

LSA 53.2 / LSA 54.2

Industrial Range Alternators - 4 pole
Installation and maintenance

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Electric Power Generation	Installation and maintenance	5382 en - 2017.10 / e
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1. GENERAL INFORMATION

1.1 INTRODUCTION

1.1.0 General points

This manual provides installation, operating and maintenance instructions for synchronous machines. It also describes the basic construction of these machines. This manual is general ; it applies to an entire group of synchronous generators. Additionally, in order to make information-finding easier, Section 1, "Characteristics and Performance", has been included, describing the machine completely (type of construction, type of bearing, protection index, and so forth...); this will enable you to determine exactly the chapters which apply to your machine.

This synchronous machine has been designed for a maximum length of service. To achieve this, it is necessary to pay special attention to the chapter concerning the periodic maintenance schedule for the machines.

1.1.1 Safety notes

The warnings "**DANGER, CAUTION, NOTE**" are used to draw the user's attention to different points:

 **DANGER :**

THIS WARNING IS USED WHEN AN OPERATION, PROCEDURE, OR USE MAY CAUSE PERSONAL INJURY OR LOSS OF LIFE.

 **CAUTION :**

THIS WARNING IS USED WHEN AN OPERATION, PROCEDURE, OR USE MAY CAUSE DAMAGE TO OR DESTRUCTION OF EQUIPMENT.

NOTE :

This warning is used when an operation, procedure, or delicate installation requires clarification.

1.1.2 Conditions of use

1.1.2.1 Generalities

A machine must only be installed, operated, by qualified and trained persons.

Any technical engineer operating, maintaining this machine must be allowed to practice in regard with local working laws (eg: to be certified to operate on high voltage devices...).

Operation which require handling must be done by qualified persons (Slings techniques; use of lifting devices ...) Local procedures must be scrupulously respected.

Any product (sealing compound; cleaning product...) used during any maintenance or servicing must be in accordance with local regulation and environmental standard.

Waste disposal issued from servicing the machine must be managed in respect with local regulation and environmental standard.

The main data of this machine are summarized in "Section 1" of this manual.


Any operating condition other than those specified by the original tender must receive a Leroy Somer agreement.

Any modification of the machine structure must receive a Leroy Somer agreement.

1.1.2.2 Vibratory analysis

It is the responsibility of the gen set manufacturer to ensure that the different assembled system will be vibratory compatible.(ISO 8528-9 and BS5000-3).

It is the responsibility of the gen set manufacturer to ensure that the shaft line torsional analysis has been done and accepted by the different parties (ISO 3046).

 **CAUTION :**
EXCEEDING THE VIBRATORY LEVEL ALLOWED BY THE STANDARD ISO 8528-9 & BS5000-3 MAY CREATE HEAVY DAMAGES (BEARING DAMAGE, STRUCTURE CRACKS ...).
EXCEEDING THE TORSIONAL VIBRATORY LEVEL OF THE SHAFT LINE (ex: ABS, LLOYD ...) MAY CREATE HEAVY DAMAGES (CRANKSHAFT FAILURE, GENERATOR SHAFT FAILURE, ...).

Refer to chapter 2.1.3.4 for further information about the accepted vibration level of the standard ISO 8528-9 and BS5000-3.

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1.2 GENERAL DESCRIPTION

1.2.1 Generator (arep)

The synchronous generator is an alternating-current machine, without ring or brush. The machine is cooled by the flow of air through the machine.

For a better comprehension, use the drawings of [chapter 10](#).

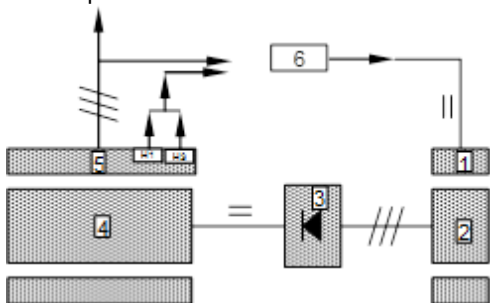
The Automatic Voltage Regulator (item 6) supplies the exciter field (static part ; item 1) in DC current.

The Exciter works as a reversed alternator.

The Exciter armature (rotating part ; item 2) generate a three-phase current which supplies the Rotating diodes bridge (rotating part ; item 3).

The Rotating diodes bridge (rotating part ; item 3) rectifies the three phases current in DC current which supplies the Revolving field (rotating part ; item 4).

The revolving field (rotating part ; item 4) excites the alternator armature (static part ; item 5) which generates a three phases current.



- 1- Excitation field winding
- 2- Excitation armature
- 3- Rotating diodes bridge
- 4- Revolving field
- 5- Alternator armature
- 6- Automatic Voltage Regulator
- H1- AREP winding detect harmonic 1
- H3- AREP winding detect harmonic 3

1.2.2 Excitation system

The excitation system is fitted at the Non Drive End side.

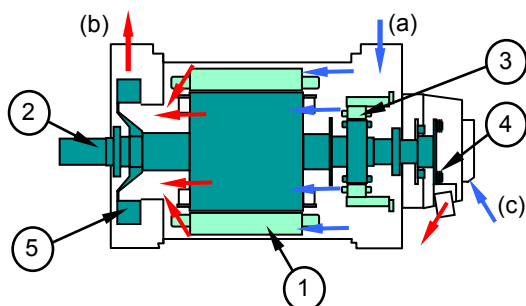
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2. DESCRIPTION OF SUB-ASSEMBLIES

2.1 STATOR

2.1.1 Electric machine armature

The alternator stator (armature) is a stacking of low losses steel laminations assembled under pressure. The stator coils are inserted and blocked in the slots, then impregnated with varnish and polymerised (VPI system).



- 1 - Stator
- 2 - Rotor
- 3 - Exciter
- 4 - Rotating diodes
- 5 - Fan
- a - Stator Air inlet (cold air)
- b - Stator air exhaust (warmed air)
- c - Rotating diodes air cooling

2.1.2 Excitation field winding

The excitation field winding comprises a wound solid element.
The excitation is flanged on the rear end shield of the machine.

2.1.3 Stator protection

2.1.3.1 Heating resistor

The heating element avoids internal condensation during the shutdown periods. It is connected to the main terminal box strip. The heating resistor is switched on as soon as the machine is shut down.

The electrical characteristics are provided in Section 1 "Technical Characteristics".

2.1.3.2 Stator winding temperature sensor

The temperature sensors are located in the zone assumed to be the hottest part of the machine. The sensors are connected to a terminal box.

Depending on the temperature rise of the machine, the temperature of the sensors should not exceed a maximum of :

TEMP. RISE class	ALARM		TRIP	
Power (KVA)	< 5000	> 5000	< 5000	> 5000
B	130 °C	125 °C	135 °C	130 °C
F	155 °C	150 °C	160 °C	155 °C
H	175 °C	170 °C	180 °C	175 °C

To improve the machine protection we recommend to set the alarm point following effective site conditions:

Alarm temperature (*) = Highest recorded temp + 10°K

Trip temperature (*) = Alarm temperature + 5 °K

(*) do not pass over the values of the previous table.

(*) Highest recorded temp: Temperature measured at the site in the worst temperature condition at the stator temperature sensor

E.g.: a class B machine (3000 kVA) reached 110°C during a factory heat run test. Set the alarm temperature to 120°C instead of 130°C as indicated in the previous chart. Set the emergency shutdown to 125°C instead of 135°C as indicated in the previous chart.

2.1.3.3 Stator air sensor

As an option an RTD or thermostat can measure the stator air inlet temperature (cold air).

Stator air inlet temperature; Alarm points and shutdown:

- alarm Nominal air inlet stator + 5 K
- shutdown 80°C

Stator air outlet temperature; Alarm points and shutdown:

- alarm Nominal air inlet stator + 35K
- shutdown Nominal air inlet stator + 40K

NOTE :

For an open drip proof machine the nominal air temperature entering the stator corresponds to the ambient temperature.

NOTE :

If quickly restarting after a stop Inhibit the stator air sensor safety "alarm" for few seconds (no more than 30 s) during the machine start up.

NOTE:

For a water cooled machine (CACW) the nominal air entering the stator may be approximated as following:
Tair entering stator = Twater entering cooler + 15°K.

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2.1.3.4 Bearing vibration sensor

The vibration level of the machines is directly linked to the duty and to the site characteristics.

We propose the following adjustment:

Vibration Alarm (*) = Site Highest Vibration level + 50%

Vibration Trip = Vibration Alarm + 50%

(*) do not pass over the values of the following chart

The machines are engineered to be able to withstand the vibration level specified by the standard ISO8528-9 and BS5000-3.

Maximum levels for : reciprocating Internal combustion engines

Nominal speed (rpm)	kVA	Generator vibration level (nominal conditions)	
		Overall (mm/s rms) (2-1000 Hz)	Any harmonics
1300 à 2199	> 250	< 20	< 0.5 mm ; pp (5 – 8 Hz) < 9 mm/s ; rm (8 – 200 Hz)
721 à 1299	≥ 250	< 20	
	> 1250	< 18	
≤ 720	> 1250	< 15	
		< 10 (*)	

(*) generator on concrete base

Maximum levels for : Turbines

Turbines (hydraulic ; gaz ; steam)	Max advised : 4.5 (overall ; mm/s rms)
------------------------------------	--

2.2 ROTOR

2.2.1 Revolving field-coil

The Revolving field is a salient pole type, without any fixing device as dove tail, cap bolt ...

The revolving field is heat-shrunk onto the shaft.

2.2.2 Excitation armature

The excitation armature is constructed by stacking magnetic steel laminations. These steel laminations are held in place by rivets.

The excitation armature is keyed and heat-shrunk onto the shaft.

The windings are enamelled copper wires, class "F" insulation (or "H", depending on the customer's request or size of the machine).

2.2.3 Fan (machines: IC 0 A1)

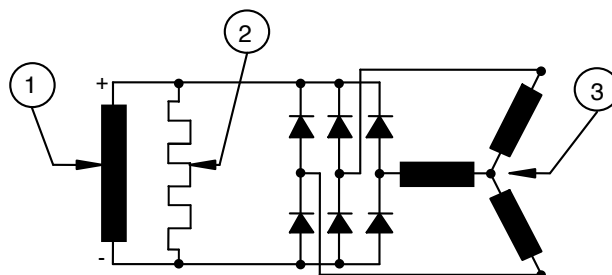
The synchronous machine is characterized by a self-ventilation system. A centrifugal fan is mounted between the revolving field coil and the front bearing.

