VILMA

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Three-phase Induction Motor

Instruction Manual

LOW VOLTAGE

Notice

- The information contained in this book is intended to assist operating personnel by providing information on the general characteristics of the purchased equipment.
- It does not relieve the user of the responsibility of using accepted engineering practices in the Installation, operation and maintenance of this equipment.

Safety Procedures

This equipment contains hazardous voltages. Death, serious personal injury or property damage can result if safety instructions are not followed.

Motors should be installed and grounded per local and national codes. Do not operate this equipment in excess of the values given on the nameplate or contrary to the instructions contained in this manual. The equipment (or a prototype) has been factory tested and found satisfactory for the conditions on which it was sold. Operation in excess of these conditions can cause stresses and strains beyond design limitations. Failure to heed this warning may result in equipment damage and possible personal injury

The successful and safe operation of motors is dependent upon proper handling, installation, operation and maintenance, as well as upon proper design and manufacture. Failure to follow certain fundamental installation and maintenance requirements may lead to personal injury and the failure or loss of the motor as well as damage to other property.

Only qualified personnel should work on or around this equipment after becoming thoroughly familiar with all warnings, safety notices and maintenance procedures contained herein. Only qualified personnel should be involved in inspection, maintenance and repair procedures and all plant safety procedures must be observed.

Qualified Person: For the purpose of this manual and product labels, a Qualified Person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he or she:

a. is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.
b. is trained in the proper care and use of protective equipment, such as rubber gloves, hard hat, safety glasses, face shields, flash clothing, etc., in accordance with established safety procedures.
c. is trained in rendering first aid.
d. is authorized specialist technician according to your local laws for work under current , hazardous voltages and safety regulations.

Danger indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury

For the purpose of this manual and product label, Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury

For the purpose of this manual and product label, Caution indicates a potentially hazardous situation which, if not avoided, may result in property damage or minor or moderate injury. It is also used to alert against unsafe practices

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment.

Contents

Foreword

This instruction manual describes and provides instructions for installation, operation and maintenance of induction motors. These instructions do not support 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, please do not hesitate to contact with us.

Receiving, Handling and Storage

1.1 Receiving

Each shipment should be carefully examined upon arrival. If the packing is damaged, unpacking should be made immediately to check whether or not the motor and its fitting are in good condition, and any damage to contents should be photographed and reported to the carrier and to us
.
All large motors are equipped with a locking device, which protects the bearing from damage due to the movement of the rotor in transit. Do not remove this device until transport is complete and coupling is ready to be fitted.

Heavy Equipment

Improper lifting can cause death, severe injury, or damage. Check eyebolts,lifting lug and eyenuts before lifting. Use proper slings and spreaders

1.2 Handling

To ensure proper handling after unpacking, the motors require the chain hoist, wire ropes and other handling equipment. When hoisting the motor, wire ropes should be attached to the lifting holes on the side of the motor frame, and should be put in hard rubber, thick cloth, etc. between the external covers for protective purposes. Then the motor is slowly and carefully raised and moved to the intended position

When unpacking and handling the motor, attention should be given to the following points

- Anticorrosive agent which is applied to the coupling shaft ends should be removed right before starting the motor. The coupling or shaft ends should be checked to ascertain whether or not they are in abnormal condition

1.3 Storage

If the motors are not put into service at the time of delivery, they should be stored according to the following conditions.

Top Heavy.
Can cause severe injury or property damage.
When lifting motor.

1. Lift only at designated locations.
2. Use spreader for lifting.
3. Apply tension gradually to cables.
4. Do not jerk or attempt to move unit suddenly.
5. Do not use cover lugs when lifting.

Outdoor Storage without appropriate packing is Not Recommended. Variations in temperature and humidity can cause condensation, resulting in corrosion of metal parts and possibly in insulation failure. Therefore, the following cover the minimum acceptable storage arrangements in an unheated but protected environment: It is preferable to use a heated facility, which would simplify meeting these conditions.
The storage facility must provide protection from contact with rain, hail, snow, blowing sand or dirt, accumulations of groundwater, corrosive fumes and infestation by vermin or insects.
There should be no continuous or severe intermittent floor vibration. Power for the space heaters and illumination should be available. There should be fire detection and a fire-fighting plan. The motors must not be stored where it is liable to be accidentally damaged or exposed to weld spatter, exhaust fumes or dirt and stones kicked up by passing vehicles

In case of Damp Location, use space heaters to prevent dampness. 

If necessary, use guards or separating walls to provide adequate protection. Avoid storage in an atmosphere containing corrosive gases, particularly chlorine, sulfur dioxide and nitrous oxides.

Temperature Control (in case motor is equipped with heaters)

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Whenever the motor temperature is equal to and below ambient temperature, water vapor can condense on and within it, promoting rapid deterioration.

Prevent this by energizing the space heaters to keep the motor temperature above ambient temperature by at least 3°C However, during periods of extreme cold or rapid temperature drops, the space heaters may not be adequate to maintain

WARNING If the motor is boxed or covered in any way when the space heaters are energized, there should be thermostatic control and sufficient surveillance to detect an over-temperature condition quickly. Ensure that temporary packaging does not contact the space heaters.

However, if the resistance drops, the windings can be permanently damaged by freezing. Therefore, the motor temperature should be kept above freezing point.

