling parts, such as pins, links, buffers, and spacers should be removed (depending on the type of coupling) and the sleeves should be axially moved over the shaft to expose the active hub portions of the coupling halves. The spacing between coupling hubs should be that recommended by the coupling manufacturer.

The parallel and angular alignment of the two coupling halves may be accomplished using the procedures outlined below, provided the procedures do not conflict with requirements supplied by the coupling manufacturer. If a machined, vertical surface is not accessible on one or both coupling halves, feeler or block gauges may be substituted for the two dial indicators in performing the angular alignment check. The two coupling halves should be aligned to within 0.001-inch parallel and 0.0015-inch angular misalignment. After the flexible coupling halves are aligned, the coupling should be lubricated and assembled in accordance with the coupling manufacturer's instructions.

Parallel Alignment for Flexible Couplings

Position the motor or generator on the foundation with the plane of its feet horizontal as discussed previously under Mounting. Axially position the motor with respect to the machine as discussed in the section entitled "Installation." Attach a dial indicator on one coupling hub with the indicating button on the machined, circumferential surface of the other coupling hub. See Fig. 1.

Set the dial indicator to zero. Mark the location of the indicating button with a visible mark. Rotate each of the two shafts in 90 degree increments, and successively read and record the dial indications when the indicator is at 3:00, 6:00, 9:00 and 12:00 o'clock angular positions. The indicating button must be positioned on the mark for each reading.

Adjust the shaft position such that the difference between the two side readings (3:00 and 9:00 o'clock) and between the top and bottom readings (12:00 and 6:00 o'clock) is less than 0.001-inch. This may require several iterations. Lateral (3:00 and 9:00 o'clock) differences are corrected by lateral movement of the unit. Vertical (12:00 and 6:00 o'clock) differences are corrected by appropriately adding or removing mounting shims. The proper shim location is shown on the outline drawing. Note that the total number of shims in a given

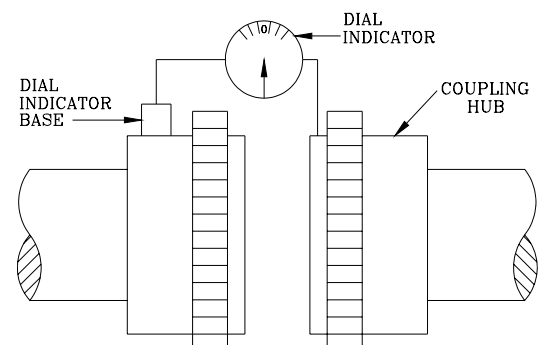


Fig. 1. Arrangement of indicator for parallel alignment



shim pack under any one foot should not exceed five, because too many shims may provide a “soft” mount on that foot. This condition could cause dynamic problems.

Drilled and tapped holes are provided in the motor or generator feet for jacking screws as a convenience in alignment. Note that jacking screws must not be used for permanent support.

Angular Alignment for Flexible Couplings

Axially separate the coupling halves to their maximum end float. Attach a dial indicator on one coupling hub with the indicating button positioned against vertical, machined surface on the other coupling hub. Attach a second dial indicator hub 180 degrees apart. See Fig. 2. Mark the locations of the indicating button with a visible mark.

Set the two dial indicators to zero. Then, with each coupling a full end float, rotate the two coupling halves in 90 degree increments. Read and record each dial indicator at 3:00, 6:00, 9:00 and 12:00 o'clock angular positions of the shaft. Two dial indicator setups, 180 degrees apart, are used to correct for possible, axial shift of one shaft with respect to the other. Use the difference in readings between the two indicators to

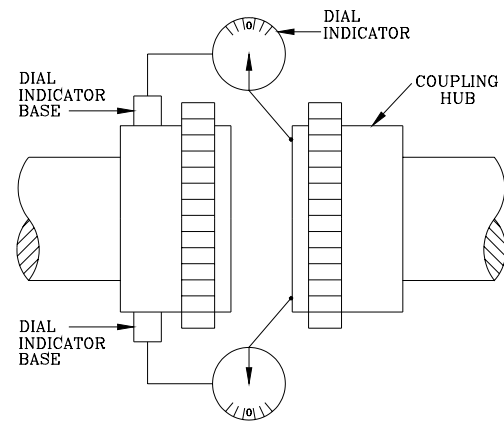


Fig 2 Arrangement of indicators for angular alignment

determine the angular misalignment between the two coupling halves. Add or remove shims under the feet as appropriate to correct for misalignment in the vertical plane. A lateral, angular movement of the unit is required to correct for misalignment in the horizontal plane. Continue the angular alignment procedure until the angular misalignment does not exceed 0.0015-inch. This may require several iterations.



Wiring and Grounding

WARNING: MOTOR AND CONTROL WIRING, OVERLOAD PROTECTION AND GROUNDING SHOULD BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND CONSISTENT WITH SOUND LOCAL PRACTICES.

FAILURE TO OBSERVE THESE CAUTIONS MAY RESULT IN DAMAGE TO THE EQUIPMENT, INJURY TO PERSONNEL, OR BOTH.

Power connections

The stator winding is terminated in the power terminal box. Connections to the stator wiring should be made in accordance with the stator connection diagram for the machine or with the connection diagram shown on the main nameplate. The stator is wound to produce clockwise rotation, facing opposite drive and when the phase sequence of the applied voltage is T1, T2, and T3 (i.e. when the phases of the supply voltage connected to the power leads reach positive maximum in that time order.). The direction of rotation can be changed by reversing any two of the connections. However, the machine should always rotate clockwise viewed from the opposite drive and unless it was specifically sold for opposite or dual rotation, since the fans, or other devices, may be directional. Machines Furnished with a single direction of rotation have an arrow on the drive end. If the owner desires to operate the motor in opposite standard rotation, first check the factory for suitability through the nearest General Electric office.

Before any electrical connections are made between the machine and the owner's power or accessory cable or wire, it is desirable to check the insulation resistance of the winding to determine if the winding is sufficiently dry for safe operation. See the section entitled Insulation Resistance on page 15. This check may prevent having to break the electrical connections later.

The stator winding leads are terminated with connectors for bolting to corresponding connectors on the cable from the owner's power supply. The bolted connections should be adequately insulated, phase-to-phase and to ground.

The rotor winding of wound-rotor induction motors is terminated on the collector rings. External

connections to the brush rigging should be made in accordance with the rotor connection diagram for the machine or with the connection diagram supplied on the inside of the collector cover. The rotor-winding amperes at rated horsepower with the slip rings shorted (i.e., no external impedance in the rotor circuit), is shown on the nameplate as Secondary Amperes. The ring-to-ring voltage of the rotor winding at locked rotor, is shown on the motor nameplate as Secondary Volts. Note that the machine should not be plugged for braking or other reasons, by control external to the motor unless the machine has been ordered as suitable for such duty. Plugging will increase the ring-to-ring voltage to twice that on the nameplate. Therefore, the rotor insulation must be designed for this higher level. Questions concerning this should be referred to the nearest General Electric office. Care should be taken to assure that insulation containing silicon is not used for the secondary conductors. A small amount of silicon in the area will greatly accelerate brush wear.

Accessory connections

Depending upon the specific equipment furnished, (see outline nameplate) the machine may include any of the following accessories:

- Stator winding resistance temperature detectors, 2 per phase
- Bearing resistance temperature detectors.
- Copper-constantan bearing thermocouples
- Bearing temperature readout capability
- Bearing temperature alarm and shutdown contact capability
- Space heaters, with either 220C or 120C maximum surface temperature
- Stator winding thermostat
- Heaters for the bearing oil reservoir. Switch for excess pressure drop across air filters



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- Proximity type vibration pickup for shaft vibration with or without proximeters (sleeve bearings only)
- Velocity vibration pickup for end shield vibration (antifriction bearings only) with alarm light and contacts

When supplied, all of the above accessories will have electrical terminations in the accessory terminal box, except for the seismic vibration pickup which has its electrical termination for the contacts at the device located on the endshield.

For all of the accessories that have electrical terminations in the accessory terminal box, a Schematic Diagram and an Accessory Lead Connection Diagram will be provided on the inside of the accessory terminal box cover. This gasketed cover should be kept closed to prevent the entrance of moisture, dust and conducting particles. The gasketed cover should be kept closed to prevent the entrance of moisture, dust, and conducting particules. The gasketed cover should also be closed for electrical safety, except when required to perform connection work inside the box.

Grounding

Two stainless-steel, grounding pads are supplied on the frame. One at each end near the foot. A pair of drilled and tapped holes, with NEMA spacing and size 1/2-13, are provided in each grounding pad. One additional stainless-steel, grounding pads are supplied inside the power terminal box in the region of the throat connection between the power terminal box and the frame. These pads are used for connection of ground leads, cable shield, etc., as may be required. These grounding pads are also drilled and tapped as described above. The machine should be grounded in accordance with the National Electric and consistent with sound local practices.