Air intake is at the rear of the machine and the exhaust on the drive end side.

The fan consists of a hub, which is keyed and heat-shrunk onto the shaft. The flange is made of welded steel, attached to the hub with hexagonal head-cap screws. The ventilation effect is obtained through, inclined blades. The air is exhausted by centrifugation. The air inlet and outlet must remain free during operation.

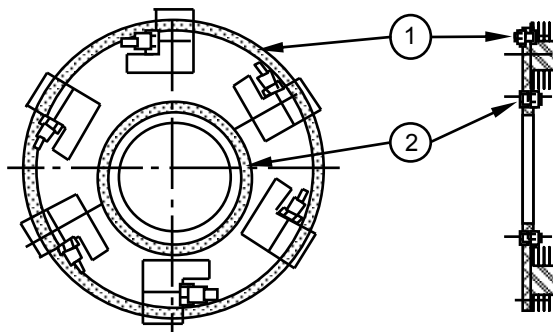
2.2.4 Rotating diode bridge

The rectifier bridge, comprising six diodes, is placed at the rear of the machine. The rotating bridge is made of fiber glass with a printed circuit to connect the diodes together. This bridge is supplied with alternating current by the excitation armature and supplies direct current to the revolving field-coil. The diodes are protected against over voltage by rotating resistors, or by varistors. These resistors (or varistors) are mounted in parallel with the revolving field-coil.



- 1 - Field
- 2 - Rotating resistors / varistors
- 3 - Exciter armature

The inner and outer rings are connected to the revolving field-coil.



- 1 - Outer ring
- 2 - Inner ring

The diode fastening screws must be tightened to the correct torque.



CAUTION :

THE ROTATING DIODE FASTENING SCREWS MUST BE TIGHTENED USING A TORQUE WRENCH CALIBRATED TO THE RECOMMENDED TORQUE.

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2.2.5 Balancing

The complete rotor has been balanced according to ISO8221 standard in order to obtain a residual imbalance less than :

Gen set : Class G2.5

Turbine : Class G1

The shaft end is cold-stamped to indicate the type of balancing (as per ISO8221)

H : balancing with **Half-key carried out as standard**

F : balancing with Full key (done on request)

N : balancing without key (done on request)

The balancing is carried out in two planes.

The first is on the fan. It is recommended, when the fan is refitted (after servicing) to respect the initial indexing.

The second is at the Non Drive End side.

The coupling must be balanced to fit the generator rotor balancing.

2.3 TERMINAL BOX

2.3.0 Description

Use the attached Terminal box drawing.

The openings provide access to the terminals.

The gland plates are made of non-magnetic materials in order to avoid circulating currents.

If accessories not supplied by Leroy Somer have to be installed in the terminal box (CT's, VT's, Shunt ...) refer to chapter.3.4.3.

2.3.1 Automatic voltage regulator (AVR)

When the automatic voltage regulator is located in the terminal box, it is fitted on a separate plate, insulated from vibration by means of dampers. The operation of the regulator is explained in Section 3.



CAUTION :

RUBBER DAMPERS MUST BE CHECKED PERIODICALLY AND REPLACED EVERY FIVE YEARS.

2.4 NAMEPLATES

2.4.1. Main nameplate

The main nameplate is fitted to the stator. It gives the manufacturer's electrical characteristics, the type of machine and its serial number. The serial number is necessary for any contact with the factory.

For machines with anti-friction bearings lubrication parameters are indicated.

2.4.2. Lubrication nameplate

The machines with Sleeve bearings have a lubrication plate attached to the bearing, indicating:

- Type of bearing
- Oil change frequency
- Oil capacity of bearing
- Oil viscosity.

The machines with anti-friction bearings have the lubrication parameters indicated on the main nameplate fixed on the stator, indicating :

- Type of bearing
- Grease-change frequency
- Quantity of grease
- Grease type

2.4.3. Rotation direction nameplate

Located on the stator an arrow indicates the direction of rotation.

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2.5 ANTI FRICTION BEARING

2.5.0 Description of antifriction bearings

The bearings ensure the rotor rotation guiding and axial location.

The bearings are protected from ambient dust by labyrinth seals and are of replaceable type.

The bearings must be lubricated regularly. The old grease is forced out at the lower part of the bearings by the force of the new grease being injected.

2.5.1 Antifriction bearing protection devices

As an option, the bearing may be equipped with RTD or PTC sensors to detect eventual overheating.

For special use in warm surroundings where the temperature of the bearings exceeds the authorised limit (for a bearing known to be in good condition), contact us.

Bearing; Alarm points and shutdown:

- alarm 90°C (194°F)
- shutdown 95°C (203°F)

To improve the machine protection we recommend to set the alarm point following effective site conditions:

Alarm temperature (*) = Highest recorded temp + 15°K
 (*) do not pass over the values of the previous chart.

E.g. : At site the common bearing temperature is 60°C. Set the alarm temperature to 75°C instead of 90°C as indicated in the previous chart.

NOTE:

Specific dedicated devices based on the analysis of the vibration signal are able to monitor bearings behavior.

2.6 Not applicable

2.7 Not applicable

2.8 Not applicable

2.9 Not applicable

2.10 AIR FILTERS

Only use approved filters. Any filter not correctly engineered may conduce to air flow restriction and then to abnormal generator cooling or to dust entering the generator.

2.11 Not applicable

2.12 TRANSPORT LOCKING SYSTEM

Certain type of Machines may have their rotor locked during transport.

The locking systems are red painted.

The locking systems must be removed just before the alternator final installation and re install if the alternator is later re transported.



CAUTION:

THE ROTOR LOCKING SYTEM MUST REMAIN IN PLACE IF THE ALTERNATOR IS SUBJECT TO BE TRANSPORTED.

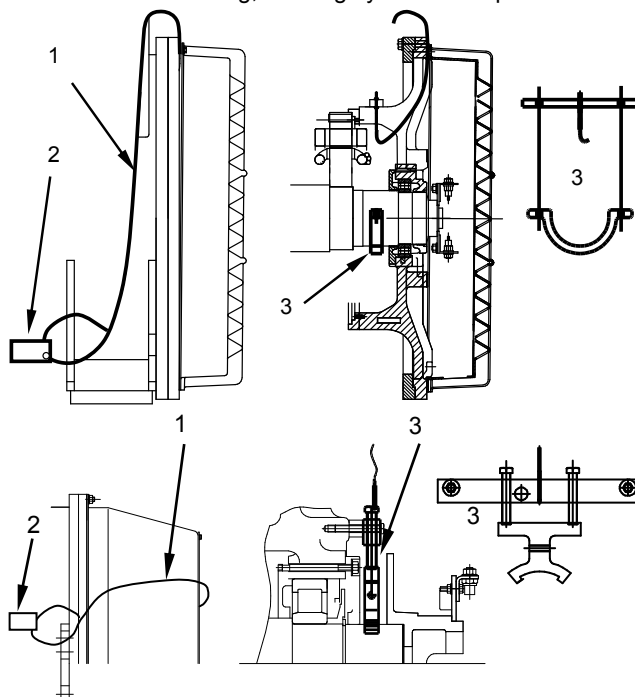


CAUTION:

THE ROTOR LOCKING FIXING SCREW MUST BE TIGHTENED TO THE NOMINAL RECOMMENDED TORQUE.

The Locking system fixing screws must be correctly tightened. A too low torque can conduce to an insufficient locking effect.

Non Drive End bearing; Locking system examples:



1 - Cable

2 – Red label out of the alternator indicating a Locking system

3 – Rotor locking system

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3. INSTALLATION

3.1 TRANSPORT AND STORAGE

3.1.1 Transport

During the transport the intermittent shocks level applied to the machines must remain below 30 m/s^2 .


Machines equipped with anti friction bearing must have their rotor locked during the transport to avoid "false brineling" problem.

Machine temperature must remain within the range -20°C to $+70^{\circ}\text{C}$. Stay down to -40°C during few hours is admitted.

The machine must be protected against bad weather conditions and condensation.

3.1.2 Storage warehouse

The machine must be stored in clean and dry premises which are not subject to abrupt changes in temperature or to high humidity (75% maximum).

 **CAUTION:**
THE HEATING RESISTOR MUST BE CONTINUOUSLY SWITCHED ON.

Storage at an ambient temperature of $+5$ to $+45^{\circ}\text{C}$ is recommended.


The machine must not be subject to vibrations higher than 1 mm/s rms .

3.1.3 Maritime packing


The synchronous machine is hermetically sealed then packed in a wooden crate.

In any case the generator must be stored in a warehouse (refer to chapter 3.1.2).

This packing provides access to the desiccant for periodic change (every 18 months).

 **CAUTION :**
BREAKING THE HERMETIC PROTECTIVE FILM DISCHARGES LEROY SOMER OF ITS LONG STORAGE GUARANTEE.

3.1.4 Unpacking and installation

 **DANGER :**
THE DEDICATED LIFTING HOOKS MUST BE USED TO LIFT THE MACHINE WITH SLINGS (ONE HOOK AT EACH CORNER OF THE MACHINE).

Rotors of machines with Sleeve bearings and single-bearing machines, are blocked during transportation so as to avoid any movement. Withdraw the retaining bars. The retaining bar is screwed to the end of the shaft and to the front support.

 **CAUTION :**
TRANSPORT LOCKING DEVICES PAINTED RED OR WITH RED STICKER MUST BE REMOVED.

The end of the shaft is protected from corrosion. Clean it before coupling.

The heating resistor must be switched on at all times.

Before starting the machine up again, it will be necessary to carry out a start-up inspection.

3.1.5 Storage measures of antifriction bearings

This chapter must be taken in consideration if a machine is stopped more than 6 months.

After 6 months of stop; grease by injecting two times the grease volume used for a standard maintenance.

Then, each 3 months turn the machine shaft line of few turns while injecting a standard grease volume.

3.1.6 Not applicable

3.1.7 Not applicable

3.1.8 Storage measures of open drip proof machines

For an open machine, it is recommended that the air inlet and outlet be closed.

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3.2 INSTALLATION OF THE MACHINE

3.2.1 Fitting the coupling (double-bearing machine only)

The coupling must be balanced separately before assembly on the machine shaft. Refer to the balancing instructions in chapter 2.2.5.

The shrinking of the half coupling onto the electrical machine shaft end must be chosen, by the gen-set manufacturer, in such way as it should be removable for maintenance (e.g.: bearing change).

3.2.2 Fitting the stator

Four plates on the frame enable the unit to be fitted to a skid.

The fixing bolts must support the forces created by the static and dynamic loads.