Inspection and Test for Initial Start-up on Site

2.1 Installation

General

Ensure that the motor enclosure is suitable for its environment, that the ambient temperature is always less than specifications for operating the motor and that all bearings are lubricated before operating the motor at all times and that all bearings are lubricated before operating the motor and there is enough cooling air supply.

Foundation

Motors should be mounted on solid and rigid foundations to ensure proper vibration and free operation. The desirable foundation and anchor bolt design will

1) accommodate at least the maximum static and dynamic foundation loads indicated on the motor outline dimension drawings.
2) have sufficient rigidity to maintain acceptable alignment after the application of load.
3) be free of natural frequencies, which are likely to be excited during normal operation (this could result in vibration problems on the motor).

In some cases where precision is required, a study of these factors should be conducted to determine the natural frequencies of the motor support

Mounting

After removing the package from the skid of the motor, remove the polyethylene shroud. Remove the motor from the skidding.

The motors should be mounted on a flat surface and packed about with shims (shim allowance is generally 2-3 mm thick).
The shims should support the maximum length of each motor foot. It is preferable to use corrosion-resistant shims such as brass or stainless steel; otherwise “shim swell“ due to corrosion may be detrimental to good alignment. Care should be taken not to distort the frame during “bolting down”.

A basic rule is to not have more than 5 shims in a shim pack under any one machine foot. Thick shim packs consisting of many thin shims will cause a soft foot and cause vibration or twisted frame (machine foot out of plane).

NOTE: Experience has shown that any base-mounted assemblies of motor and driven units temporarily aligned at the factory, no matter how rugged or deep, may twist during shipment. Therefore, alignment must be checked after mounting.

CAUTION

Remove the Locking Device of Large Motors

In case motors are equipped with a device for preventing the shaft from movement in order to protect the rolling face of bearing from damages due to vibration in transit, this must be removed before use.

This locking device is fitted on the drive side or on the non-drive side. Before connecting a motor to a machine, the fitting bolts should be loosened, and the fitting device should be taken off.

The rotor is locked by a rotor locking device for the purpose of protection during transportation. These are normally locked on the drive end shaft, but sometimes locked on the non-drive end shaft. The locking device shall be taken off by simply loosening the screw bolt. As the locking device is generally painted in yellow-brown , it can be easily visible

CAUTION

2.2 Inspection of Installation

After installation, check for looseness of bolts and nuts on the terminal boxes, cooler boxes and so on. Then, the foundation and centering of the motors should be checked. These items are normally checked and reviewed on the erection records.

Checklist for inspection of installation

1. **Outside view of machine**

- No damaged portions/parts.
- Confirmation of caution, nameplate.

2. **Removal of rotor locking device**
(If necessary)

3. **Check for no looseness**
- End covers.
- Terminal boxes.
- Cooler boxes.

4. **Check around foundation**
- Motor levelling.
- Tightness of foundation bolts.

5. **Inspection of accessories (in case motor is equipped with)**

2.3 Measurement of Insulation Resistance

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment.

The insulation resistance of stator, rotor and auxiliaries shall be measured before the initial start-up of the machine or after a long period of standstill. The insulation resistance testing is available method for determining the extent of moisture absorption and dirtiness of the insulation. The insulation resistance of new machines with dry windings is very high. If the machine has been subjected to incorrect transportation and bad storage environment such as high humidity, salty and dirty, the insulation resistance can be extremely low. Based on the result of insulation measurement, correct cleaning and drying action shall be determined and conducted.

Procedures for insulation resistance test

The insulation resistance is measured by using an insulation resistance meter (Megger). Guidelines for test voltage are presented in the following table

Winding rated (V)*	Insulation resistance test(MΩ)
< 1000	500
1000 - 2500	500 - 1000
2501 - 5000	1000 - 2500
5001- 12000	2500 - 5000
> 12000	5000 - 10000

* - Rated line-to-line voltage for three-phase AC machines, that is the rated voltage of machines.

- The test voltage guidelines were quoted from IEEE 43-2000.

The test voltage is applied between the winding and the frame for 1 minute. The test is usually performed to the whole windings as a group. In case that the test is conducted to each phase winding, the frame and other windings not under test shall be grounded. Before the insulation resistance test is conducted, the following actions shall be taken.

-- Verify that all power supply cables are disconnected.
-- The winding temperature is measured.
-- All resistance temperature detectors are grounded.
-- All other external equipment such as VFDs , surge capacitors, lightening arrestors, current transformers and etc are disconnected and grounded

2.4 Recommended minimum values for insulation resistance

The actual winding insulation resistance to be used for comparison with IR1min is the observed insulation resistance, corrected to 40°C, obtained by applying a constant direct voltage to the entire winding for 1 min. Generally, the insulation resistance value for dry windings exceeds the minimum values significantly. It is impossible to give definite values, because resistance is affected by the machine type, humidity, temperature, aging, operation period and etc. Therefore, the following values can only be considered as guidelines.

Recommended value for Insulation Resistance (IR)

For most dc armature and ac windings built after 1970 (form – wound coils)
IR1min > 100 MΩ

Generally for new stator IR1 min must be more than 500 MΩ

If the measuring conditions are extremely warm and humid, IR1min value of stator windings above 100 MΩ may be accepted.

2.5 Suitability for operation

Recommended minimum values of the IR may be used to estimate the suitability of the winding for operation. If the IR is low because of dirt or excessive moisture, it may be improved to an acceptable value by cleaning and drying. It may be possible to operate machines with IR values lower than the recommended minimum values; however, it is not recommended. In all cases where the test values fall below the recommended minimum values, investigations should be undertaken to determine the cause to such low readings.