Operation

Operating Voltage and Frequency

Variations of applied stator voltage and frequency from the rated nameplate values will result variation of machine performance. Torque, efficiency, power factor, heating and stator current will change. Also, noise and vibration levels may change. The torque varies as the square of the voltage; therefore, a 10 percent decrease in voltage will decrease the torque by 19 percent. For best operating performance, nameplate voltage and frequency should be maintained.

The machine will operate successfully, under running conditions and at rated load, with variations in voltage or frequency up to the limits indicated below:

1. Plus or minus 10 percent of rated voltage, at rated frequency.
2. Plus or minus 5 percent of rated frequency, at rated voltage.
3. A combination of variation in voltage and frequency of 10 percent (sum of the absolute quantities) of the rated values, provided that the variation in frequency does not exceed plus or minus 5 percent of its rated value.

Performance of the machine within these voltage and frequency variations will not be in accordance with the values established for operation at rated nameplate voltage and frequency.

Line-to-line Voltage Balance

Polyphase machines are sensitive to unbalance in the applied line voltages. If unbalances exist in the applied line voltage, unbalance in phase currents will result. The resulting unbalance in currents will, in general, be significant. For example, the locked-rotor current will be unbalanced by the same percentage as the voltage, but at operating speed the percentage unbalance of the current will be 6 to 10 times the percent unbalance of the voltage. Percent Voltage Unbalance is defined as follows:

$$\text{Percent Voltage Unbalance} = \frac{\text{Maximum Voltage Derivation} - \text{Average Voltage}}{\text{Average Voltage}} \times 100$$

$$\text{Voltage Unbalance} = \frac{\text{Maximum Voltage Derivation} - \text{Average Voltage}}{\text{Average Voltage}} \times 100$$

Where Average Voltage is arithmetic average of the three line voltages and Maximum Voltage Derivation is the greatest line voltage deviation from the average.

Unbalanced line voltages result the production of negative sequence currents in the machine that produce fields which rotate in a direction counter to the normal field. This results in an increase in current, losses and heating with reduction in torque, efficiency and power factor. Accordingly, line voltages should be as closely balanced as can be determined on a voltmeter.

If line voltage unbalance exists, the machine may be damaged and should be derated in accordance with Figure 20-2 of NEMA Standard MG-20.55, in order to reduce the possibility of such damage. Derating factors, for several values of line voltage unbalance, are given below.

Percent Voltage Unbalance	1	2	3	4	5
Operating Factor	0.99	0.95	0.89	0.82	0.75

In addition, the selection and setting of the machine overload-protective device must consider the derating factor and the increase in current, resulting from line voltage unbalance. This is a difficult procedure which must be done by a person familiar with setting protective devices to adequately protect the machine. It is recommend that the nearest General Electric office be contacted if assistance is required.



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Insulation resistance

WARNING: BEFORE MEASURING INSULATION RESISTANCE, THE MACHINE MUST BE AT STANDSTILL AND ALL WINDINGS BEING TESTED MUST BE CONNECTED TO THE FRAME AND TO GROUND FOR A TIME TO REMOVE ALL RESIDUAL ELECTROSTATIC CHARGE. GROUND SURGE CAPACITORS, IF FURNISHED, BEFORE DISCONNECTING AND ISOLATE FROM LEADS BEFORE MEGGERING. FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN INJURY TO PERSONNEL.

Insulation resistance is determined by applying a dc voltage, typically 500 or 1000 Volts, across insulation, measuring the current flow after the voltage has been applied for a specific length of time and then determining the ratio of voltage to current. Because the current flow is low, the value of insulation resistance will be great in terms of ohms. Accordingly, megohms are used as a practical unit.

Factors affecting insulation resistance are as follows:

1. Moisture
2. Surface cleanliness of the insulation
3. Temperature
4. Length of time of applying the dc test voltage
5. Magnitude of the applied dc test voltage

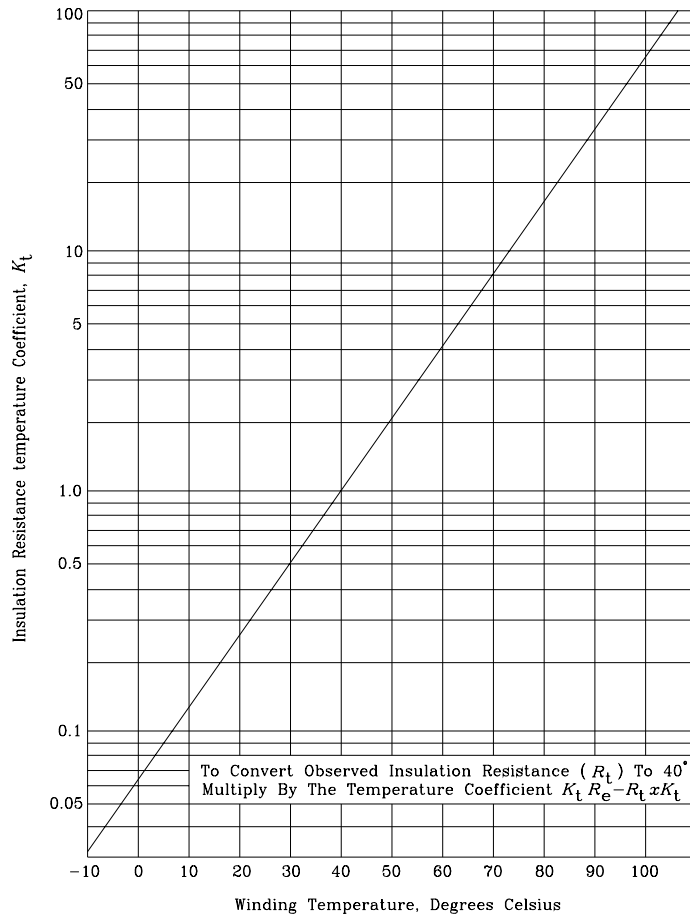


Fig. 1. Temperature correction factor curve



The magnitude of the applied dc test voltage only slightly affects the value of the insulation resistance and the use of a 500 Volt or 1000 Volt megger for stator windings (and a 500 Volt megger for rotor windings) is suitable for machines covered by this Instruction Manual. The environmental conditions of moisture and surface cleanliness, together with the ambient temperature, largely determine the value of insulation resistance. The insulation must be clean and dry and the measured value must be corrected to 40C. This value is then compared to a minimum acceptance criteria. Moisture and dirt will decrease the insulation resistance of a winding and these conditions must be corrected in order to increase it.

The insulation resistance of a winding measured by a 500 Volt or a 1000 Volt megger, with the test applied for 1 minute, should not be less than.

$$R = KV + 1$$

where : R = Insulation Resistance in megahoms, corrected to 40C base

KV = rated voltage of the winding in kilovolts

To convert the actual insulation resistance reading of the megger, R_t , taken at an ambient winding temperature in degree Celsius, to R, make the following conversion.

$$R = K_t R_t$$

The temperature correction factor, K_t , can be determined for any specific winding or a reasonable approximation can be used. Both methods will be described.

To determine the temperature correction factor for a specific winding, make several measurements (at least five) at several different temperatures, all of which are above the dew point. Then plot the results, with measured insulation resistance on a log scale and winding temperature on a linear scale. The results should approximate a straight line, from which the value of insulation resistance at 40C can be determined.

A more general method, with reasonable accuracy, is to use the curve, Fig. 1, to determine K_t as a function of the winding temperature at the time of measurement. It is based on doubling the insulation resistance for each 10C reduction in temperature, for conditions above the dew point. It has been found to be reasonable for new windings.

The polarization index is frequently helpful in evaluating the cleanliness and freedom from moisture of a winding. The polarization index is a measure of the change in insulation resistance with the time duration for which the test is applied. It is conducted by applying the megger for 10 minutes and determining the insulation resistance at 1 minute and 10 minutes. The polarization index is the ratio of the 10-minute insulation resistance reading to the 1-minute insulation resistance reading, both readings have been corrected to a 10C temperature base. Clean, dry windings should exhibit a polarization index of 2 or more.

Each winding of each unit will have its own insulation resistance history which is unique to it. It is recommended that the insulation resistance be measured and recorded at least every six months, and more often if feasible, and that the polarization index be measured and recorded at least once a year. This accumulated information will provide a data base which will be helpful in managing preventative maintenance.

The user is referred to **IEEE Standard 43, IEEE Recommended Practices for Testing Insulation Resistance of Rotating Machinery**, for a more complete discussion of the complete subject of Insulation Resistance.