The machine may be positioned by means of 4 dowel pins. The dowel pins make later realignment easier. (The use of pins is optional).

The machine may be aligned through the use of 4 jacking-screws. These jacking-screws allow the machine to be positioned according to the various axes.

3.3 MACHINE ALIGNMENT

3.3.1 Alignment general points

3.3.1.1 General points

The alignment aims to obtain the driving shaft and the driven shaft coaxial when operating at the nominal conditions (machine rotating; at its operating temperature).

The machine must be aligned according to the Leroy Somer standard and adhere to the manufacturer's alignment standard for the drive machine.

When heating the machine has its shaft line which grow up. Between stop and rotation the shaft axis location inside its bearing is different. The total axis height elevation is composed of the thermal elevation and of the bearing elevation.

⚠ CAUTION:
THE ALIGNMENT MUST BE DONE TAKING IN CONSIDERATION OF THE SHAFT THERMAL GROWTH CORRECTION.

The correct locating of the parts must be obtained by inserting shims under the machine feet.

The double-bearing machines are mounted with bearings (ball or roller) or Sleeve bearings. The axial clearance of the bearings (if the machine has Sleeve bearings) must be distributed as well as possible, taking into account the axial thermal expansion. The Anti friction-bearing machines with a positioning bearing (standard machine) do not have axial play.

The machines are delivered with the rotor mechanically centered (axially and radially) in relation to the stator.

⚠ CAUTION :
THE ALIGNMENT STANDARDS OF MANUFACTURERS OF DRIVE MACHINES ARE FREQUENTLY MORE ACCURATE THAN THOSE OF LEROY SOMER.

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3.3.1.2 Shaft elevation caused by Thermal elevation

$$\Delta H \text{ (mm)} = \lambda (^{\circ}\text{K}^{-1}) \cdot H_{(m)} \cdot \Delta T (^{\circ}\text{K})$$

$H_{(m)}$ = Height of the machine axis

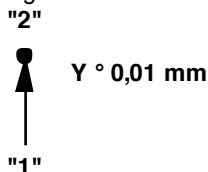
ΔT = frame temperature elevation = 30°C

λ = Coefficient of steel elongation = 0.012 °K-1

3.3.1.3 Not applicable

3.3.1.4 Shaft elevation of Anti-friction bearing machine

Caused by thermal growth of the anti friction bearing itself



1 - cold, in rotation, or stopped

2 - hot, in rotation, or stopped

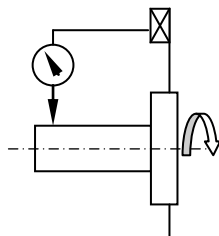
3.3.1.5 Generator check before alignment

Check the generator shaft end run out.

Total Indicator Reading must be within 0.04 mm.

NOTE:

RUN OUT CHECK CAN BE NOT FEASIBLE ON SLEEVE BEARING MACHINE BECAUSE OF THE TOO HIGH NECESSARY BREAK AWAY TORQUE NEEDED TO TURN THE ROTOR.



3.3.1.6 Alignment procedure "Double concentricity" alignment method

NOTE:

LASER DEVICES CAN MAKE THE JOB EASIER THAN WITH THE SHOWN PROCEDURE.

This method is not sensitive to axial movements.(the alignment methods using axial measure may often be perturbed by small axial movement of the rotor).

It is possible to check the alignment with the coupling installed.

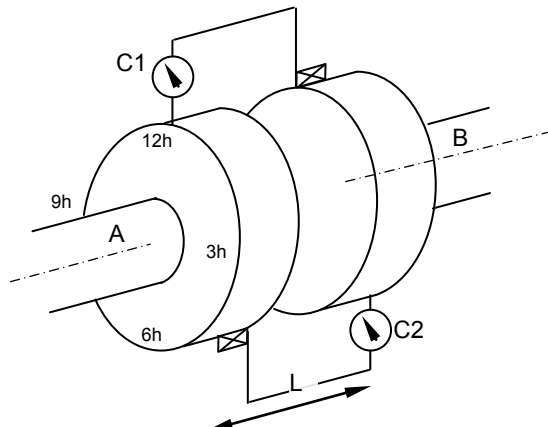
Equipment required :

Two rigid brackets. The rigidity of the two brackets is very important.

Two micrometers

Implementation :

During the measures, both shafts must turn simultaneously in the same direction. (For example : the coupling installed with its screws untightened). By turning both shafts simultaneously, the measurement is not affected by the error resulting from run out of the two shaft ends.



The "C1" and "C2" micrometers are located at an angular difference of 180°.

More the distance "L" is long better should be the sensitivity to detect the angular error.

The reading should be performed 4 times for the "C1" and "C2" micrometers : at 12h, 3h, 6h, 9h.

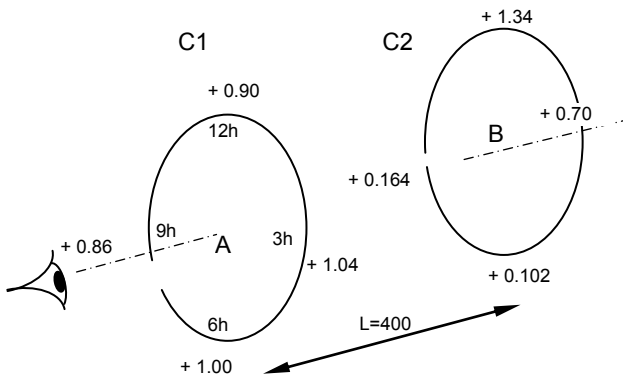
It is recommended to record the results and draw the axes for better evaluation, as explained below. Interpretation of measurements by means of an example.

Values given in millimeters. The reading is considered positive (+) when the micrometer stylus is pushed inwards.

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MEASUREMENTS



Measurements referring to the vertical plane:

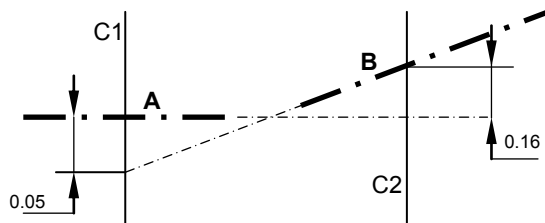
Considering the vertical plane "C1": The vertical action towards the top of shaft "A" on the micrometer is dominant.

In the plane "C1" the axis "A" is higher than axis "B"
 $(0.9 - 0.1) / 2 = -0.05 \text{ mm}$

In the vertical plane "C2", the vertical action towards the top of shaft "B" on the micrometer is greater.

In the plane "C2" the axis "B" is higher than axis "A"
 $(0.134 - 0.102) / 2 = 0.16 \text{ mm}$

The respective position of the axes is as follows:



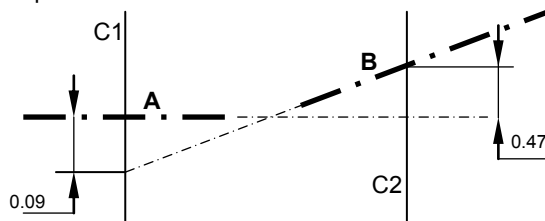
Regarding the vertical plane the angular alignment error is:
 $(0.16 + 0.05) * 100 / 400 = 0.0525 \text{ mm}/100\text{mm}$ (not acceptable)

Measurements referring to the horizontal axis:

In the plane "C1" the axis "B" is further to the right than "A"
 $(0.104 - 0.86) / 2 = 0.09 \text{ mm}$

In the plane "C2" the axis "B" is further to the left than "A"
 $(0.70 - 1.64) / 2 = -0.47 \text{ mm}$

The representation of the shafts is as follows:



Regarding the horizontal plane the angular error is:
 $(0.47 + 0.09) * 100 / 400 = 0.14 \text{ mm}/100\text{mm}$ (not acceptable)

In the both planes the parallelism error is:

$\sqrt{5^2 + 9^2} = 0.103 \text{ mm}$ or $\sqrt{16^2 + 47^2} = 0.496 \text{ mm}$ (not acceptable)

3.3.2 Two bearings machine alignment (flanged)

3.3.2.1 Machines without axial end play (standard)

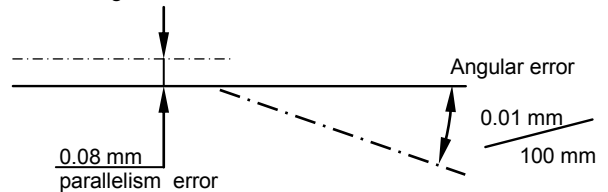
The alignment must take the tolerances of the coupling into account.



CAUTION:

A MISALIGNMENT EVEN IF ACCEPTABLE BY THE COUPLING MUST NOT CREATE STRESSES LEVEL NOT ACCEPTABLE BY THE BEARING.

Shafts alignment limits to follow:



To check the alignment, there are different methods: the "double concentricity" method is described in the "alignment procedure" chapter 3.3.1.6.

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3.4 ELECTRICAL CONNECTIONS

3.4.0. General points

The installation must comply with the electrical schematics attached in Section 5.

Check that all the protection devices are correctly connected and in good working order.

The assembler has the responsibility to mechanically and electrically protect the generator within the best practice rules and to secure any operation over the defined tender (respect of capability curve ; overspeed ...).

For low-voltage machines, power supply cables must be connected directly to the machine terminals (without adding washers, etc).

For high-voltage machines, power supply cables should be connected to separate terminals or to current transformer terminals.

NOTE:

THE GLAND PLATE IS MADE OF NON MAGNETIC MATERIAL.

⚠ CAUTION

DO NOT ADD WASHERS TO THE POWER SUPPLY CABLE TERMINALS OTHER THAN THOSE USED BY THE MANUFACTURER OF THE ELECTRIC MACHINE.

Check that the lugs are tightened (refer to chapter 5.8).

⚠ CAUTION

ALL CURRENT TRANSFORMERS MUST BE CONNECTED OR SHUNTED.

⚠ CAUTION

THE VOLTAGE TRANSFORMER MUST NEVER BE SHUNTED.

⚠ CAUTION

THE INSTALLED POWER CABLES MUST BE FIXED AND SUPPORTED IN SUCH A WAY AS TO BE ABLE TO WITHSTAND THE VIBRATION LEVEL REACHED BY THE GENERATOR IN OPERATION (refer to chapter 2.1.3.4).

The power cables must not stress (push, pull, bend, ...) the generator terminals.