2.6 Insulation resistance measurement for auxiliaries (in case motor is equipped with)

To ensure correct operation of the machines protections and other auxiliaries, their condition can be determined by an insulation resistance test. The test voltage for the space heater shall be 500 VDC and for other auxiliaries 100 VDC. The recommended minimum value of the space heater is over than 1 MΩ. The insulation resistance measurement for temperature sensors is not recommended.

2.7 Direction of Rotation

The objective of the first starting is to check the direction of rotation of the machine.

The machine should turn in the same direction as the driven equipment demands. In general all low voltage motors are both directional, except hollow shaft motors which are equipped with non reverse racket. In case of hollow shaft motor, the machine may only be operated in the specified direction of rotation as shown with the arrow on it.

Machines suitable both directions, If the desired direction of rotation for some reason is different from the one specified on the machine, to alter the direction of rotation, interchange the power supply phases.

2.8 Manual Rotation

If possible, rotate the rotor manually to ensure that it is free to move without rubbing or scraping and to lubricate the bearing surfaces. A minimum of 10 revolutions is recommended.

2.9 Connection to Power and Grounding

Examine the nameplate data to know the correct power supply. Also check heater power where applicable. Check all connections to ensure that they have not come loose during transport. Make certain that the correct cable size has been selected and connected to phase rotation as shown in motor terminal box. The motor and control wiring, overload protection and grounding should be done in accordance with the National Electrical Code and local requirements.

In case of the wound rotor, check to see that brushes are “free“ in the holder and the pressure of the brushes is applied correctly. Ensure that the slip ring surface is clean and free from contamination. Avoid “fingerprint” marks on ring surface. To maintain the proper degree of protection, make sure all gaskets and cover plates are properly fixed and sealed. Any unused entry holes should be plugged.

Cabling glands must always used. Danger

3.0 Solo Run Test

WARNING **Do not exceed number of specified hot and cold starts per hour.**

Will cause overheating. Allow time between starts to permit stator windings and rotor cage to cool

Before coupling with the load machine, the motor is normally run through a solo running test. At the initial start, the motor is inching operated for approx. 1-2 sec.

At that time, inspection of the correct direction of rotation, abnormal noises, and lubrication conditions are checked during the idling. If these items have any problems, the supplied power shall be taken off, checked and reported
in detail.

The motor is then restarted. The motor is run 1-2 hrs. and vibration amplitude on the bearing housing and bearing temperature are measured and recorded.

Do not operate equipment beyond design limitations.

Can cause personal injury or damage to equipment.
Operate in accordance with instructions in the manual and nameplate ratings

WARNING

3.1 Alignment

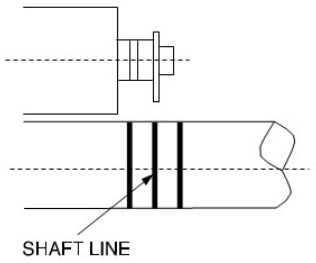
The correct alignment of machinery is very important for reducing the stress and vibration of the shaft and the wear of the bearing and coupling. In case a coupling maker gives those instructions, it is recommended that the instructions be followed.

Flexible Coupling

The flexible coupling set forth herein means the one driven through the rubber brush or the leather brush including the gear coupling. In aligning the motor equipped with the sleeve bearing, attention is to be paid to the endplay of the motor bearing and to the position of the coupling. The center of the motor bearing endplay is indicated by the endplay indicator.

The bearing endplay can be equally divided by setting the endplay indicator to the standard line of the shaft as shown in the Figure below.

Endplay Indicator



WARNING

In case the coupling is used, it may be considered that the rotor can be easily moved in the axial direction. In fact, however, it hardly slides in the axial direction at the coupling as the torque grows greater. When by some reason the rotor has undergone some axial movement, and the coupling does not provide enough slip to allow the rotor to return to the magnetic center of the motor, it will continue to operate with the bearing end in contact with the shoulder of the journal.

Rigid Coupling

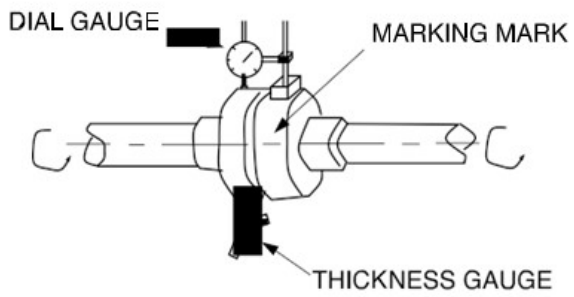
In case of the sleeve bearing, when both flanges are connected to each other, the endplay indicator is referred to install the flexible coupling in order to determine the position of the motor

Alignment

NOTE: The foot plane is of concern for each unit of rotating equipment. Check driven equipment if necessary.