Pre-start inspection

Before the machine is started for the first time, a pre-start inspection should be made. The following are some of the items frequently overlooked.

1. Measure the insulation resistance of the windings. For machines located in or near salt air or other corrosive environments, a polarization index should also be taken.

2. Verify that the voltage and frequency corresponds to the nameplate.

3. Verify that the phase sequence of the applied voltage is correct for the desired direction of rotation. Verify that the desired direction of rotation agrees with the nameplate.

4. For totally-enclosed, water-cooled machines, verify that the cooling-water temperature does not exceed the value on the nameplate.

5. The lubricant used should agree with the nameplate and this instruction book.



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6. Verify that the bearing housings on machines with self-lubricated bearings have been filled to the proper level.
7. The oil flow to each bearing housing on flood or forced lubricated machines should be adjusted so the oil level in each bearing housing is maintained.
8. All accessory devices should be connected and operational.
9. All protective and control equipment should be installed and operational.
10. The machine hold down bolts should be tightened and the foot doweling completed.
11. The coupling alignment should be in accordance with previous instructions.
12. The interior of the motor frame, top cover, terminal boxes and fan casings (for Totally-enclosed Air-to-Air Cooled Machines) should be free of tool, waste and other foreign materials.
13. The air gap of the machine should be free of foreign material.
14. Guards should be in position to protect personnel from moving parts such as coupling, etc.
15. Walls, baffles, other equipment, coupling guards, etc., should not obstruct the necessary movement of air required to adequately ventilate the machine.
16. Any load condition of the drives equipment which contributes its load torque, at low speed, should be set compatible with the starting torque specified for the motor (i.e., if it is necessary to start the driven equipment in an unloaded condition, in order to correspond to the starting torque specified for the motor, then verify that the driven equipment is appropriately unloaded).
17. All covers should be in place and properly secured. The cover on the power terminal box and the accessory terminal box should be properly secured.

Initial test run

The starting current of a motor is several times the rated current. This starting current causes the windings to heat at a much higher rate than normal and causes the windings to heat at a much higher rate than normal and causes magnetic forces on the end turns to be many times normal. The section of this publication entitled "Frequency of Starts and Load Inertia" should be read, since the user may also be considering checkout and adjustment of some of the control and protection equipment at this time. **The limitations on starting must be observed at all times to prevent damage to the machine.**

After verifying that the machine and the rest of the system is ready for operation, a controlled initial start should be made and a test run performed to verify that the unit is properly installed and is operational. For this run, it is recommended that several people be appropriately located in order to observe any problems. The following are the minimum steps to be taken on the initial test run. **Note that the machine must be shut down immediately if any problem occurs.**

1. If so equipped (See Outline Drawing), start auxiliary lubrication system and verify oil flows. Also check interlocking to make sure machine is prevented from starting unless the lubrication system is functioning and the machine will be shut down on the loss of lubrication.

2. Start the machine. (For a generator, bring up to speed with prime mover.)

3. Listen for any unusual noise during acceleration and running.

Machines with oil-lubricated bearings only.

4. Observe oil flow and/or oil ring action for each bearing.

5. Verify that the rotor runs at the magnetic center.

6. Observe and record each bearing temperature and the rate at which it is increasing for each bearing. Initially temperatures will rise rapidly and then should level off.

NOTE: Bearing temperatures should not exceed 95C for a sleeve bearing.



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7. Observe the temperature of windings (Resistance Temperature Detectors (RTD's) are provided on all machines). In no case should the windings exceed the sum of the rated rise on the nameplate plus the maximum design ambient.

8. Determine that the amplitude of vibration is not excessive (see the section entitled "Vibration" in this publication). Misalignment should be the first item to check if there is unacceptable vibration.

9. Verify that all accessories supplied with the machine are functioning normally and are performing consistent with the load on the machine and system.

10. Verify that all control and protective devices are functioning normally and are performing consistent with the load on the machine and system.

11. The machine should be operated and fully observed for not less than two hours and should be free of any problems before it is released for normal duty.

12. As stated earlier, **the machine must be shut down immediately if any problem occurs.** Should any problem occur, it source should be determined and corrected, and then the initial test run should be repeated.

Vibration

General Electric motors and generators, covered by this Instruction Manual, are balanced at the factory, in accordance with NEMA Standard MG 1-20.52 and MG 1-20.53, to be within the following limits (unless otherwise specified in the sales contract).

Speed (RPM)	Maximum Peak-to-Peak Amplitude (Inches) on Bearing Housing	Maximum Velocity Inches/sec, zero-peak
3600	0.0005	.094
1800	0.0016	.15
1200	0.0024	.15
900 and below	0.0025	.12

Vibration amplitude measurements are made on the bearing housing and are taken in the vertical, horizontal and axial directions.

If the owner's half coupling was sent to the factory to be mounted onto the machine shaft extension, the rotor is balanced with the half coupling installed. Otherwise, the rotor is balanced with a half key (i.e., the keyway is filled with a steel bar equal in length to the key length shown on the outline and flush with the top of the keyway). The shaft key furnished with the machines of 1500 rpm and higher is a full-length, full key with a three-inch long half key extension on one end. To maintain factory balance, cut the key to length as follows. See Fig. 2.

1. Measure the coupling hub length (H) and cut the full key to length H by cutting the excess from the full key end.

2. Cut the half key end so that the overall key length equals the key length shown on the outline drawing.

3. Full key must fill coupling/keyway. Half key must fill shaft/keyway.

WARNING: TO AVOID EXCESSIVE STRESSES IN THE KEY, THE MAXIMUM LENGTH OF THE HALF KEY SHOULD NOT EXCEED 3.0 INCHES.

FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN DAMAGE TO THE EQUIPMENT, INJURY TO PERSONNEL, OR BOTH.

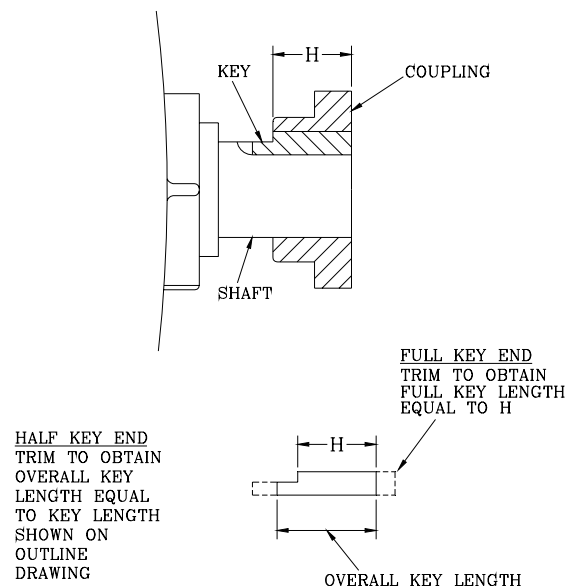


Fig. 2. Key alignment



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The foundation should be constructed in accordance with the requirements in the section entitled "Foundation" on page 7. If the unit has been properly aligned, the amplitude of the vibration of the installed motor should be as stated in the above table. If vibration amplitudes are significantly greater than these values, the instruction referenced above should be reviewed. Misalignment is the most probable cause of excessive vibration. Other possible causes are "soft" shim packs under one or more feet, loose foot bolts or an inadequate foundation. Contributions to vibration from the driven equipment should not be overlooked.

Do not operate the machine with excessive vibration. If the cause cannot be found and corrected, contact the nearest General Electric office.

Frequency of starts and load inertia

When a motor starts, it must accelerate the rotational inertia of its own rotor and that of the driven equipment from standstill to full speed. Accordingly, it must transfer and store a larger amount of energy into the rotating parts in a short time. An equal amount of energy is dissipated in the rotor windings in the same short period of time.

During the starting period, current in the windings are several times the rated value. This causes heating of the windings at a significantly greater rate than occurs at full-speed operation. Also, because magnetic forces are proportional to the square of the current, forces on the winding end turns are many times greater than the normal condition.

For the above reasons, the frequency of starts and the magnitude of rotational inertia of the connected load, must be limited for squirrel-cage induction and synchronous motors. The motors covered by this Instruction Book (unless otherwise stated in the, sales contract), are suitable for accelerating the rotational inertia of the driven equipment in accordance with Standard MG 1-21.42. The motors are suitable for the following frequency of starts.

1. With the motor initially at ambient temperature, two starts in succession, coasting to rest between starts.

2. With the motor initially at a temperature not exceeding its rated temperature, one start.

It is recommended that the total number of starts made in the life of the machine be controlled, with an effort to minimizing them, since the life of the machine is affected by the total number of starts.

Wound rotor induction motors have the capability to accelerate high inertia loads with limited stator current through the use of external resistance inserted in the rotor circuit. The motor characteristic is changed by adjusting the resistance. Most of the energy dissipated in the rotor circuit during the acceleration is dissipated in the resistor external to the motor.