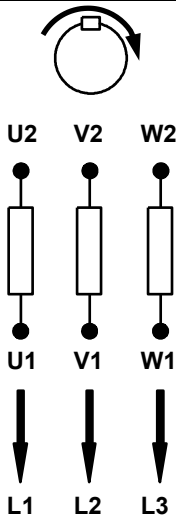
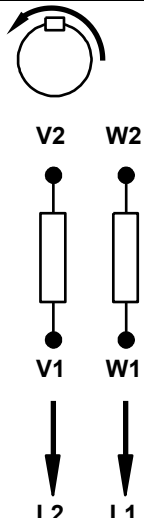
3.4.1 Phase-sequence

3.4.1.1 Standard units ; IEC 34-8

Except by special request of the customer, the phase-sequence is carried out using the IEC 34-8 standard.

An arrow located on the front bearing indicates the direction of rotation.

In the terminal box a specific marking plate indicates the specific generator phase sequence.

Clockwise rotation viewed from the shaft drive end	Counter clockwise rotation viewed from the shaft drive end
The phases are marked: U1, V1, W1.	The phases are marked: U1, V1, W1.
Viewed when facing the terminal box door the terminals are : U1, V1, W1	Viewed when facing the terminal box door the terminals are : U1, V1, W1
The installer connects : L1 --> U1 L2 --> V1 L3 --> W1	The installer connects : L3 --> U1 L2 --> V1 L1 --> W1
	

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3.4.1.2 On request ; NEMA

An arrow located on the front bearing indicates the direction of rotation.

In the terminal box a specific marking plate indicates the specific generator phase sequence.

Counter clockwise rotation viewed from the stator connection (NEMA) (Clockwise rotation viewed from the shaft drive end following IEC)	Clockwise rotation viewed from the stator connection (NEMA) (Counter clockwise rotation viewed from the shaft drive end following IEC)
The cables are marked: U1, V1, W1. The terminals are marked : T3, T2, T1	The cables are marked: U1, V1, W1. The terminals are marked : T3, T2, T1
Viewed when facing the terminal box door the terminals are : U1, V1, W1	Viewed when facing the terminal box door the terminals are : U1, V1, W1
The installer connects : L1 --> (U1) T3 L2 --> (V1) T2 L3 --> (W1) T1	The installer connects : L3 --> (U1) T3 L2 --> (V1) T2 L1 --> (W1) T1

3.4.2 Insulating distances

Products not delivered by Leroy Somer and then installed in the terminal box must meet the electrical insulating distances.

This applies to power cables and lugs, and to added transformers, etc.

Nominal Voltage	500 V	1 KV	2 KV	3 KV
Phase-Phase in the air (mm)	25	30	40	60
Phase-Earth in the air (mm)	25	30	40	60
Phase-Phase Creeping (mm)	25	30	40	70
Phase-Earth Creeping (mm)	25	30	40	70

Nominal Voltage	5 KV	7,5KV	12,5KV	15 KV
Phase-Phase in the air (mm)	120	180	190	190
Phase-Earth in the air (mm)	90	120	125	125
Phase-Phase Creeping (mm)	120	180	190	190
Phase-Earth Creeping (mm)	120	180	190	190

3.4.3 Added products in the terminal box

This may apply to site added customer CTs ; VTs etc.

Leroy Somer must be informed if some appliances have to be installed in the generator terminal box.

The products not delivered by Leroy Somer and then installed in the terminal box must meet the electrical insulating distances. Refer to chapter 3.4.2.

The installed appliances must be able to withstand vibration.

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4. START-UP

4.1 ELECTRICAL START-UP INSPECTION

4.1.0 General points

Electrical connections (auxiliaries, safeties and power connections) must comply with the schematics provided.

Refer to Section 5 to get the concerned schematics.

⚠ DANGER:
CHECK THAT ALL SAFETY EQUIPMENT OPERATES CORRECTLY.

4.1.1 Winding Insulation

The insulation and the polarization index must be measured on start up.

To measure the insulation (refer to chapter 5.10).

4.1.2 Electrical connections

The phases must be connected directly to the machine links (with no spacers or washers, etc).

Make sure that the lugs are sufficiently tightened.

⚠ CAUTION:
ALL CURRENT TRANSFORMERS MUST BE CONNECTED BEFORE START UP. IF CURRENT TRANSFORMER NOT USED ITS OUTPUT MUST BE SHORTED.

4.1.3 Parallel operation

4.1.3.1 Definition of parallel operation

• Between machines

Operation mode named by Leroy Somer "1F".

At least two alternators are connected in parallel to supply a load.

The Automatic Voltage Regulator is in voltage regulation mode.

A droop Current Transformer is necessary to share the reactive load.

• With the mains

Operation mode named by Leroy Somer "3F".

At least one alternator is connected in parallel with the mains (Public electricity network).

The Automatic Voltage Regulator is in Power Factor regulation mode.

4.1.3.2 Possibility of parallel operation

⚠ CAUTION:
PARALLEL OPERATION CAN ONLY BE USED FOR ALTERNATOR ENGINEERED FOR SUCH OPERATION.

4.1.3.3 Parallel coupling

⚠ CAUTION:
A WRONG SYNCHRONIZATION CAN LEAD TO MAIN DAMAGES (HIGH MECHANICAL OVERTORQUE AND OVER CURRENT).

During synchronization the following values must not be overpass:

Max frequency shift : 0,1 Hz

Max phase offset : 10° (electrical angle)

Max voltage (phase - neutral) between machines :
(at phase offset =0) 5 % of the nominal voltage

In case of wrong synchronization, or mains micro interruption inducing a fault over the indicated limits Leroy Somer will not be considered as responsible of the damages.

4.2 MECHANICAL START-UP INSPECTION

4.2.0 General points

4.2.0.1 Alignment ; fixing ; prime mover

The installation must comply with the manufacturer's installation rules for drive machine (alignment, mounting).

An arrow at the drive end, end shield, indicates the direction of rotation.

4.2.0.2 Cooling

The air inlet and exhaust must be unobstructed.

The cooling auxiliaries (water circulation in the cooler, etc) must be operating.

4.2.0.3 Lubrication

Lubrication must be carried out as per chapter 5. Lubricant quantity and periodicity as per Section 1.

4.2.1 Anti friction bearing machines start up

The bearings are pre-lubricated in the factory, but before they are put into service, it is necessary to re grease in order to fill the free spaces in the greasing circuit and to evacuate the storage grease.

⚠ CAUTION
UPON START-UP, GREASE THE MACHINE WHILE IT IS RUNNING.

Record the temperature of the bearings during the initial operating hours. Poor lubrication can cause abnormal heating.

If the bearing hisses, lubricate it immediately. Some bearings may make a clattering noise if they do not operate at normal temperature. This may occur if the weather is very cold or when the machine is operating under abnormal temperature conditions (start-up phase, for example). The bearings will become quieter after having reached their normal operating temperature.

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4.2.2 Not applicable

4.2.3 Not applicable

4.2.4 Vibrations

The vibration measurement must be taken on each bearing in the three directions. The measured levels must be lower than the specified values indicated in the chapter 2.1.3.4. Adjust the sensor as per chapter 2.1.3.4.

4.3 START-UP SEQUENCE

The generator start up (commissioning) must follow the following sequences:

4.3.1 Static checks

Machine fixing as per chapter 4.2.
Alignment as per chapter 3.3.
Cooling as per chapter 4.2.0.2.
Electrical connections as per chapter 4.1.2.
Winding insulation as per chapter 5.10.

4.3.2 Rotating checks

4.3.2.0 Rotor speed rate of rise (Standard unit)

There is no restriction regarding the rate of rise of the rotor spin up from stop to nominal speed.
There is no restriction regarding the load rate of rise.

4.3.2.1 Rotating checks not excited

Run the generator without excitation by steps to verify the bearings temperature as per chapter 2.5.1.
At the nominal speed (not excited) measure the vibrations. Check that the vibration level is in accordance with the generator duty (as per chapter 2.1.3.4).

4.3.2.2 Rotating checks at no load excited

In AVR manual mode; Voltage adjustment; check the excitation current value (refer to Section 4 for the AVR manual and to Section 2 for the generator test report)
In AVR automatic mode; Voltage adjustments; Voltage range; check the excitation current value (refer to Section 4 for the AVR manual and to Section 2 for the generator test report).
At the nominal speed (excited) measure the vibrations. Check that the vibration level is in accordance with the generator duty (as per chapter 2.1.3.4).

4.3.2.3 Generator and site safety parameters

Proceed to the site safeties adjustment (over voltage relay, over current relay, differential protection; negative sequence relay...). The setting points are not in Leroy Somer scope of supply.
The settings must comply with the generator data sheet (eg: capability curve; thermal damage curve ...).
Check the synchronizer setting following chapter 4.1.3.3.
For any operation at a speed exceeding the nominal range (generally the main frequency +3%) the generator excitation must be shut off (refer to the electrical schematics).

4.3.2.4 Rotating checks at full load

Operating In parallel with the mains.
Adjust the Power Factor
Load the generator step by step :
Check the excitation current at 25% of the rated load.
Check the excitation current at 100% of the rated load.

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At the nominal speed (full load) measure the vibrations.
Check that the vibration level is in accordance with the
generator duty (as per chapter 2.1.3.4).

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4.3.3 Generator start up check list

TYPE		SERIAL N°	
Voltage		V	Frequency Hz
Output Power		kVA	Speed rpm
		Power Factor	

STATIC CHECKS

Mechanical checks

- Direction of Rotation (refer to Section1) Clock Wise ☐ or Anti-clock Wise ☐
- Mechanical Fixing of the generator (refer to chapter 4.2) ☐
- Coupling - Alignment to the engine (refer to chapter 3.3) ☐
- **Cooling** : Coolant flow (refer to Section1 ; chapter 4.2.0.2) ☐
- Air inlet and exhaust free ☐
- **Bearing lubrication** : Sleeve Bearings Lubrication (flow ; level ; oil type) (refer to Section1) ☐
- Or Anti-friction Bearings Greasing (refer to Section1 & chapter 4.2.1)
- Temperature sensors (correct readings) (refer to Section1 & chapter 2.5.1) ☐
- Space Heaters (refer to Section1) ☐

Type of AVR : 1F ☐ 3F ☐

Electrical connections between alternator, AVR and main panel : (refer to Section 4 & drawing Section 5)

- Output power cables connections following phase order (refer to chapter 3.4.1) ☐
- Terminal box connections ☐
- AVR detection voltage ☐
- Supply power and excitation terminals ☐
- Network detection (3F only) ☐
- Command signals (equalization and synchronization for 3F) ☐
- Excitation polarity and booster ☐
- Protective devices : (Bearing oil level fault detectors; Temperature sensors, etc) ☐
- External accessories (e.g.. remote potentiometer) ☐

ALL CURRENT TRANSFORMERS MUST BE CONNECTED

Windings insulation

	Winding temp:.....°C	Voltage	1 minute (MΩ)	10 minutes (MΩ)	Polarisation index
Static parts	3 Phases / Ground				
	"U" /Ground				
	"V" /Ground				
	"W" /Ground				
	"U" / "V"				
	"U" / "W"				
	Exciter field / Ground				
Rotating parts	Rotor / Ground	≤ 500 V			
	Exciter armature / Ground	≤ 500 V			
	Rotating resistances	≤ 500 V			
	Rotating diodes	≤ 500 V			

All works must be carried out by a qualified and authorized person.