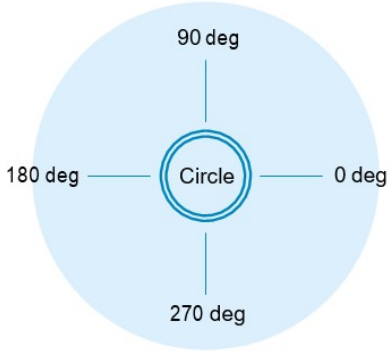
Alignment is made to bring the shaft centers of the motor and machine combined with it into the same line; the parallel and eccentricity are measured through the coupling. Generally a thickness gauge or a taper gauge is used in measuring the parallel, and in measuring the eccentricity, a dial gauge is to be fitted to the coupling on one side; the both shafts are to be turned by 0 deg, 90 deg,180 deg and 270 deg; and the dial gauge reading is to be taken at the four points as shown in Fig. 4. The alignment accuracy is to be generally 0.025 mm or less (both plate and circle).

Procedure for Alignment



Measurement of Eccentricity

The both shafts are to be simultaneously turned; the values shall be obtained from the measurement made at four points by means of a dial gauge and are to be recorded; and the corrected value is to be obtained in the following manners



Measured Values

The difference between the total of the measured values at the left and right points and the total of the measured values at the top and bottom points should not exceed 0.03 mm. The improper fitting of the dial gauge and the erection of the fitting arm, if any, may cause greater difference.

Frame Distortion Check

In addition to ensure the proper alignment of the coupling, care should be taken to ensure that the motor frame is not distorted during alignment.

To confirm that distortion has not occurred, we recommend the following procedure be adopted:

1) Align the motor within tolerances as required by section “alignment.”
2) Apply a dial gauge between the motor frame adjacent to one mounting foot and the foundation and set indicator to zero.
3) Loosen hold down bolt and record movement of dial gauge measurement.
4) Re-torque hold down bolt.
5) Repeat steps 1-4 for all hold down bolts, one at a time

3.2 Test Run of Motor

Carry out the initial operation in accordance with contractual agreements. The initial operation may only be carried out by trained personnel who have been assigned to do this by the person responsible for the plant

After coupling with the load machine, the motor is inching operated at first.

When both motor and load machine show no abnormality, the motor is restarted with a minimum load. At that time, the current, supplied voltage is checked and recorded.

Do not exceed number of specified hot and cold starts per hour. Will cause overheating. Allow time between starts to permit stator windings and rotor cage to cool

3.3 Terminal Box

Transport, Storage
Always keep the cover and the cable entries tightly closed.

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment

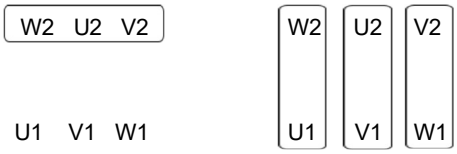
Description

1) Application
In the terminal box, the connection is made between the stator winding and the supply cable from the system. The terminal box is mounted on the machine frame at an easily accessible location.

3.4 Termination

General

Ensure that the power supply agrees with the rating plate data. For DOL starting, plates must be placed for Star or Delta depending the nominal voltage as this is shown in the nameplate



Y Connection Δ Connection

D.O. L

The supply cables should be matched to the rated current and plant-specific conditions (e.g. ambient temperature, method of cable installation, etc.). Connect the supply-cable conductors.

Connection by Means of Cable Lugs

The size of cable lugs must be matched to the size of the supply cable. Use appropriate units with sufficient current-carrying capacity.

Installing and Entering the Cable

The following steps are recommended for split entry:

- Cut the sealing insert so that its opening is some millimeters smaller than the cable diameter.
- Introduce the cable into the cable gland. In the case of a very small cable diameter, the cable diameter should be increased by applying insulation tape at the securing point to ensure concentric positioning of the cable in the sealing insert.
- Provisionally attach the terminal box cover in order to check whether perfect sealing is achieved both at the flange surfaces and at the entry point with enough prestressing. If this is not the case enlarge the sealing insert cut out or adjust the cable diameter by means of insulation tape. The securing bolts should then be tightened alternately in steps.
- Unused entry openings always must be closed off by suitable plugs.
These must be of permissible resistant material,
- conform to degree of protection IP55

Earth Connection

An earth terminal for connecting the cable earth conductor is provided in the terminal box or on the frame.

The minimum connection cross-section of earth connections should be selected according to IEC 34-1 with reference to live conductors.

Make sure in any case of installation and maintenance work that the equipotential bonding is maintained.

Final Checks

Before closing the terminal box, check the following:
- Conductor connections and, if applicable, the circuit connections have been made correctly.
- Interior of the terminal box is clean and free from remainders of cable material.
- All terminal screws and the appropriate cable entry parts are firmly tightened.

- Remove any projecting wire ends!

- Connection leads are not subject to strain and the insulation cannot be damaged.

- Unused entry openings are closed off by suitable plugs
.
- All seals and sealing surfaces are in perfect condition. If sealing of the joints is effected by metal-to-metal joints only, the surfaces should be cleaned and thinly regreased.

- Entry glands fulfill all requirements concerning degree of protection, conditions of installation, permissible lead diameter.

3.5 Operation

Safety Advice

Covers to prevent accidental contact with live or rotating parts and those required for proper air guidance and thus effective cooling should not be opened during operation. During maintenance or inspection work in the immediate vicinity of the terminal box or of the rotating machine suitable measures should be taken to protect personnel against hot gases escaping under short-circuit conditions.

Only switch off the electrical machine during the main running period in an emergency, in order to protect the switchgear and electrical machine

3.6 Maintenance

Voltage power source must be disconnected before working on equipment.
Failure to disconnect power source could
Result in injury or death.
Terminal box only to be opened by skilled personnel.

1) Safety Advice

Before any work is started on the machines, particularly before covers are removed from live parts, make sure that the machine/plant has been correctly disconnected from the power supply.