Oil level

Sleeve bearing machines are furnished with an oil level gauge in each bearing housing. Refer to the **Parts Identification Instruction** for this model to locate the oil level gauge. The gauges are either bulls eye type, with a circular glass window, or column type.

With the bulls eye type gauge, the centerline of the gauge indicates maximum oil level and the bottom of the gauge indicates minimum oil level



Maintenance - General

General

The machine covered by this Instruction Manual has been designed with reliability and utility as goals. It is constructed of high quality materials. If it is installed, operated and maintained in accordance with the instructions in this manual, it can be expected to give many years of trouble-free service.

Importance of a Maintenance Program

The purchase and installation of a large electric machine represents a significant capital investment which should be protected by a thorough maintenance program. This program should include the machine as well as the protective and control equipment.

A maintenance program is based on four concepts: (1) maintaining cleanliness, (2) periodic inspection, (3) keeping adequate records, and (4) taking corrective action on a timely basis. Periodic inspection provides the system and discipline for maintaining cleanliness as well as assuring that parts are functioning properly. The frequency of periodic inspections can vary from several per day for such items as winding temperature readout (if printout and/or automatic shutdown control is not provided) to once per month for a general inspection on the interior of the unit. The keeping of accurate records is necessary to maintain a history of the unit and to provide a procedure for checkoff and verification of the various items. If a problem is encountered, whether it be a minor and a frequently encountered problem, such as a cleaning, or a significant problem such as increased vibration levels, it should be corrected as quickly as possible after determining its need. If the unit should require significant repairs in the course of its life, it is recommended that they be done in a General Electric Service Shop.

WARNING: BEFORE INITIATING MAINTENANCE PROCEDURES, DISCONNECT ALL POWER SOURCES TO MACHINES AND ACCESSORIES. FOR MACHINES EQUIPPED WITH SURGE CAPACITORS, DO NOT HANDLE CAPACITOR UNTIL DISCHARGED BY A CONDUCTOR SIMULTANEOUSLY TOUCHING ALL TERMINAL AND LEADS, INCLUDING GROUND. THIS DISCHARGE CONDUCTOR SHOULD BE INSULATED FOR HANDLING.

REPLACE ALL GROUNDING CONNECTIONS PRIOR TO OPERATING.

FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN INJURY TO PERSONNEL.

Importance of Cleanliness

The location of the connected equipment will necessarily determine the location of the machine. Accordingly, considerable variation between different applications and between different sites will be encountered. To a significant degree, the choice of the enclosure will compensate for variations in environment, particularly for moisture and weather conditions. However, the preservation of cleanliness of the ventilating inlet and outlet openings, air ducts, winding, space heaters, accessory connection blocks, etc., is essential.

Ventilating air will bring environmental contamination to the active parts of an ambient ventilated machine. Properly maintained air filters will significantly reduce the amount of particles in the air, but cannot totally eliminate them. Totally-enclosed type enclosures will greatly, but not completely, reduce the interchange of external environmental air and internal recirculating air.

Dirt particles, entrained in the ventilating air, tend to accumulate in air ducts and on the surface of the windings. This accumulation will have adverse effects such as an increase in operating temperature, decrease in insulation resistance and more rapid deterioration of the insulation. Dirt particles in the lubricating oil or grease supply will cause more rapid bearing wear and even bearing failure. Acid and alkali vapors can, over a period



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of time, cause corrosive deposits to develop which further contribute to deterioration.

Keep metal particles such as copper, iron or steel away from the machine. This is especially important for iron and steel since such particles will adhere magnetically and are extremely difficult to remove. They may be agitated by magnetic fields present during operation causing abrasion and eventual failure of insulation. If for any reason sawing, drilling, machining, etc., of ferrous materials must be done in the general vicinity of the unit, such work should be done as remotely as possible. The unit should not be in operation at that time. All filings, chips, etc., should be completely removed prior to starting the unit. The same precautions should be observed for copper chips or other conducting materials.

In removing dirt and contamination from the machine, a vacuum is much preferred to positive air pressure. Air pressure does not remove, but only relocates, the objectionable material. It frequently drives and embeds foreign material into the sides of insulation as well as into natural crevices inside the machine. A suction hose from an industrial-type vacuum cleaner

should be used for cleaning. The hose wand or nozzle, which comes into direct contact with the machine parts, should be small enough in cross-section as to produce a reasonably high air velocity at the entrance to the wand. This is necessary to accelerate and move the foreign material into the vacuum hose.

Frequency of Inspection

Frequency of inspection will vary with the item being inspected and with the severity of local environmental conditions.

Certain items, such as winding temperature, bearing temperature and vibration amplitude should be monitored on a conditions basis. If local provision has been made for readout or printout of these parameters, and if contacts and relays are provided to shut down the unit in case of above-normal temperatures, then all that is required for inspection is to assure that the protective equipment is operational and set to detect abnormal operation. Conversely, if no provision has been made to

Item	Frequency of Inspection	
	Clean Conditions	Severe Conditions
Stator winding (including bracing and support structures, coil end connections, insulation resistance check)	Yearly	Quarterly
Rotor end ring (or end turns)	Yearly	Yearly
Rotor removal (rotor and stator bore)	Every Five Years	Every Five Years
Stator core (with rotor removed)	Every Five Years	Every Five Years
Brushes and collector rings	Quarterly	Monthly
Bearing inspection	Every Three Years	Yearly
Bearing lubrication	Twice Yearly	Bi-Monthly
Separate lube system (if supplied)	Quarterly	Monthly
Top cover (filters)	Quarterly	Monthly



protect the winding and bearings from over temperatures by means of protective relays, then the maintenance program must discharge the local operator with being aware of the winding and bearing temperatures on a continuous basis. This also applies to vibration monitoring and protective equipment.

Routine inspection and maintenance of the stator winding, rotor winding, core, brushless exciter, brushless and collector rings (for machines supplied with this equipment), bearings and top covers should be done on a scheduled basis. However, the frequency will depend upon the severity of local environmental conditions. Installations located in clean environments will require only occasional routine inspections. Other installations located in severe environments, such as paper mills, cement mills, steel mills, power stations, etc., will require routine inspections more frequently. The accompanying tabulation is suggested as a basis for a maintenance program for these two cases. There will be may installations falling between then, as well as installations with extremely severe conditions. Good judgment and common sense should be exercised when structuring the maintenance program. **Improper maintenance and inspection can result in premature failure.**

Stator Winding Inspection and Maintenance

For special applications, such as belt drives, or on smaller machines, a one piece solid end shield and bearing may be supplied. Generally, direct-drive machines are arranged to permit the removal of the upper half of the end shield from either end for inspection purposes without disturbing the motor line-up.

To gain access to the stator winding, first remove the end shield upper half on each end of the unit. To accomplish this, remove the screws which secure it to the frame and to the bottom half of the end shield. Note that a gasket is located between the mating surfaces for sealing against moisture and dirt. This gasket should be kept free of dirt for use during reassembly. On smaller frame sizes, one or two men can lift the cover. On larger frame sizes a hoist or crane is required.

Removal of the upper half of the end shield exposes the top-half or a large opening in the end of the frame. The air deflector or baffle can be seen inboard of this semi-circular opening. Remove the top-half of the air deflector on each end of the unit. To accomplish this, remove the screws which secure it to the internal ring and disconnect the L-clamps joining the upper and lower air deflectors. If further accessibility is desired, rotate the

ring and lower the deflector. Remove the screws holding the lower deflector to the ring. The lower air deflector can now be removed. Note that reassembly of the air deflector and end shield cover is the reverse of the disassembly steps. This disassembly will provide access to the entire top-half and some portion of the bottom-half of the stator end turns, end turn bracing and ends of stator wedges. For a routine inspection, this provides sufficient view of the winding to indicate its general condition and allows room for cleaning with a flexible vacuum hose. When the rotor is removed on a less frequent schedule, more of the winding is accessible.

For a routine inspection clean the accessible portions of the winding with a vacuum hose equipped with an appropriate non-metallic wand or nozzle. Refer to the "Importance of Cleanliness" section of this publication. (Note that, if this is an emergency inspection instead of a routine one, the first step is to look for the fault, before disturbing the existing status of the winding by cleaning.)

Inspect the stator coil bracing and support structure. Look for evidence of looseness, movement or chafing of the coil ends relative to the support structure. Small "tails" and other similar surface irregularities of the epoxy varnish on, and around, the surface geometry of the coil bracing system is not significant and results from the curing of the vacuum-pressure impregnation of the prewound core. Check for tightness of the bracing gussets to the core plate.