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ROTATING CHECKS

WITH EXCITATION - AT NO LOAD CONDITIONS

- Verification of the bearings temperature (refer to chapter 2.5.1) _____ °C ☐
- In manual mode :
 - Voltage adjustment _____ ☐
 - Excitation current check _____ ☐
- In automatic mode :
 - Voltage Setting (referring to nominal voltage) _____ ☐
 - Excitation current check _____ ☐
- Parallel coupling : Adjustment to parallel operation (3F) _____ ☐

A FAULTY SYNCHRONISING CAN BE THE ORIGIN OF DAMAGES (HIGH MECHANICAL OVER-TORQUE)

- Maximum acceptable values for synchronization to the mains :
 - Maximum frequency shift 0,1 Hz ☐
 - Maximum Phase offset 10 ° ☐
 - Maximum voltage (P.N.) difference 5% of Un ☐

Control / Adjustment of the site safety Parameters

- Over-voltage, _____ ☐
- Over-current (by short-circuit on stator in separate excitation mode), _____ ☐
- Negative sequence relay, _____ ☐
- Over-speed, _____ ☐
- Differential protection (in static conditions), _____ ☐
- Other protective device. _____ ☐

CHECK THAT ALL SAFETY EQUIPMENT OPERATES CORRECTLY

WITH EXCITATION - LOADED

Take the load gradually from 0 to 100% in steps of 25%

Record for each step (refer to Section 1):

- Electrical output (KW)
- POWER FACTOR
- Voltage (V)
- Current (A)
- Excitation Current / voltage
- Winding temperature

Time	KW	pf	Volts	I (A)	I (ex)	U1 (°C)	V1 (°C)	W1 (°C)

- Bearings temperature (if thrust sensor available, please record its value)

Time	DE Thrust (°C)	DE Radial (°C)	NDE Radial (°C)

- Oil inlet temperature (if applicable ; refer to Section 1)
- Oil flows (if applicable ; refer to Section 1)
- Bearings vibrations (mm/s) (refer to chapter 2.1.3.4)

DE-V	DE-H	DE-A	DE-V	DE-H	DE-A

All works must be carried out by a qualified and authorized person.

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5. MAINTENANCE AND SERVICING

5.0 GENERAL



DANGER :

BEFORE ANY WORK ON THE GENERATOR, MAKE SURE THAT THE START-UP CANNOT BE ACTIVATED BY ANY MANUAL OR AUTOMATIC SIGNAL. CHECK THAT ALL LOCKS ARE ENGAGED AND FOLLOW THE SITE SAFETY PROCEDURES.



DANGER:

BEFORE WORKING ON THE MACHINE, MAKE SURE THAT YOU HAVE UNDERSTOOD THE OPERATING PRINCIPLES OF THE SYSTEM. IF NECESSARY, REFER TO THE APPROPRIATE CHAPTERS IN THIS MANUAL.

To obtain additional information on the maintenance of sub-assemblies, refer to the chapters dealing with the sub-assemblies concerned.

When a defective part is replaced with a spare part, make sure that it is in good condition.

For any electrical work use electrical schematics for assistance.

The whole machine must be kept clean.



CAUTION :

ALL THE CLEANING PERIODS INDICATED IN THIS MANUAL MAY BE CHANGED (INCREASED OR DECREASED) ACCORDING TO SITE CONDITIONS.

The air inlet and air outlet surfaces must be maintained clean (Louvers can be cleaned as per the filters) refer to chapter 5.7.1.



CAUTION :

DIRT ENTERING THE MACHINE MAY POLLUTE AND THUS REDUCE THE ELECTRICAL INSULATION.



CAUTION :

ANY PRODUCT (SEALING COMPOUND, CLEANING PRODUCT...) USED DURING MAINTENANCE OR SERVICING MUST BE IN ACCORDANCE WITH LOCAL REGULATION AND ENVIRONMENTAL STANDARD.

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5.1 MAINTENANCE SCHEDULE

5.1.0 Not applicable

5.1.1 Stator

	Hours	Comments	Task duration
Winding temperature	24	Daily operation, (without gen stop)Refer to 2.1.3.2	
Insulation	8000	(*1) Refer to 5.10	4hrs
Polarization index	8000	(*1) Refer to 5.10.2	
Bolts tightening	8000	(*1) Refer to 5.8	2 hrs
Winding visual inspection	8000	(*1) Refer to 5.10	1 hr
Stator RTD function	8000	(*1) Refer to 2.1.3.2	
Cleaning air inlet and outlet	1000	(*1) Refer to 5.7	

5.1.2 Rotor

Insulation	8000	(*1) Refer to 5.10	0.5 hr
Polarization index	8000	(*1) Refer to 5.10.2	
Winding visual inspection	8000	(*1)	
Cleaning diodes	8000	(*1)	0.5 hr
Diodes and varistor check	8000	(*1)	
Diodes tightening	8000	(*1)	

5.1.3 Terminal box

Cleaning	8000	(*1)	0.5 hr
Regulator assembly & supports	8000	(*1) Applicable if mounted in the terminal box	
Bolts tightening	8000	(*1)	1.5 hrs

(*1) or once a year

5.1.4 Not applicable

5.1.5 Anti friction bearing

Following technical specification in "Section 1"

Re greasing		See lub plate; Or every 6 months whichever come first	
Bearing temperature	24	Daily operation, (without gen stop)Refer to 2.5.1	

5.1.6 Not applicable

5.1.7 Rubber dampers

Rubber dampers	8000	Refer 2.3.1	
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5.1.8 Filters

Following technical specification in "Section 1"

Cleaning	1000	Cleaning following site conditions; Refer to 5.7.1	4 hrs
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5.1.9 Not applicable

5.1.10 Protection devices

Protection devices	8000	(*1)	
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(*1) or once a year

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5.2 AIR GAP CHECK

5.2.1 General points

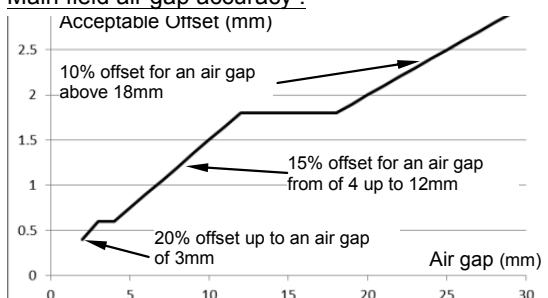
The air gap measurement is not always possible because of a lack of access. When the air gap can be reached the measure can be distorted because of paint and resin coating on the checked surfaces.

Measure the air gap at different points (minimum four different points spaced of 90°).

Calculate an averaged value (sum of the measures divided by the number of measures).

Compare the averaged value to each measure.

Main field air gap accuracy :



Eg : for a nominal air gap of 3 mm an air gap measured value of 2.4 mm is acceptable

Eg : for a nominal air gap of 10 mm an air gap measured value of 8.5 mm is acceptable

Exciter air gap accuracy :

50% of the nominal value (eg: for an a nominal air gap of 3mm a read value of 1.5 mm is acceptable)

Permanent Magnet Generator (optional) air gap accuracy:

50% of the nominal value (eg: for an a nominal air gap of 1mm a read value of 0.5 mm is acceptable)

5.2.2 Double bearing machine

Verification of the air gap is not necessary. The rotor is mechanically centered by its construction. Even after dismantling and reassembling the machine, the rotor will return to its position without verification of the air gap. The exciter air gap of generators type A60 and A62 can be adjusted on site by 2 jacking screws.

5.3 ANTI FRICTION-BEARINGS

5.3.1 General points

NOTE:

Few international studies report that more than 80% of the anti friction bearing installed worldwide for any duty are prematurely damaged because of lubrication trouble. To preserve your machine we recommend to closely fulfill the recommendations of this manual.

They must be lubricated regularly with the same type of grease as used in the factory. For information concerning the lubrication quantity and interval, refer to Section 1: "Characteristics and Performance".



CAUTION:

LUBRICATION MUST BE CARRIED OUT AS PER SECTION 1 OR AT LEAST EVERY 6 MONTHS WHICHEVER COME FIRST.

NOTE:

After a regreasing the bearing temperature may increase of 10 to 20°C.

This temporary temperature increase may stay few tens of hours.

NOTE:

In case of a "stand by" duty or generator with short operation cycles it is recommended to run the machine during at least 3 hours after each regreasing.

NOTE:

For re greasing period lower than 2000 hours we recommend to install a continuous greasing system to limit the maintenance operators visit.

These type of system must be disable during machine stop. The grease contained in these systems must not be stored over a period of 1 year.

5.3.2 Cleaning bearings from old grease

This note is applicable when the type of grease is changed.

Dismantle the machine in order to get to the bearing.

Remove the old grease with a palette knife.

Clean the lubricator and the grease removal tube.

For greater cleaning efficiency, use a brush with solvent.

NOTE:

Used solvent must be in accordance with local regulation and environmental standard.



DANGER:

THE PROHIBITED SOLVENTS ARE:

CHLORINATED SOLVENT

(TRICHOLORETHYLENE, TRICHLOROETHANE) WHICH BECOMES ACID

FUEL-OIL (EVAPORATES TOO SLOWLY)

GASOLINE CONTAINING LEAD

BENZINE (TOXIC).

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After cleaning ensure that the bearing becomes perfectly dry.

Fill the bearing with the new grease.

Re-assemble the cage and the parts, which have been dismantled, filling them with grease (2/3 of the empty spaces must be filled with new grease).

Use a grease pump to complete the bearing lubrication (while machine running).

5.3.3 Cleaning bearings assembly area

Bearing life is directly impacted by the cleanliness of the lubricant. The dirt must not enter or pollute the bearings. Excess of grease must be removed before operation in order to avoid pollution of the environment as well as the alternator.