Please adhere to the general “5 safety rules”
- Isolate the equipment from the power supply,
- Provide a safeguard to prevent unintentional reclosing,
- Verify safe isolation from the supply,
- Earth and short-circuit,
- Provide barriers or covers for adjacent live parts.

2) Tightness, High-current Loading

The terminal boxes should be inspected regularly to ensure that they are tight, that the insulation is undamaged and that the connections are firmly attached. If the terminal box is subject to extremely high current loading it is recommended connecting parts and cable connectors be checked.

If any dust or moisture has penetrated the terminal box, clean and dry out the terminal box. The seals and sealing surfaces should also be checked and the cause of faulty sealing should be remedied.

3) Tightening Torque
Required tightening torque for current-carrying bolted joints is given in below table.

3) Tightening Torque
Required tightening torque for current-carrying bolted joints is given in below table.

Screw Strength class	Tightening Torque (Nm)	
	Steel	Brass
M5	-	2.9
M6	10.8	4.9
M8	20.7	9.8
M10	42.4	19.7
M12	73.9	34.5
M16	177.4	82.8

The tolerance of tightening torques is±10%

NOTE: Replace the cover and tighten up the screws (taking safety elements into consideration

4. In case motor is equipped with auxiliary Terminal Boxes

Description

Application

The auxiliary terminal boxes are employed for connection of auxiliary circuits. If specially ordered for anti-condensation heater, an auxiliary terminal box for anti-condensation heater may be supplied, etc.

Installation / Termination

When making the connections of auxiliary circuits wiring diagram for auxiliary circuits is given.

The cross-section of a supply cable should be selected on the basis of the rated current and plant-specific conditions.
The connection terminals for auxiliary circuits are suitable for conductor cross-sections of at least 2.5mm2.

The ends of the conductors should be stripped in such a way that the remaining insulation reaches almost up to the terminal.

Installing and Entering the Cable

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To maintain the degree of protection IP all screwed-in glands must be firmly tightened and sealed by suitable measure, e.g. by means of an adhesive or by fitting sealing ring. The same measures are required when fitting screwed-in plugs

Cable Glands are given and are always screwed in place, fixed in position and sealed in accordance with degree of protection IP55 by use of LOCTITE.

For adapting the cable diameter to the gland conditions it may be necessary to apply a layer of insulation tape to the leads to enlarge its overall diameter or to cut out some rings of the sealing insert.

With extreme lead diameter it may be necessary to replace the glands by those of appropriate dimensions.

Cable Glands must always be used.

Unused entry openings always must be closed off by suitable plugs

5. Anticondesation Heaters (in case motor is equipped with)

Description

Application

Anti-condensation heaters fitted in electrical machines warm the air inside the stationary machine to a temperature above that of the surroundings, thus effectively preventing moisture condensation.

Installation

The anti-condensation heater consists of one or more tubular heating elements connected together or by the mean of heating belt. These heating tubes are combined to form units and are installed in the stator frame. The arrangement constitutes the so-called “stabilized design”, i.e. the heating temperature stabilizes itself at the rated voltage thanks to the optimum balance of heater rating and heat dissipation. Special temperature monitoring devices are therefore not necessary.

Connecting the Supply Cable

The heater connections are brought to terminals which are located in a separate terminal box and may be made without cable lugs.

Connection must be made in accordance with wiring diagram documented in the approval specification. The supply connection of the heaters must be interlocked with the main breaker of the machine to ensure that the heaters are switched off when the machine is running and switched on once the machine has come to a standstill

Through appropriate series connection of the heating tubes, even the temperature of explosion- proof machines can be limited such that these machines meet the requirements of “stabilized design” and do not require any additional temperature monitoring measures. For this reason, no changes may be made in the original heating-tube connection!

Insulation Testing

The heater may only be put into operation if the specified minimum insulation value of 1 Mega-ohm is obtained from measurement of the insulation resistance with the heater connected.

For the period after commissioning of machines equipped for anti-condensation heating, it is assumed that either the machine itself is in operation or the anti-condensation heater is heating the stationary machine.

Maintenance

1) **Safety Advice**
The anti-condensation heater is switched on when the machine has come to a standstill. Therefore, it must be switched off before any protecting cover is opened for maintenance work.

2) **Cleaning**
With respect to maintenance, occasional cleaning performed during routine maintenance of the machine and the replacement of any damaged parts is sufficient

3) **Repairs**
Should replacement of the heatings become necessary use the same type of heaters. Install the new ones securely and lock the fixing elements.

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6. Maintenance of Windings

General

It is important to keep the machines in good condition by performing periodical maintenance to prevent the insulation from being damaged by moisture, dirt and other foreign matter.

If the machines have been operated under high humidity conditions, not been used for a long time, or been subjected to sudden changes in ambient temperature, the insulation may have absorbed considerable moisture, causing deterioration of the insulation.

Other causes of insulation breakdown include operation of the machines at an overcurrent exceeding the rated current, use under an ambient temperature exceeding the specified values as may be possible with a heated air blower which directly radiates heat over the machines, and overheated windings resulting from dust accumulating on the core packs and coil ends. All of the above items impair insulation and reduce the life of the machine.

Cleaning of Coils

The method selected will depend on the type of machines, type of insulation, kind of dirt, and other conditions and circumstances.