Inspect the stator coils end turns, connections and wedge ends. All dirt or other foreign material accumulations between coil sides should be removed while exercising care not to damage the integrity of the coil insulation. The surface of the coils should be free of localized areas of damaged insulation resulting from impact, such as would occur from being struck by an edge of the rotor during a previous disassembly and reassembly of the rotor assembly.

Because of the large volume of ambient air which passes through ambient ventilated machines, certain airborne, abrasive particles can wear away some of the coil insulation over a period of time. Accordingly for steel mill, coal mine, taconite and certain other applications, considerable attention should be given to observe this condition.

If cracks are evident in the varnish and are associated with evidence of movement and chafing of the bracing system, they should be investigated.

With the end shield cover and top air deflector cover removed, access to the stator slot wedges is somewhat limited. However, it is possible to obtain a reasonable impression of wedge conditions from an inspection of the ends. On a less frequently scheduled



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basis, when the rotor is removed, the entire length of the wedge may be viewed. The wedges should be tightly secured. They should show no evidence of movement or migration. The ends of the wedge should be free of fraying. Again as indicated above for coil insulation, abrasive environmental contaminants can wear away wedges. However, such an affect may not be visible on the wedges except at inspection in which the rotor is removed.

The insulation resistance should be measured and recorded during each inspection of the winding. Refer to the section entitled Insulation Resistance on page 15. If the measured value of insulation resistance in megohms is less than $(KV + 1)$, when corrected to 40C, the machine should not be put back into service until steps have been successfully taken on the winding to restore its insulation resistance to that value, or more. At this point, a polarization index measurement may also be helpful as additional data on the condition of the winding. See the information on page 16 - Polarization Index.

Moisture and dirt are the two primary causes of low insulation resistance of a winding. Accordingly, the first two steps in correcting such a condition are to dry the winding and to remove all possible dirt and contamination. Space heaters should always be turned on when the machine is shut down. If this is not done, the insulation resistance will usually decrease because of condensation on the windings. Space heaters may be used to dry out a winding, but adequate time must be allowed to accomplish it. Also, low voltage may be applied across the winding terminals (ac or dc) to circulate a fraction of must be monitored in order to keep the temperature below rated during the drying out

process. Six to eight hours, depending upon the size of the unit, are required for drying a winding with circulating current. The winding should be thoroughly cleaned, in order to remove dirt and contamination, as an important part of the program to increase the insulation resistance value.

A thorough cleaning and drying program will usually restore the winding insulation resistance to $(KV + 1)$ megohms, or more, corrected to 40C. If it does not, it is probable that some additional factor, beyond moisture and dirt, exists. If the incoming cable was not disconnected from the motor leads in the conduit box, the additional cable could significantly affect the insulation resistance. Surge capacitors which are directly connect to the stator winding could procedure a similar affect. In both cases, the connection with the stator winding should be opened and the insulation resistance test repeated.

If all the above corrective actions fail to restore the insulation resistance value, it is highly probable that expert Assistance will be required. It is recommended that a General Electric Service Shop be contacted for assistance.

There are additional tests which are available for use on stator windings, particularly on older windings, to determine their present condition and serviceability. Among these are high potential dc and ac testing. It is important that such testing be done only by people trained in conducting the tests, to avoid unnecessarily damaging the winding, to correctly interpret the results and to observe all the safety precautions necessary to protect personnel. If it is desired to do such testing at some point in the history of the unit, it is recommended that a General Electric Service Shop be contacted.



Maintenance - Grease Recommendation

General

Bearings must carry the weight of the rotor; normal magnetic forces between the rotor and stator; any lateral belt pull; and still maintain the rotor in accurate location relative to the stator bore. Accordingly, they constitute a very important part of the unit and have been selected to give long life on a unit which has been correctly installed, aligned and maintained.

The antifriction bearings used on this unit are grease lubricated. The grease consists of a lithium base soap impregnated with a suitable lubricating oil. It is placed in close proximity to the bearing and the oil seeps out of the soap structure and lubricates the balls or rollers as they move relative to the inner and outer race. Although the amount of grease required to lubricate antifriction bearings is not great, it is essential that grease always be present, that the grease be of the correct type and that it be clean and free of contamination. The correct grease viscosity, specified in SSU units at 100F, is given on the nameplate. The antifriction bearings used are specified on the nameplate.

Bearings should be lubricated once every six months for normal, applications associated with moderate to average environmental conditions of dirt, moisture and heat. For more severe conditions of any one or more of the above environmental conditions, the lubrication frequency should be increased to every two months.

To lubricate the bearings, first stop the unit and remove voltage from all circuits. Remove the grease plug, located on the outboard side of the end shield, at the bottom of the bearing housing, and make certain that the grease-relief hole is free of hardened grease. The grease fitting is located at the end of the pipe below the horizontal split. (on totally-enclosed, air-to-air cooled machines the grease fittings are located on the side of the external fan casing. The grease relief plug is connected to a spiral rod which assists in purging grease from the bearing cavity). Wipe the grease fitting clean.

Using a hand-operated grease gun, apply the specified grease. Continue to apply grease until old grease cases to purge from the grease-relief hole and it is apparent that new grease is purging. Make certain that the purged grease is captured and removed from the side area. Leave the grease-relief hole plug temporarily off. Start the unit and operate for about 30 minutes. Any excess grease will be expelled from the grease-relief hole. Again, stop the unit and remove voltage from all circuits. Then, replace the grease plug and remove the excess grease which was just purged.

It is important that end shield vibration and bearing noise be monitored.

Some conditions which can cause bearing failures to occur are:

1. Insufficient grease, or too much grease.
2. Incorrect grease specification.
3. Ambient temperature conditions either too hot or too cold for the viscosity of the grease being used.
4. Contaminated grease.
5. Misalignment of unit and driven equipment (in parallel, angular or axial misalignment).
6. Seals too tight.
7. Bearing operated longer than design life (L_{10} 130.000 hours for direct drive) (L_{10} 40.000 hours for belted drive) will have an increased risk of failure.

If one or both bearings exhibit an increase in vibration, noise or temperature, above the normal operating conditions, the unit should be shut down and the cause determined and corrected.



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Cleaning

Since the method of greasing anti-friction bearings tends to purge the housing of used grease, removal of all grease should be required infrequently.

Whenever the motor is disassembled for general cleaning, however, the bearings and housings should be cleaned of old grease by washing with a grease-dissolving solvent.

If so desired, the ball bearing may be cleaned without disassembling the machine. Follow this procedure:

1. Remove the alemite fitting and the relief plug.
2. Free both holes of any hardened grease.

3. Pass flushing liquid through the housing while the machine is operating. Flush until no grease comes out with the liquid. For flushing use hot mineral oil (not more than 100 C or 212 F).

4. Continue the cleaning by alternately injecting small amounts of flushing liquid while the relief plug is in place and drawing off the liquid by removing the drain plug.

5. Regrease the bearing and then insert the relief plug.

Grease Recommendation

In order to assure proper relubrication of the motor, regrease with Shell Alvania R2 or a grease meeting the following specifications:

Worked penetration	265-296
Oil viscosity, SSU at 100F	400-550
Soap type	Sodium or lithium
N-H bomb, minimum hours for 30 psi drop at 210F	750
Bleeding, maximum weight % in 500 hours 212F	10
Rust inhibiting	Yes

Grease for Low Temperature: Esso Beacon 315

Grease for High Temperature: Rycon #2



Maintenance - Drive-End Bearing

1. End Shield Bolt
2. End Shield
3. Inner Bearing Cap
4. End Shield Bearing Cap Screw
5. Antifriction Bearing
6. Snap Ring
7. Shaft
8. Grease Slinger

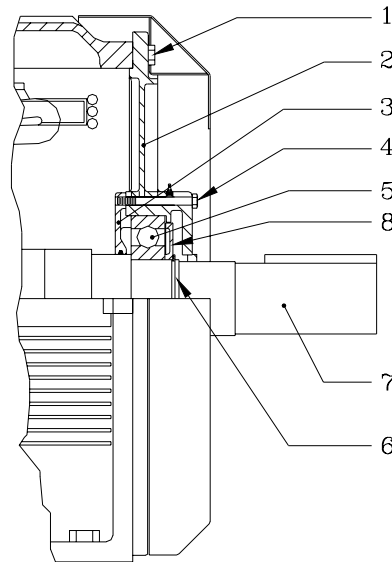


Fig. 1 Drive-End

Bearing Maintenance

One of the most important features in the successful operation of an induction motor is the bearings.

The machines covered by these instructions are supplied with anti-friction bearings.

A conscientiously applied program of preventive maintenance will add years of useful life to the bearings. In order to assure proper operating conditions, see section Grease Recommendation.

Bearing Repair and Replacement

Even though high-quality design and workmanship are incorporated in a bearing, it sometimes becomes necessary to remove it for maintenance. It is for this reason that the following instructions are included.