Periodically:

clean the labyrinth seals outside face. Remove the excess of grease which may appears onto the shaft.

Remove the excess of dry old grease from the bearing exhaust channel (use a clean blade).

After removing the old grease check that a small fresh volume of grease will plug the exhaust channel (to avoid pollution coming back to the bearing).

5.3.4 Bearing removal

The inner bearing race is mounted, shrunk onto the shaft.

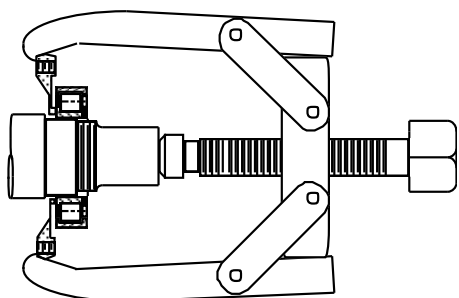
The outer bearing race is free, or slightly tightened, on the hub (depending on the type of bearing). To remove the bearing from the shaft, it is necessary to use a dedicated hub-puller to avoid damaging the surface of the shaft.

Typical bearing drawing assembly is joined in chapter 10.

⚠ CAUTION:
CLEANLINESS IS IMPERATIVE

NOTE:

Heat the bearing during the pulling operation is recommended to prevent the shaft from being scored.



5.3.5 Bearing re-assembly

A bearing can be refitted if it is known to be in perfect condition. As far as possible we recommend to use a brand new bearing.

Before refitting a bearing, carefully clean the surface of the bearing and the other parts of the bearing.

Measure the shaft diameter to check it is within the recommended tolerances.

To install the bearing on the shaft, it is necessary to heat the bearing. The heat source may be an oven or a space heater (the use of oil baths is not recommended). The use of an induction bearing heater is recommended.

⚠ CAUTION:
NEVER HEAT A BEARING TO MORE THAN 125°C (257°F).

Push the bearing up to the shaft shoulder, and check after cooling that the inner ring is still in contact with the shoulder. Lubricate using the recommended grease. Fill the bearing covers with new grease.

5.4 Not applicable

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5.5 LUBRICANTS

5.5.1 Greases

Recommended lubricant:

MOBIL POLYREX EM (polyurea base).

SKF LGWA2 (lithium complex base).

Recommendation for a substitution grease choice ::

Mineral oil or PAO (SHC)

Base (soap) grade NLGI 2

Lithium complex base (Lithium base accepted)

Base oil viscosity at 40°C: 100 to 200 mm²/s

Dye penetration test (DIN 51817) : 2% minimum

Greases recognized as possible substitution grease:

CASTROL LMX NLGI2

TOTAL Multis complex EP2



CAUTION :

THE USE OF A SUBSTITUTION GREASE CONDUCE TO REDUCE THE RE GREASING PERIOD OF 30%.

NOTE:

Lithium and complex lithium soap can be mixed

Lithium complex and calcium lithium soap can be mixed

In case of change of grease brand it is recommended to proceed to a massive greasing to waste the previous grease.

NOTE:

Mixing different types of grease never give as result an addition of the good greases properties ! Mixing of different types of grease must be done only after getting the grease supplier agreement or after cleaning the bearing from the old grease.

5.5.2 Oils

5.5.2.1 General

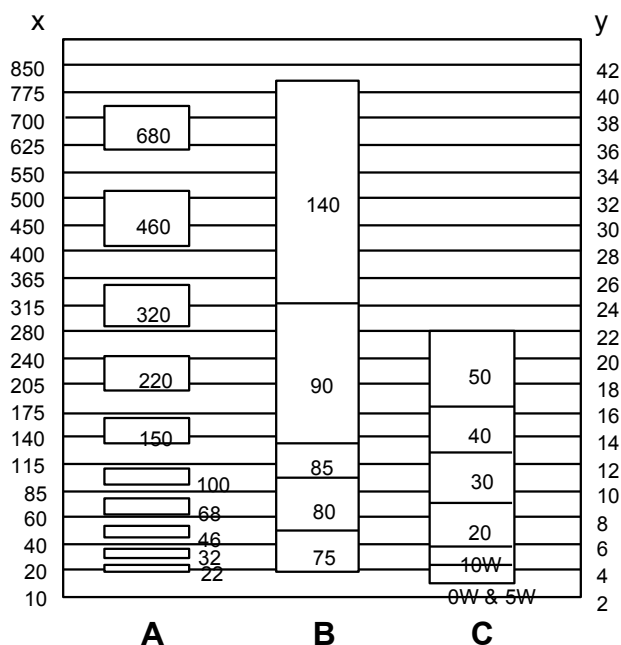
We do not have any special recommendation regarding any mineral oil manufacturer.

The used oil must comply with the requested viscosity (refer to Section 1).

For frequent cold starting (lower than -15°C) without oil sump heater, please contact us. A new oil viscosity may be advised.

Use a non-foaming mineral oil, without additives. If an oil containing additives has to be used, make sure that the supplier confirms the chemical compatibility of the oil and the anti-friction properties.

Viscosity data (for information) :



x - CST at 40°C

y - CST at 100°C

A - ISO (VG)

B - SAE J306c Transmissions

C - SAE J300d motors

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5.5.2.2 Synthetic oils

Since the synthetic lubricants are not standardized, no guarantee can be given regarding their chemical and mechanical behavior. Some synthetic lubricant may become acid and destroys bearing parts (white metal, oil ring, sight indicator...) in a short time.

If synthetic oil has to be used; during the first 2000 hours of use the lubricant should be checked at short intervals.

Synthetic oils group concerns :

- Synthetic hydrocarbons (SHC)
- Poly-Alpha-Olefins (PAO)
- Esther (Diester/Polyolester)
- Phosphoric ester / Phosphoric triarylester
- Polyglycols / Polyalkylglycols
- Biodegradable lubricants
- White oils



CAUTION:

SYNTHETIC OILS MAY BE USED WITHOUT "LS" APPROVAL ONLY IF USED LUBRICANT ARE ISSUED FROM THE FOLLOWING LIST.

Authorized synthetic oils without "LS" special agreement:

	viscosité (cSt ; 40°C)	Type
KLUBER	32	Summit SH 32
	44	Summit SH 46
	62	Summit SH 68
	81	Summit SH 100
MOBIL	31	SHC 624
	65	SHC 626
SHELL	32	Madrella Oil AS 32
	48	Madrella Oil AS 46
	68	Madrella Oil AS 68
PANOLIN	46	Turwada Synth 46
	68	Turwada Synth 68

5.5.2.3 Mineral oils

Mineral oils containing special additives (diesel engine oils) must have a Total Base Number (marked TBN or BN) strictly below 40 mgKOH/g.

5.5.2.4 Oil filtering and pollution

Following indications are related to the maximum acceptable oil pollution level and to the oil filtering level (filter efficiency) which has to be installed to obtain a clean oil.

Refer to Section 1 to get data about the used bearing.

The viscosity change must remain within +/- 10% of a fresh oil lubricant.

Acid Number (TAN) : must not exceed 2.

Acidity change must remain (TAN) +/- 0.5 mg KOH/g of a fresh oil lubricant.

Humidity ratio must remain below 0.05 %.

This paragraph applies to bearings designed for high axial thrust (tilting pads technology as used in bearings typeA) or oil lubricated anti friction bearing :

Maximum acceptable pollution:

following ISO 4406 : 17/15/12

following NAS 1638 class 7

Filtering level to ensure :

following ISO 16889 : $\beta_{10(c)} = 100$ (filtering 10 μ)

This paragraph applies to standard bearings with low axial thrust, self lub or oil circulation (as types E..Z.K ; E..Z.Q) :

Maximum acceptable pollution:

following ISO 4406 : 18/16/13

following NAS 1638 class 9

Filtering level to ensure (oil circulation bearing):

following ISO 16889 : $\beta_{25(c)} = 100$ (filtering 25 μ)

5.6 Not applicable

5.7 AIR FILTER

5.7.1 Cleaning

5.7.1.1 Air filter cleaning period

The cleaning period depends of the site conditions and can change.

The cleaning of the filter is requested if the record of the stator winding temperature (using the stator winding sensors) indicates an abnormal increase in temperature.

5.7.1.2 Air filter, cleaning procedure

The filter element (flat or cylindrical) is immersed in a tank of cold or warm water (temperature less than 50°C). Use water with detergent added.

Shake the filter gently to ensure that the water flows through the filter in both directions.

When the filter is clean, rinse it with clear water.

Drain the filter properly (there must be no more formation of droplets).

Refit the filter on the machine.

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⚠ CAUTION:

DO NOT USE WATER WITH A TEMPERATURE HIGHER THAN 50°C, DO NOT USE SOLVENTS.

NOTE :

Do not clean the filter using compressed air. This procedure would reduce filter efficiency.

5.8 BOLT TIGHTENING

5.8.0 General

It is recommended to use a Liquid thread lock compound on any fixing screws, or plugs (except for electrical contact) which have been untighten or dismantled during any operation.

A medium strength thread locker as or similar as "Loctite 242" ; or "Omnifit 100M" (from Henkel).

5.8.1 Steel screw in steel tapping

If no torque value is specified into the concerned chapter the following values can be used for fixation of parts metal onto metal.

Bolt : Steel / Steel (with medium strength thread locker)			
Ø nominal (mm)	Torque (N.m)	Ø nominal (mm)	Torque (N.m)
3	1,0	18	222
4	2,3	20	313
5	4,6	22	430
6	7,9	24	540
8	19,2	27	798
10	37,7	30	1083
12	64,9	33	1467
14	103	36	1890
16	160		

5.8.2 Plugs

If no torque value is specified into the concerned chapter the following values can be used for plugs tightening.

Steel and copper alloy Plugs (medium strength thread locker)			
Ø nominal (inches)	Torque (N.m)	Ø nominal (inches)	Torque (N.m)
G3/8	30	G1 ¼	160
G1/2	40	G1 ½	230
G3/4	60	G2	320
G1	110	G2 ½	500

5.8.3 Electrical contact

If no torque value is specified into the concerned chapter the following values can be used for brass (or copper alloy) clean and dry threads.



CAUTION :

THE USE OF ANY COMPOUND ONTO ELECTRICAL CONTACT THREAD IS FORBIDDEN.

Thread	M5	M6	M8	M10	M12	M14	M16
Torque [N.m]	2.5	4	8	20	35	57	87

5.8.4 Rotating diodes



CAUTION :

THE ROTATING DIODE FASTENING SCREWS MUST BE TIGHTENED USING A TORQUE WRENCH CALIBRATED TO THE RECOMMENDED TORQUE.WITHOUT USING ANY THREAD COMPOUND.