Cleaning by Wiping with Cloth

Wiping cloths can be used for cleaning when the machine is small, the surfaces to be cleaned accessible, and the dirt to be removed dry.

Waste should not be used, as lint will adhere to the insulation and increase the collection of dirt, moisture, and oil.

Cleaning by Means of Compressed Air

Compressed air, used to blow out dirt with a jet of air, usually effective especially where dirt has collected in places that cannot be reached with a wiping cloth. Cleaning can be done more quickly with compressed air than with wiping cloth especially on the large machines. If blowing with compressed air results in simply transferring dirt from one place to another on the machine, little is accomplished.

There are a number of precautions to be observed when using compressed air: Air being blown should be dry, especially if blowing against insulation. Moisture condenses and accumulates in air lines and hoses.

Care should be taken to assure this has been completely dried out before using the compressed air on insulation. Compressed air should never be more than 3 kg/cm2 (pressure. Higher pressures can damage insulation and force dirt under loosened tape.

Care should be taken not to blow loosened dirt into inner recesses where it will be difficult to remove and where it might obstruct ventilating ducts.

Wear goggles when blowing dirt out with compressed air and be careful not to direct the air jet toward others. Failure to heed this warning can result in injury to the eyes.

Cleaning by Means of Solvents

Solvents are usually required to remove grease and oil dirt. A lint-free cloth wet with solvent may be dipped in the fluid.
Petroleum distillates are the only solvents recommended for cleaning electrical apparatuses. These solvents, classed as Safety-Type Solvents, have a flash point of above 37.8 C deg and are available from most oil companies and other supply sources under various trade names:

- Mineral spirits, cleaner's naphtha, and similar products with a flash point above 37.8 C deg.
- Gasoline, naphtha, and similar grades must not be used for cleaning. They are highly volatile and present a great fire hazard.

Avoid prolonged or repeated contact with petroleum distillates or breathing their vapors. These solvents can cause severe skin irritation, are toxic, and are readily absorbed into the system. Failure to heed this warning can cause severe personal injury or death.
Do not use carbon tetrachloride or mixtures containing carbon tetrachloride for cleaning purposes. Carbon tetrachloride and its fumes are highly toxic. Failure to heed this warning can result in serious illness or death.
Avoid excessive contact with cleaning solvents and breathing their vapors. Some solvents are extremely toxic and readily absorbed into the system.

Use of Space Heaters

When the motor is operating, its interior is not humid and in a dry condition. But it absorbs humidity at rest. In order to prevent absorption of humidity, in case space heater are installed inside the frame, they should be immediately energized after the motor comes to a stop, and the temperature inside of the motor should be controlled 3 to5 C deg higher than the ambient temperature.
If there is no space heater, a 100-150-W incandescent lamp may be used.

Connect this heating system according to its output and reference voltage.
Arrange the control so that the heating system
- switches on after the electrical machine switches off.
- switches off before the electrical machine switches on.

Drying Insulation

CAUTION

Should the insulation resistance for the winding have poor insulation resistance due to the ingress of moisture, then the windings must be dried to improve the insulation resistance to the minimum specified value before the application of insulation resistance. The preferred method of drying windings is the external heat method. The alternative is the internal heat method.

The External Heat Method.

* Temperature-controlled oven
The best method is to dismantle the motor (including bearings) and place the motor in a temperature- controlled oven at 110°C max. for 8-10 hours depending on oven efficiency to remove moisture .

*Other method is drying in a dry room with clear air, 80 °C warm, with the vapour exhaustion, the motor not being disassembled but the holes /for the air gap measuring/in the end shields must be opened, drying time depends on the wetness range.

* Alternative external heat method is to remove end shields and covers, connect the anti-condensation heaters, and fit additional “low intensity resistance heaters” in and around the motor.

A temperature controller should control additional resistance heaters with a probe adjacent to the winding at the top of the motor. The temperature should be set for 100°C to 120°C. The drying process will take approximately 10-16 hours once the correct temperature is achieved.

< Key Points to Remember >

1) Heaters must be the “low intensity resistance heaters” types otherwise the insulation might be burnt.
2) The motor may need to be covered by some thermal insulation to retain the heat.
3) A vent opening should be placed in the tip of the thermal insulation tent for the evaporated moisture to escape.
4) Sufficient space should be allowed between the heaters and any winding insulation so as not to generate local excess heating of the winding insulation.

The Internal Heat Method

With this method, the heat is applied by passing current through the windings to generate heat. Extreme caution should be exercised using this method so that you do not damage the internal insulation before the windings are up to optimal temperature.

This method should only be used if all winding resistance is greater than 1 megohm

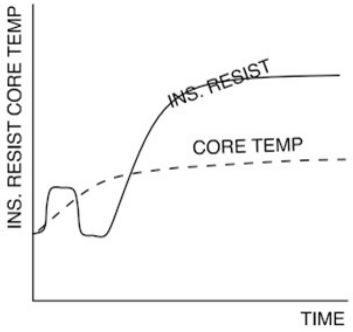
WARNING

This method must be performed from specialized personnel or by a company servise department

Determination of Dried Insulation

During the drying process the insulation resistance should be checked with a 500-V (low-voltage machine) DC low-energy source meter (e.g. megger) and then recorded after 1 minute.
This process should be repeated every hour until the results show the winding is dry.

Once the resistance will stabilize. After the windings cool down, the insulation value should increase.