Care must be taken to avoid scratching or nicking the critical surfaces of the balls or rollers.

Bearing Disassembly

Extreme care is the disassembly of a machine for bearing removal. In addition, the surfaces of the shaft

bearing fit and the bearing itself must be protected during and after disassembly operations.

Bearings may be removed for cleaning or replacement by using the following procedure:

1. Remove bolts (13) which secure the fan end cover (14).
2. Remove bolts (8) which secure the fan (7) and remove the fan.
3. Remove bolts (2) which secure the fan casing (11) and remove it.
4. Remove the bearing (5) by using a puller or by tapping against the bearing cap (3).

Bearing Reassembly

Cleanliness is important when working with bearings. Before reassembling a bearing, all bearing and machined surfaces should be thoroughly cleaned with a suitable solvent. Examine the machined fits of the end shield, cartridge, slinger, and grease cap for burrs. It is important that these surfaces be smooth.

Reassembly of the bearing should be performed in the following manner:



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1. Inspect the bearing housing and related parts for foreign material. Clean if necessary.

2. The machined fits and critical surfaces of the end shield, bearing housing, bearing cap and bearings should be free of all nicks, scratches or burrs. If any polishing is done, care should be taken to avoid a deposit of metal dust in and around the bearing assembly.

3. The internal surface of the bearing housing should be coated with a thin film of the recommended grease. The shaft and the shaft fit of the grease housing and grease cap should also receive a very light coating of the recommended grease. These precautions, although not absolutely essential, will guard against corrosion of the critical surfaces.

4. Heat the bearing in oil to a temperature between 50 C and 125 C (122 F to 257 F) and place it on the shaft. Hold it against the shaft shoulder until the bearing cools.

5. Replace the bearing nut and washer.

6. Procure a stud, 8 inches long, threaded on one end (3/8-16 thread). Screw the stud into one of the holes in the inner bearing cap to facilitate lining up the bearing-cap holes with the holes in the end shield.

7. All subsequent reassembly steps will be a reversal of the disassembly procedure.



Maintenance - Opposite Drive-End Bearing

1. Fan Casing
2. Fan Casing Bolt
3. Air Casing
4. Grease Fitting Pipe
5. End Shield Bolt
6. Air Casing Bolt
7. End Shield
8. End Shield Bearing Cap
9. Inner Bearing Cap
10. Bearing Insulation
11. Antifriction Bearing
12. Shaft
13. Gasket
14. Grease Slinger
15. Snap Ring
16. End Cover
17. End Cover Screw

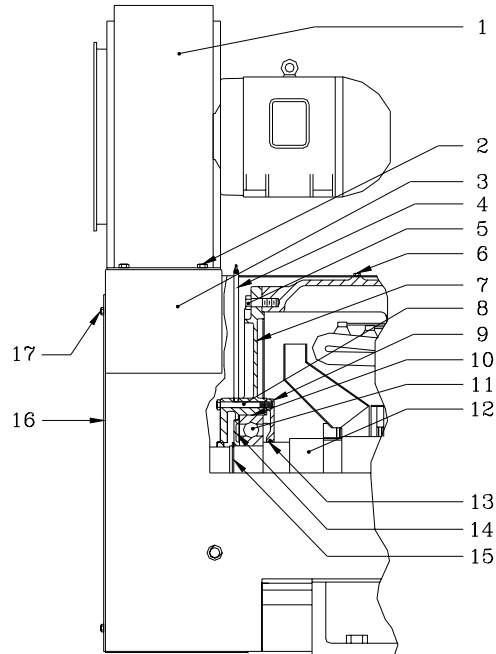


Fig. 1 Opposite Drive-End

Bearing Maintenance

One of the most important features in the successful operation of an induction motor is the bearings.

The machines covered by these instructions are supplied with anti-friction bearings.

A conscientiously applied program of preventive maintenance will add years of useful life to the bearings. In order to assure proper operating conditions, see Grease Recommendation.

Bearing Repair and Replacement

Even though high-quality design and workmanship are incorporated in a bearing, it sometimes becomes necessary to remove it for maintenance. It is for this reason that the following instructions are included.

Care must be taken to avoid scratching or nicking the critical surfaces of the balls or rollers.

Bearing Disassembly

Extreme care is the disassembly of a machine for bearing removal. In addition, the surfaces of the shaft bearing fit and the bearing itself must be protected during and after disassembly operations.

Bearings may be removed for cleaning or replacement by using the following procedure:

1. Remove bolts (17) which secure the end cover (16).
2. Remove grease fitting pipe (4) and all instruments coupled to bearing.
3. Remove the fan casing bolts (2) and remove the fan casing (1).
4. Remove the air casing bolts (6) and remove the air casing (2).
5. Remove the bearing cap screw (9).
6. Remove the end shield bolts (5) and remove the end shield (7).
7. Remove the snap ring (5) and the grease slinger (14).



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8. Remove the bearing (17) by using puller or by tapping against the inner bearing cap (9).

Bearing Reassembly

Cleanliness is important when working with bearings. Before reassembling a bearing, all bearing and machined surfaces should be thoroughly cleaned with a suitable solvent. Examine the machined fits of the end shield, cartridge, slinger, and grease cap for burrs. It is important that these surfaces be smooth.

Reassembly of the bearing should be performed in the following manner:

1. Inspect the bearing housing and related parts for foreign material. Clean if necessary.

2. The machined fits and critical surfaces of the end shield, bearing housing, bearing cap and bearings should be free of all nicks, scratches or burrs. If any polishing is done, care should be taken to avoid a deposit of metal dust in and around the bearing assembly.

3. The internal surface of the bearing housing should be coated with a thin film of the recommended grease. The shaft and the shaft fit of the grease housing and grease cap should also receive a very light coating of the recommended grease. These precautions, although not absolutely essential, will guard against corrosion of the critical surfaces.

4. Heat the bearing in oil to a temperature between 50 C and 125 C (122 F to 257 F) and place it on the shaft. Hold it against the shaft shoulder until the bearing cools.

5. Replace the bearing nut and washer.

6. Procure a stud, 8 inches long, threaded on one end (3/8-16 thread). Screw the stud into one of the holes in the inner bearing cap to facilitate lining up the bearing-cap holes with the holes in the end shield.

7. All subsequent reassembly steps will be a reversal of the disassembly procedure.

NOTE: Care must be taken with bearing insulation (10).



Operational Difficulties

WARNING: HIGH VOLTAGE AND ROTATING PARTS CAN CAUSE SERIOUS INJURY. THE USE OF ELECTRIC MACHINERY, LIKE ALL OTHER UTILIZATION OF CONCENTRATED POWER AND ROTATING PARTS, CAN BE HAZARDOUS. MAKE CERTAIN THAT THE VOLTAGE IS REMOVED FROM ALL CIRCUITS AND THAT NO MECHANICAL PARTS ARE ROTATING. INSTALLATION, OPERATION AND MAINTENANCE OF ELECTRIC

MACHINERY SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. FAMILIARIZATION WITH NEMA PUBLICATION MG-2, SAFETY STANDARDS FOR CONSTRUCTION AND GUIDE FOR SELECTION, INSTALLATION AND USE OF ELECTRIC MOTORS AND GENERATORS, THE NATIONAL ELECTRICAL CODE AND SOUND LOCAL PRACTICES IS RECOMMENDED.

TROUBLE - SHOOTING CHART

Trouble	Possible Cause	Action
Motor will not start	Power not connected	Connect power to control, and control to motor. Check contacts.
	Low Voltage	Check motor nameplate value with bus voltage.
	Wrong control connections	Check connections with control wiring diagram.
	Driven machine locked	Disconnect motor from load. If motor starts satisfactorily, check driven machine.
	Open circuit in stator or rotor winding	Measure/compare winding resistance of each phase.
	Winding grounded	Test for grounded winding.
	Excessive load torque	Check motor capability.
Noise or vibration	Overload control trip	Wait for motor to cool. Try starting again.
	Motor running single phase	Stop motor. Then try to start. It will not start on single phase. Check for "Open" in one of the lines or circuits.
	Supply bus unbalanced	Check balance by measuring current and voltage in each phase. Correct the power supply to obtain balanced voltages.