Diode	Tightening torque
SKx 100/..xx	10 N.m
SKx 130/..xx	10 N.m
SKx 240/..xx	30 N.m

5.8.5 Synthetic parts

This applies to parts made of light synthetic raw material (plastic covers; fiber glass covers; fiber glass fan air shroud ...).



CAUTION :

THE USE OF A THREAD LOCK COMPOUND IS IMPERATIVE.

Thread	M8	M10	M12	M14	M16
Torque [N.m]	15	15	15	15	15

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5.9 ELECTRICAL MEASURING INSTRUMENTS

5.9.1 Instruments used

- AC voltmeter 0-600 Volts
- DC voltmeter 0-150 Volts
- Ohmmeter 10E-3 to 10 ohms
- Megohmmeter 1 to 100 MOhms / 500 Volts
- AC Ammeter 0- 4500 A
- DC Ammeter 0-150 A
- Frequency meter 0-80 Hz

Low resistance can be measured by means of an appropriate ohmmeter or by using a Kelvin or Wheatstone bridge.

NOTE :

The identification of the equipment polarity may differ from one ammeter to another.

5.10 WINDINGS INSULATION CHECK

5.10.0 General

The insulation resistance enables the status of the machine insulating to be verified.

The following measurements can be taken at any time without any damage to machine insulating material.

The insulation check must be done :

- Before the start up
- After a long standstill
- As soon as an abnormal operation occurs
- At maintenance intervals (refer to chapter 5.1)

If the measurement indicates a poor result we advise contacting our Service department.

To perform the measurement the generator must be stopped.

If the insulation resistance is less than that required, it is necessary, to clean and to dry the machine (refer to chapter 5.13).

! DANGER :

BEFORE ANY WORK THE RULES CONCERNING THE SAFETY OF MATERIALS AND PERSONS MUST BE APPLIED (TOTAL LOCKING OF THE GENERATOR FUNCTIONS, GROUNDING OF THE PHASES ...).

5.10.1 Insulation measure

Disconnect the three phases at the generator terminals.

! CAUTION

ALL ACCESSORIES MUST BE DISCONNECTED (AVR , EMC FILTER, ...).

REFER TO THE ELECTRICAL SCHEMATICS TO IDENTIFY THE ACCESSORIES TO DISCONNECT.

The measurement has to be taken between one phase and the earth. Reading is done after 1 minute of test.

	Test voltage (VDC)	Criteria (MΩ ; 40°C)
Stator: $U \leq 3$ kV	500	200
Stator: $3 \text{ kV} < U \leq 6.6$ kV	2500	1000
Stator: $U > 6.6$ kV	5000	1000
Rotor	500	100
Exciter (Stator & Rotor)	500	100
Excitation auxiliary windings (AREP)	250	100
PMG (stator)	100	100
Heating element	500	100
Resistance Temperature Detectors	500	100

If the insulation resistance is not measured with a tested element à 40°C a corrective factor has to be used.

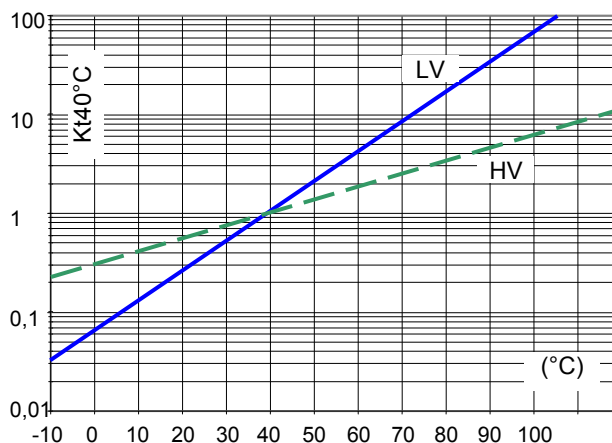
$$R_{m\ 40^{\circ}\text{C}} = R_t \times K_{t40}$$

R_t Measured insulation resistance

K_{t40} Corrective factor

Curve LV for generator voltage ≤ 3 kV

Curve HV for generator voltage > 3 kV



If the minimum insulation level is not reached, dry the windings (refer to chapter 5.13).

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5.10.2 Polarization index

The polarization index enables the status of the machine insulating to be verified and gives an indication of the pollution of the winding.

A poor polarization index may be corrected by a cleaning and drying of the winding.

The following measurements can be taken at any time without any damage to the machine insulating material.



CAUTION

ALL ACCESSORIES MUST BE DISCONNECTED (AVR , EMC FILTER...).

REFER TO THE ELECTRICAL SCHEMATICS TO IDENTIFY THE ACCESSORIES TO DISCONNECT.

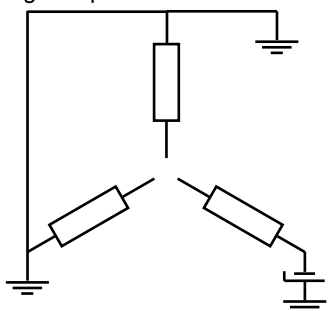
NOTE:

It must be done using a stable DC source.

Use a specific polarization index appliance (refer to chapter 5.10.1 for the correct applied voltage).

Proceed for each phase.

Open the winding star point.



Apply the requested voltage.

After 1 minute record the Insulating resistance " $R_{1 \text{ min}}$ ".

After 10 minutes record the Insulating resistance " $R_{10 \text{ min}}$ ".

$$i_p = \frac{R_{(t=10\text{minutes})}}{R_{(t=1\text{minute})}}$$

Polarization index	Diagnostic
$i_p < 1$	Poor
$2 < i_p < 1$	Monitored
$2 < i_p < 4$	Good
$i_p > 4$	Very good

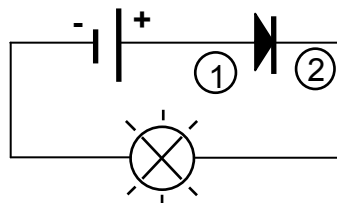
5.11 ROTATING DIODE BRIDGE TEST

Carry out the test using a D.C. source as indicated below.

A diode in good condition should allow the current to flow **only** in the anode-to-cathode direction.

Disconnect the diodes before the test.

3 ... 48 volts



1 - Anode

2 - Cathode

Diode type	Positive	Negative
SKR	diode housing	diode wire
SKN	diode wire	diode housing

When reassembling ensure that the diodes are tightened to the correct torque.

5.12 CLEANING THE WINDINGS

5.12.0 General points

The cleaning of the winding is a heavy service operation which has to be engaged only if necessary.

The cleaning of the windings become necessary as soon as the insulation resistance and/or the polarization index are not satisfactory (refer to chapter 5.10.2).

5.12.1 Coil-cleaning products

A long term efficient cleaning can only be done in a work Shop if equipped with specialized devices. A site cleaning, because less efficient, can be considered only for a transient period.



CAUTION :

USED CLEANING AGENT MUST BE IN ACCORDANCE WITH LOCAL REGULATION AND ENVIRONMENTAL STANDARD.



CAUTION:

SOLVENTS, WHICH ARE HIGHLY CHLORINATED AND SUBJECT TO HYDROLYSIS IN DAMP ATMOSPHERES ARE PROHIBITED. THEY QUICKLY BECOME ACIDIFIED, PRODUCING CORROSIVE AND CONDUCTIVE HYDROCHLORIC ACID.



CAUTION:

DO NOT USE TRICHLORETHYLENE, PERCHLORETHYLENE, OR TRICHLORETHANE.

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Avoid mixtures sold under various trademarks which often contain white spirit (which evaporates too slowly) or chlorinated products (which are likely to become acidified).



CAUTION:
DO NOT USE TOO STRONG ALKALINE PRODUCTS.
THEY ARE DIFFICULT TO RINSE AND CAUSE
REDUCTION OF INSULATION RESISTANCE BY FIXING
THE HUMIDITY.

5.12.2 Cleaning operation

Use a soft alkaline product or a dedicated cleaning agent. We recommend the use of the cleaning agent "ASOREL CN" from "Rhône Chimie Industrie" ; 07300 Tournon ; France. This cleaning agent do not make the rinsing operation imperative.

It is essential to avoid entry of cleaning agents and dirt into the slots. Apply the product with a brush, sponging frequently in order to avoid accumulation in the housing. After cleaning, a rinsing operation is imperative. Hot soft water (less than 80°C) used under pressure (less than 20 bars) can be used.



CAUTION:
AFTER CLEANING THE GENERATOR, DRYING IS
IMPERATIVE TO RECOVER THE CORRECT WINDING
INSULATION.

5.13 DRYING THE WINDING

5.13.0 General points

All electric machines must be stored under dry conditions. If a machine is placed in damp surroundings, it must be dried before it is put into service. Units operating intermittently or placed in areas with high temperature variations, are exposed to dampness and must be dried very thoroughly if necessary.

5.13.1 Drying method

5.13.1.1 General points

During the drying operation measure the winding insulation and the polarization index each 12 hours.

To survey the insulation progress, record the measured values and plot the obtained progress function of the time.

When the insulation value becomes constant, the machine can be considered as dry.

When the resistance is constant, it may be assumed that the machine is dry. This operation may take up to 72 hours, depending on the size of the machine and on the degree of dampness.



CAUTION:
TAKE FIRE-PREVENTION MEASURES DURING THE
DRYING OF THE MACHINE.
ALL THE CONNECTIONS MUST BE TIGHTENED.

5.13.1.2 Drying generator in a stopped position

The procedure "Drying generator in rotation" should be preferred to the following one if it is possible to run the generator at its nominal speed.

Several thermometers must be positioned onto the winding and the temperature must not exceed 75°C (167°F). If one of the thermometers exceeds this value, immediately reduce the heating effect.

Dry by using an external source of heat, for example, heaters; lamps; or hot air blowers.

Leave openings to exhaust the damp air.

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5.13.1.3 Drying generator in rotation



CAUTION

THIS OPERATION MUST BE DONE BY A QUALIFIED OPERATOR.

Disconnect the machine from the mains.

Short circuit the machine stator at the machine terminals.

Disconnect the Voltage regulator. If booster current transformer used, short-circuit the booster.

Run the machine at its nominal speed (to air cool the machine) with cooling system in operation.

Energized the machine (exciter field) using an separate excitation source. Use a DC source (batteries ...).