Change in insulation resistance

Notes on Drying Insulation

1) A temperature-controlled oven should be used if the windings have been completely immersed in water.
2) Should the windings contain contamination, the windings should be properly cleaned before attempting to dry windings. Contact your factory representative for further advice.
3) All processes for drying insulation should be performed under the supervision of qualified personnel. Failure to observe proper procedures may result in permanent damage to the insulation or winding system. For further advice contact your factory representative.

7. Maintenance of Bearings

Rolling-contact Bearings
Mounting

The motor is provided with the antifriction bearings filled with a grease by the manufacturer and this immediately operative

Electrical machines fitted with rolling-contact bearings mentioned above are subject to the following instructions supplementing and modifying the operating instructions of the machine:

The locating bearings are deep-groove ball bearings for horizontally mounted machines. These bearings may also be in pairs with cylindrical roller bearings in the case of bearings that are not guided radially and are prevented from rotating by compression springs.

The locating bearings for vertically mounted machines are angular-contact ball bearings of type range 72 or 73 (angular-contact ball bearings with increased axial fixation).

The floating bearings are deep-groove ball bearings or cylindrical roller bearings. In case of deep-groove ball bearings as floating bearings, the axial play is compensated by means of compression springs/

Regreasing

NOTE: A common mistake is over-lubrication of bearings. When grease is added without removing the drain plug, the excess grease must go somewhere and usually it is forced into and through the inner bearing cap and is then thrown into the windings. Excess grease in the bearing can cause bearings to run hot and could lead to bearing failure.

Initial lubrication of the bearings is normally carried out already in the works.

Keep the new grease meticulously clean. Greases having a different soap base should not be mixed since this would reduce the grease quality.

For regreasing, clean the lubricating nipple and press in the grease quantity, using a grease gun. The shaft should rotate during regreasing; hence, the machines need not be stopped. After regreasing, the bearing temperature will rise by a few degrees and will drop to the normal value when the grease has reached its normal service viscosity and the excess grease has been forced out of the bearing.

The old grease from several regreasing operations gathers in the space inside the outer bearings caps. Remove the old grease when overhauling the machines.

The model of bearing is favorably chosen as for direction and size of load (type of construction, forces acting on the shaft) and therefore it should not be changed.

Lubrication

The efficiency length of the grease filling depends on the type a size used bearings, on the speed, on the grease quality and on the operating conditions. The grease filling becomes worm-out after a certain time and it is necessary to refill or replace it regularly. The bearings provided with the grease regulators and they are regressed during operation via the grease nipples.

In case the machines are stored at warehouse or storage area for longer than 6 months, the existing lubricant shall be poured out and be replaced with new one. Bearing lubrication demands special lubricant, this is like SHELL ALBIDA EMC 3 , ESSO unirex N3 , or SKF LGHQ 3 any other but with the same consist base lithium.

Dismantling, Assembling

May cause bearing damage(brinelling) if outer race of bearing is struck. BECAREFUL When replacing bearing. Avoid subjecting bearing to impact.

The below grease quantities are determined for common operating conditions and grease quality as specified. Under abnormal conditions, dustiness, humid atmosphere, impact load effects, vibrations and oscillating motion, higher temperature, the regressed frequency and the grease quantity more or less become shorter

Frame	Grease amount	3000 RPM	1500RPM
180	30 gr	8500 hrs	17000 hrs
200	30 gr	6000 hrs	12000 hrs
225	30 gr	4000 hrs	6000 hrs
250	30 gr	4000 hrs	6000 hrs
280	30 gr	4000 hrs	6000 hrs
315	30 gr	4000 hrs	6000 hrs
355	30 gr	4000 hrs	6000 hrs
400	30 gr	4000 hrs	6000 hrs

8. Motor Protection

Installation it is recommended to include to its control design the electric motors to be protected in case on not normal operation. humidity, etc.

It is desired if possible :

- Control Fuses to be installed
- Circuit Brakers
- Rtds, etc
- Voltage Unbalancing Controllers

The attention of the electric motor operation and condition is the best protection against faults and " shut down " events during its operation. Part of the supervision, it is the daily inspection of the electric motor. During the inspection of motor operation the user can observe any kind of overshoots from the desired operation' such as bearing, dangerous vibrations and "suspicious" smell.

<u>Hazardous Voltage</u>.
Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment

9. TROUBLESHOOTING

Abnormality		Probable Cause	Remedy
Motor fails to start	Power source & line	1. Drop in line voltage	A check is to be made with a voltmeter.
		2. Great drop in voltage due to inadequate line capacity and impedance drop	1. A check is to be made on voltage at motor terminal before and at time of starting. 2. Similar change in voltage is to be checked at motor terminal.
		3. Cut line or unbalanced	Defective parts are to be repaired.
	Starter	4. Erroneous wire connection	To be repaired.
		5. Cut line or unbalanced voltage	To be reconditioned.
		6. Drop in line voltage	Compensator tap connection is to be raised.
		7. Cut line or unbalance in starting resistor	Resistance is to be measured; repairs are to be made.
	Motor	8. Cutting of stator coil or of rotor coil	Resistance and current are to be measured, and repairs are to be made.
		9. Erroneous connection of stator coil	To be reconditioned.
		10. Failure of a phase after starting	Check the power supply cables
		11. Stator core is in contact with rotor	A check is to be made by turning by hand.
		12. Defective bearing	Bearing is to be disassembled and examined.
		13. Insufficient starting torque	1. Squirrel cage motor, motor is to be replaced with the one having larger capacity and of the wound type. 2. Wound motor, tap for starting resistor is to be replaced.
		15. Wrong connection in the leads such as: Δ instead of Y, etc	Correct the Connection
	Load	16. Overload	Load is to be reduced. <u>Low Main Voltage</u>
Length of time required for acceleration after starting		1. Inadequately low voltage	A check is to be made on voltage drop of power source and line.
		2. Overload or inadequate torque	Load is to be checked, if load is normal, motor capacity is to be changed.