TROUBLE - SHOOTING CHART



**GEEP-164-I Horizontal Induction Motor
TEAO, Antifriction Bearing**

Trouble	Possible Cause	Action
Noise or vibration (cont'd)	Misalignment	Check parallel, angular and axial alignment.
	Air gap not uniform. (Machines furnished without one bearing)	Center the rotor.
	Noisy ball bearings	Check lubrication. Replace bearings if noise is persistent and excessive.
	Loose on foundation	Realign machine. Tighten hold-down bolts.
	Foreign material inside unit	Clean inside for unit.
	Shorted field turns (synchronous)	Check impedance of each pole. Determine if one pole has noticeable difference.
Overheating	Overloaded	Measure loading with ammeter and compare with full load current on nameplate. Reduce load.
	Electrical load unbalance	Check for voltage unbalance or single phasing.
	Restricted ventilation	Clean filters, air passages and windings. Check water cooling if applicable.
	Incorrect voltage and frequency.	Check nameplate values with power supply. Also check voltage at terminals with machine under full load.
	Stator winding shorted. (line-to-line)	Inspect winding for damage. Obtain expert help for repair.
	Stator winding ground. (line-to-ground)	Inspect winding for damage. Obtain expert help for repair.
	Incorrect field current (synchronous)	See nameplate - apply correct field.
	Incorrect speed	Check speed, compare with nameplate.
Bearings overheating (journal type)	Alignment	Check parallel, angular and axial alignment. Correct as required.

TROUBLE - SHOOTING CHART



**GEEP-164-I Horizontal Induction Motor
TEAO, Antifriction Bearing**

Trouble	Possible Cause	Action
Overheating (cont'd)	<p>Insufficient oil</p> <p>Contamination in oil or improper grade of oil</p> <p>Oil rings rotating slowly or not rotating at all (if oil rings are used).</p> <p>Rings bent or otherwise damaged in reassembling.</p> <p>Oil seals bound up or damaged.</p>	<p>Add oil; if oil supply is very low, drain, flush with clean oil, and refill.</p> <p>Drain the oil. Flush with clean oil, and relubricate using oil viscosity specified on nameplate.</p> <p>Oil ring has worn spot, replace with new ring.</p> <p>Replace oil rings.</p> <p>Replace seals.</p>
Bearings Noisy or Vibrating (antifriction type).	<p>Defective bearings or rough journal.</p> <p>Wrong-grade of grease</p> <p>Insufficient grease</p> <p>Too much grease</p> <p>Defective or damaged bearing</p> <p>Foreign material in grease.</p>	<p>Replace bearings or resurface shaft.</p> <p>Remove old grease and relubricate using grease recommended by this Instruction Book.</p> <p>Remove relief plug and regrease bearing. Replace plug after ½ hour running.</p> <p>Remove relief plugs and let motor run until excess grease is purged. Then reinstall plug.</p> <p>Replace bearing.</p> <p>Remove relief plug. Purge contaminated grease from bearings. Relubricate until only clean grease is exiting relief plug.</p>
Low insulation resistance or insulation failure.	<p>Moisture</p> <p>Dirt</p> <p>Conducting particles have penetrated insulation.</p>	<p>Dry winding</p> <p>Clean winding</p> <p>Obtain expert help for repair.</p>

TROUBLE - SHOOTING CHART

Trouble	Possible Cause	Action
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**GEEP-164-I Horizontal Induction Motor
TEAO, Antifriction Bearing**

<p>Low insulation resistance or insulation failure (cont'd)</p>	<p>Mechanical damage to insulation.</p> <p>Voltage surges have damaged insulation.</p> <p>Excessive temperatures</p>	<p>Obtain expert help for repair.</p> <p>Obtain expert help for repair</p> <p>Obtain expert help for repair</p>
<p>Wound rotor motor: Motor runs at reduce speed wit external resistance out of circuit.</p>	<p>Excessive impedance between unit and rotor control</p> <p>Wrong Connections.</p> <p>Open circuit in rotor (including cable to control).</p>	<p>Use adequately-sized conductors</p> <p>Check stator, rotor and exciter connections, check control wiring.</p> <p>Test by "ringing out" circuit and repair.</p>
<p>Synchronous generator: Failure of the machine to produce rated output.</p>	<p>Wrong connections</p> <p>Open circuits</p> <p>Prime mover</p> <p>Inadequate excitation</p> <p>Shorted field turns</p> <p>Ground in field leads</p>	<p>Check stator, rotor and exciter connections, check regulator wiring.</p> <p>Test by "ring out" circuit and repair.</p> <p>Check speed, run at rated speed.</p> <p>Check excitation. Compare with name-plate and correct.</p> <p>Impedance check all poles - determine if one pole is noticeably less than others.</p> <p>Check lead insulation - check condition where leads exit shaft.</p>
<p>Brushes sparking</p>	<p>Overload</p> <p>Dirt between brush and ring</p> <p>Brushes stuck in holders</p> <p>Incorrect brush tension</p> <p>Rough collector rings</p> <p>Eccentric rings</p>	<p>Check for overload with ammeter and eliminate overload. Clean rings, adjust brush pressure and replace brushes.</p> <p>Clean rings, brushes and brush rigging.</p> <p>Use correct brushes, clean brush holders.</p> <p>Check brush tension and correct.</p> <p>Stone or turn rings.</p> <p>Turn rings or replace collector.</p>

BOLT TIGHTENING REFERENCE



**GEEP-164-I Horizontal Induction Motor
TEAO, Antifriction Bearing**

Bolt size	Torque in LB. FT	
	Dry	Lubricated
1/4 - 20	8	7
5/16 - 18	17	14
3/8 - 16	30	23
7/16 - 14	50	38
1/2 - 13	75	56
5/8 - 11	150	112
3/4 - 10	260	188
7/8 - 9	400	284
1 - 8	580	438
1 1/4 - 7	1120	823
1 1/2 - 6	1940	1311



Spare Parts

General considerations

The machines covered by this Instruction have been designed and manufactured to provide excellent reliability and quality. If properly handled, stored, installed, operated and maintained, and if the site is equipped with adequate protective equipment, the unit will give many years of reliable service. However, as with all power equipment, certain parts are subject to normal wear. In addition, there is great variation between sites in severity of environmental conditions.

For these reasons an adequate stock of spare parts is important, as insurance, in order to minimize down time of the unit. The correct number of spare parts to carry in stock depends upon how critical the installation is to the owner. This decision must be weighed with an evaluation of the severity of environmental conditions at the site and of the effectiveness of the local maintenance program.

Parts subject to wear

Two parts which are in physical contact in which there is relative motion between the two members will experience wear. Sleeve bearings and oil rings are in contact with the shaft and move relative to the shaft. The balls or rollers of antifriction bearings are in contact with, and move relative to the inner and outer race. Brushes are in contact with, and move relative to collector rings and brush holders. Oil seals are in contact with and move relative to the shaft.

All of the mentioned parts are subject to wear. The rate of wear, in each case, is determined by factors discussed previously. It is recommended that these parts be regularly stocked as spare parts.

Other parts

There are other essential parts which may deteriorate at an unpredictable rate, over a period of time, for which the mode of failure is more subtle. Air filters used to remove dirt should be inspected and cleaned periodically, over a period of time, corrosive and other types of chemical contaminants, as well as certain types of physical contaminants, will cause air filters to deteriorate. This may cause throttling of cooling air and

an undesired increase in operating temperature of the unit.

The insulation of all the electrical windings will give long life if operated within temperature ratings, if cleaned in accordance with instructions and if not damaged. Lightning surges, switching surges, general system disturbances and other abnormal voltage conditions have the potential to cause dielectric damage that can result in turn and ground insulation breakdown over a period of time. The large magnitude of ambient air which passes through the machine and over the coils for ambient breathing machines can cause the winding insulation to be abraded and even penetrated by abrasive particles, conducting particles, moisture and normal dirt.

Criticality of the application

The owner should evaluate the critical nature of this machine's application at it relates to the economy of potential downtime and loss of production.

Three categories are listed below under **Recommended Spare Parts**.

1. Non-Critical - Minimum Protection (Basic Spares)
2. Semi-Critical - Adequate Protection
3. Critical - Full Protection

These recommendations are being made to assist the owner in developing a **Protection Planning Program** for parts to be maintained in stock.

Recommended Spare Parts

The recommended list of spare parts is as follows:

1. Non-Critical Application - Basic Spares - Minimum (one set of each item, as originally supplied)
Bearings
*Oil Rings
*Oil Seals
*Air Filter
*Brushes, Brush Holders and Collector
*Diode Rectifiers
*Silicon Controlled Rectifiers

Note:

*When so Equipped

2. Semi-Critical Application - Adequate Protection (one set of each item, as originally supplied)



First Seven Items in (1) (as applicable)

Prewound Stator Core

Synchronous Rotor Wound Poles

Exciter Rotor

Exciter Stator

Rectifier Assembly

} Synchronous Machines only

2. Critical Application or Multiple Units - Full Protection (one set of each item, as originally supplied)

First Seven Items in (1) (as applicable)

Rotor

Stator

Exciter Rotor

Exciter Stator

Rectifier Assembly

} Synchronous Machines only

Ordering Parts

A general view of the machine is given in the instruction section entitled "Parts Identification". When ordering parts or seeking additional information from your General Electric Company contact, include the serial number and model number of the machine as well as the rating and the part number reference from the Parts Identification section.



Belt and Chain Drives

General

A belt or chain drive delivers torque by virtue of an unbalance in tension between the two sections of the belt or chain. Thus, there is an unbalanced, lateral force on the belt sheave or chain sprocket. The lateral force is transmitted to the bearing of the drive motor and is a significant component in the magnitude and direction of the bearing loading.

The capability of a motor to deliver torque by or a chain drive is a function of the motor horsepower, speed, and bearings. Unless the motor was specifically ordered suitable for this type of drive, it should not be employed without first consulting the factory, through the nearest General Electric office.

Belt and chain drive motors can be furnished with the slide rails for adjusting belt tension. Such slide rails should be levered and adjusted as discussed for foundation caps and sole plates, under Mounting. The slide rails should be positioned such that the axis of the drive motor shaft and the axis of the driven equipment shaft are parallel and that the centerline of the belt sheave or chain sprocket on the drive motor is in the same vertical plane as the sheave or sprocket of the driven equipment. The relative location of the drive motor and driven equipment should permit belt or chain tightening or loosening. The belt sheave gear sprocket should be mounted as close to the motor end shield as reasonably possible.

For V-belt drives, align the sheave or pulley with considerable care to avoid axial thrust on the bearings. The belt tension should be such as to just prevent slippage at full load. Too great a belt tension will cause additional bearing loading than is necessary resulting in overtighten the belt tension on high-inertia loads in order to prevent belt slippage and “squealing” during the acceleration period. The belt tension should be set to just prevent slippage at full load, full speed conditions and to allow slip during acceleration.

The tension ratio, the pulling ratio and the peripheral belt speed should not exceed the following values:

Type of Belt	Tension Ratio	Pulling Ratio	Peripheral Belt Speed*
V-belt	7/1	8/1	5000 feet/minute

*Unless otherwise recommended by the belt manufacturer.

For chain drives, adjust the chain length relative to the distance between sprocket centerlines to permit a slight sag of the chain on its slack span or side. The distance between sprocket centerlines should not be less than the diameter of the larger sprocket, plus the radius of the smaller one. The maximum acceptable chain manufacturer. The lubrication and maintenance of the chain should be in accordance with the chain manufacturer’s instructions.



Machine Description

General

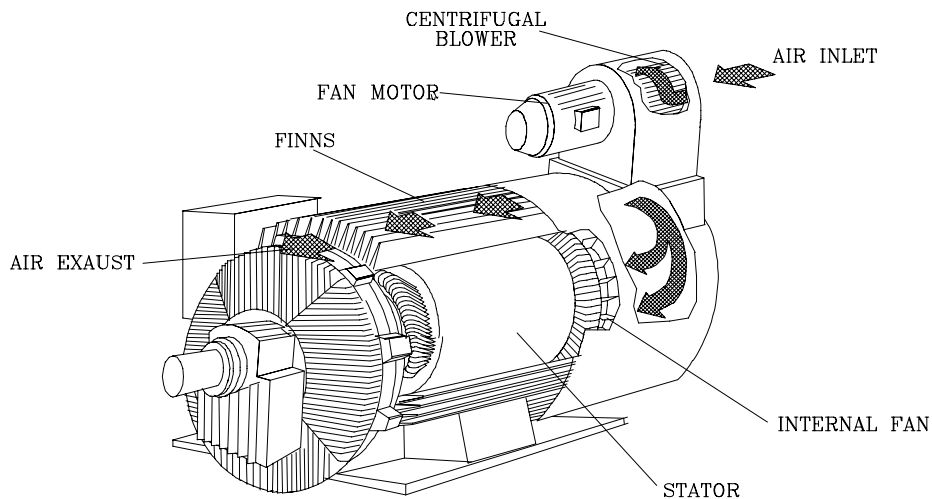
General Electric horizontal motors, totally enclosed, air over, can be used in confidence in many indoor locations where forced-air cooling is required.

These motors receive special inspection during manufacturing and assembly operations to assure the purchaser that all parts have been manufactured in accordance with strict reliability-assurance standards.

Enclosure and Ventilation

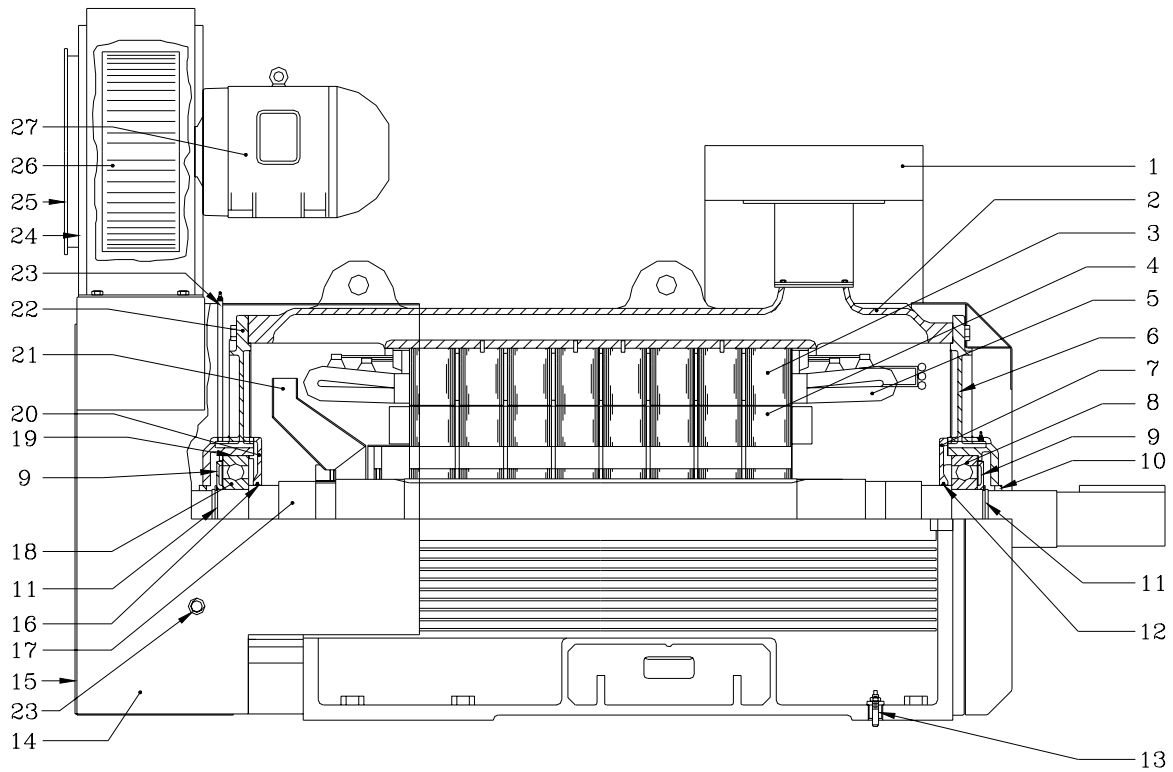
These motors are built with cast finned frame. The cooling system is designed so that the external air does not reach the active parts or the air inside the machine.

The ambient air is drawn through the blower air inlet. The centrifugal blower develops the air pressure necessary to force cooling air through the finned frame and this heated air is exhausted from the finns to the ambient air.





Parts Identification



- | | |
|-------------------------|--------------------------|
| 1. Conduit Box | 15. End Cover |
| 2. Frame | 16. Gasket |
| 3. Stator Laminations | 17. Shaft |
| 4. Rotor Laminations | 18. Antifriction Bearing |
| 5. Stator Coils | 19. Bearing Insulation |
| 6. End Shield | 20. Inner Bearing Cap |
| 7. Inner Bearing Cap | 21. Internal Fan |
| 8. Antifriction Bearing | 22. End Shield |
| 9. Grease Slinger | 23. Grease Fitting Pipe |
| 10. Inpro Seal | 24. Fan Casing |
| 11. Snap Ring | 25. Air Inlet Louver |
| 12. Gasket | 26. Centrifugal Fan |
| 13. Dowel Pin | 27. Fan Motor |
| 14. Air Casing | |

Fig. 1 General view - Antifriction Bearing



GEEP-164-I Horizontal Induction Motor TEAO, Antifriction Bearing

General

To assist in identifying the machine parts, a general view Fig. 1 is presented in page 1. Each part is marked by a reference number for identification. This listing is generated from the parts list for this machine.

Use of the general view and the list permits easy identification of each machine part by its actual number. When ordering spare or renewal parts, include this part number in addition to the model and serial number of the machine.



GE Industrial Control Systems