Abnormality	Probable Cause	Remedy
Rotation in reversal direction	Phase reversal	Two phases of U,V,W (or R,S,T) at starter or motor terminal are to be changed..
Motor body overheated	1. Overload	Load is to be reduced. (to rated current)
	2. Overcurrent due to voltage drop	a. A check is to be made with a voltmeter power source Voltage is to be raised. b. Load is to be reduced.
	3. Excessive iron loss due to overvoltage	A check is to be made with a voltmeter power source. Voltage is to be reduced.
	4. Cut line or imperfect contact in one phase	To be reconditioned.
	5. Short-circuiting and grounding of coil	Resistance and current are to be checked and reconditioned.
	6. Contact between stator and rotor	Judgment can be made according to noise; bent shaft, bearing, etc., are to be corrected.
	7. Inadequate ventilation due to dust	Cleaning is to be carried out
Vibration	1. Unbalance of rotor a. Bending of shaft b. Loose joint c. Residual unbalance d. Critical speed of shafting e. Dust attached to rotor f. Imperfect connection between coupling and shaft	To be repaired. To be tightened by bolts securely. To be readjusted. To be cleaned. To be reconditioned.
	2. Improper magnetic center	To be reconditioned.
	3. Defective bearing	Refer to the “Bearing” section.
	4. Coupling deflection	To be reconditioned.
	5. Abnormal contact between shaft and stationary part, such as end cover, etc.	a. To be checked by turning manually. b. To be disassembled for detecting defects.
	6. Unsatisfactory contact of brush	Brush is to be checked for contact.
	7. Improper alignment	To be reconditioned.
	8. Sinking of foundation	To be reconditioned.
	9. Transmission of vibration from combined machine	Insulation for vibration.
	10. Unequal pitch of claw coupling	Reconditioning of pitch.
	11. Improper bush of flexible coupling	Reconditioning of pitch.

Abnormality	Probable Cause	Remedy
Noise	1. Disagreement of air gap 2. Single-phase operation	1.Causes are to be detected; repairs are to be made. 2.Causes of single-phase operation such as line cutting and imperfect contact are to be detected; repairs are to be made.
	3. Short-circuits of layer and phase of stator coil and rotor coil	To be reconditioned
	4. Abnormal contact between shaft and stationary part such as end cover	1. A check is to be made by turning manually. 2. To be disassembled for inspection
	5. Unsatisfactory foundation and installation	Readjustment of installation
	6. Loose bolts for foundation	Foundation bolts are to be tightened
	7. Gap between foundation and base	Reconditioning of installation
	8. Resonance with foundation	Readjustment of foundation.
Unbalance of phase current	1. Voltage unbalance	Power source and lines are to be checked and balanced.
	2. Single-phase operation	Line cutting and improper contact are to be reconditioned
	3. Secondary circuit	1. Rotor shaft coil resistance is to be measured and reconditioned. 2. Contact of brush or short-circuit ring is to be checked. 3. A check is to be made on endring contact of a squirrel cage motor.
Flaking of rolling elements	1. Excess of tightening allowance	1. Care should be taken on shaft at time of assembling and on bearing box at time of matching.
	2. Erroneous selection of clearance	2. Clearance is to be re-inspected.
	3. Minus operating clearance	3. Care should be taken at time of assembly
	4. Thermal expansion	4. Examination of working condition.
Breakage (total or partial) (a) Fracture (b) Cutting	1. Advancement of flaking caused by shock and below 2. Great tightening allowance & large round corner of fitted part	Careful handling. Examination of tightening. Examination of machining accuracy of shaft & bearing housing.
Rust (a) Rust formed all over surface (b) Rust on local place (c) Contact erosion on joint surface	1. Unsatisfactory condition of storage 2. Left alone 3. Inadequate cleaning 4. Rust-preventive reagent 5. Condensation 6. Inadequate allowance of tightening	Inspection of storage room. Careful handling. Examination of rust-preventive reagent. Re-examination of machining of shaft & bearing housing. Re-examination of working
Great damage of the bearing.	Bearing operated with more load than the appropriate.	Examination of the balancing, the belts stress, the coupling force to the shaft. Decrease the bearing load; remove any added loads to the shaft.
Corrugation creations on the bearing during the operation of the electric motor	Electricity passes to the bearing.	Careful Inspection by an authorized technician.
High levels of overheating temperatures during long time of operation	Bearing wearing ring must be in contact with the shaft surface.	Bearing cover fitting, replace the bearing-wearing ring. The user must be ensured for the proper fitting and the wear ring stiffening.
Noise like whistle of grease lubricated bearing.	Bearing runs dry.	Fill in with lubricant
High levels of overheating temperature immediately after starting.	a) Large quantity of lubricant oil. b) Not enough lubricant.	a)Fill with lubricant oil until the correct quantity. The electrical motor will recover its normal temperature in a small time interval. b) Fill in with lubricant