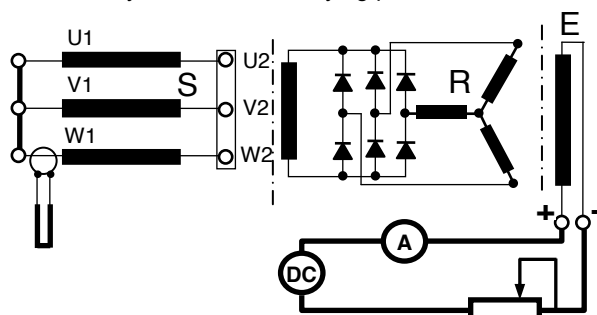
Install an amp meter on excitation supply line.

Adjust the excitation current to get 2/3 of the nominal excitation current (refer to name plate data or alternator test report).

Warm up during 4 hours, stop and leave it to cool down (winding temperature < 50°C).

Check the winding insulation and the polarization index

If necessary conduce other drying period...



S - Stator

R - Rotor

E - Exciter

5.14 RE-VARNISHING



CAUTION:

RE VARNISHING MUST ONLY BE CONSIDERED IF ABSOLUTLY NECESSARY. A RE VARNISHING OPERATION DONE ON A WINDING STILL DIRTY OR NOT PERFECTLY DRY MAY CONDUCE TO A DEFINITIVE LOSS OF INSULATION.

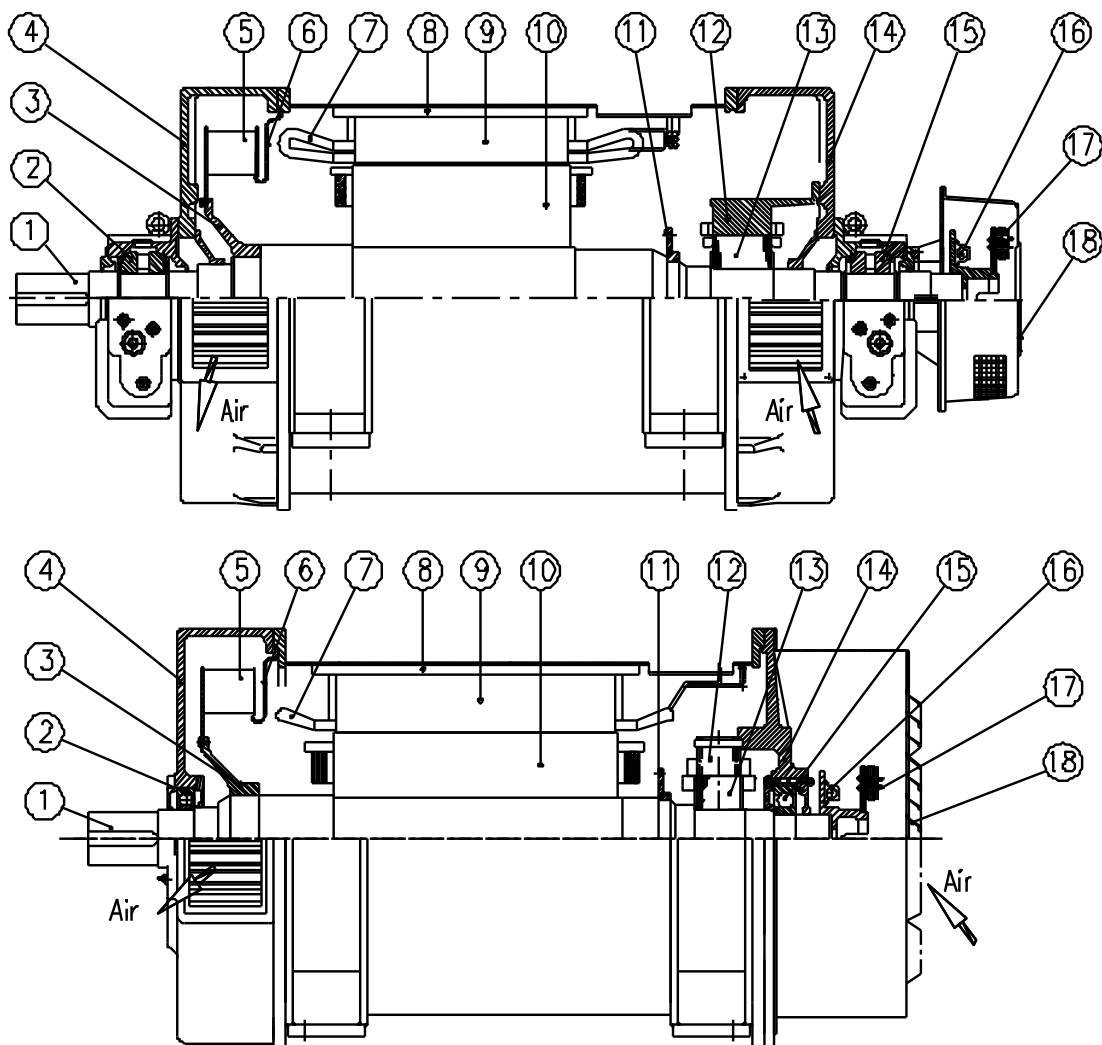
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10. TYPICAL ASSEMBLIES AND DRAWINGS

10.1 MACHINE CUT VIEWS

10.1.1 Machine type A53 ; A54

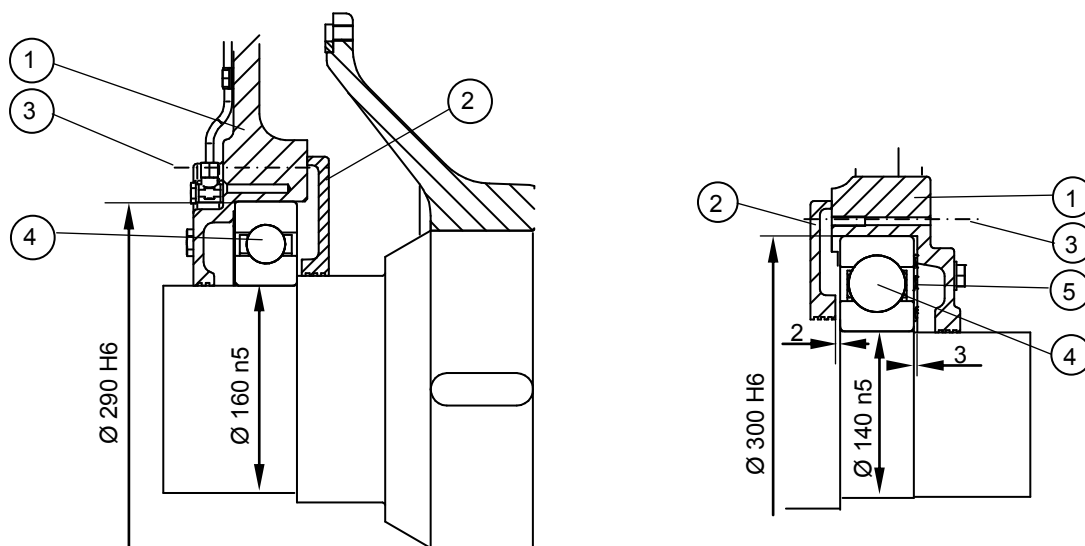
- | | | | |
|---|---------------------|----|-------------------------|
| 1 | Rotor | 10 | Polar wheel |
| 2 | Bearing (drive end) | 11 | Balancing disc |
| 3 | Fan hub | 12 | Exciter field |
| 4 | Drive end shield | 13 | Exciter armature |
| 5 | Fan | 14 | Non drive end shield |
| 6 | Fan screen | 15 | Bearing (non drive end) |
| 7 | Stator winding | 16 | Rotating resistances |
| 8 | Stator ribs | 17 | Rotating diodes |
| 9 | Stator lamination | 18 | Diode bridge cover |



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10.2 ANTI FRICTION BEARING ASSEMBLY

10.2.1 Machines A53 and A54 ; standard:



Bearing assembly " Standard "			
Drive end		Non drive end	
1	End shield	1	End shield
2	End cover	2	End cover
3	End cover stud	3	End cover stud
4	Ball bearing	4	Ball bearing
		5	Bearing pre load spring

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Declaration of EC compliance and incorporation

This Declaration applies to the generators designed to be incorporated into machines complying with the Machinery Directive Nr 2006/42/EC dated 17 May 2006.

MOTEURS LEROY-SOMER	MLS HOLICE STLO.SRO	MOTEURS LEROY-SOMER	DIVISION LEROY-SOMER
Boulevard Marcellin Leroy	SLADKOVSKÉHO 43	1, rue de la Buelle	STREET EMERSON
16015 ANGOULEME	772 04 OLOMOUC	Boite Postale 1517	Nr4 Parcul Industrial Tetarom 2
FRANCE	CZECH REPUBLIC	45800 ST JEAN DE BRAYE	4000641 CLUJ NAPOCA
		FRANCE	ROMANIA

Declares hereby that the electric generators of the types:

LSA40, LSA42.3, LSA44.2, LSA44.3, LSA46.2, LSA46.3, LSA47.2, LSA49.1, LSA49.3, LSA50.1, LSA50.2, LSA51.2, LSA52.2, LSA52.3, LSA53.1, LSA53, LSA53.2, LSA54, LSA54.2, TAL040, TAL042, TAL044, TAL046, TAL047, TAL049, as well as their derivatives, manufactured by Leroy-Somer or on Leroy-Somer's behalf, comply with the following International Standards and Directive:

- EN and IEC 60034-1, 60034-5 and 60034-22
- ISO 8528-3 "Reciprocating internal combustion engine driven alternating current generating sets. Part 3. Alternating current generators for generating sets"
- Low Voltage Directive Nr 2014/35/UE dated 26 February 2014

Furthermore, these generators, designed in compliance with the Machine Directive Nr 2006/42, are therefore able to be incorporated into Electrical Gen-Sets complying with the following International Directives:

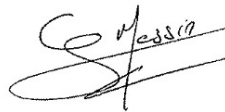
- Machinery Directive Nr 2006/42/EC dated 17 May 2006
- EMC Directive Nr 2014/30/UE dated 26 February 2014, as intrinsic levels of emissions and immunity are concerned

WARNING:

The here mentioned generators should not be commissioned until the corresponding Gen-Sets have been declared in compliance with the Directives Nr 2006/42/EC and 2014/30/UE, as well as with the other relevant Directives.

Leroy-Somer undertakes to transmit, in response to a reasoned request by the national authorities, relevant information on the generator.

Technical Managers
J.P. CHARPENTIER Y. MESSIN



Service & Support

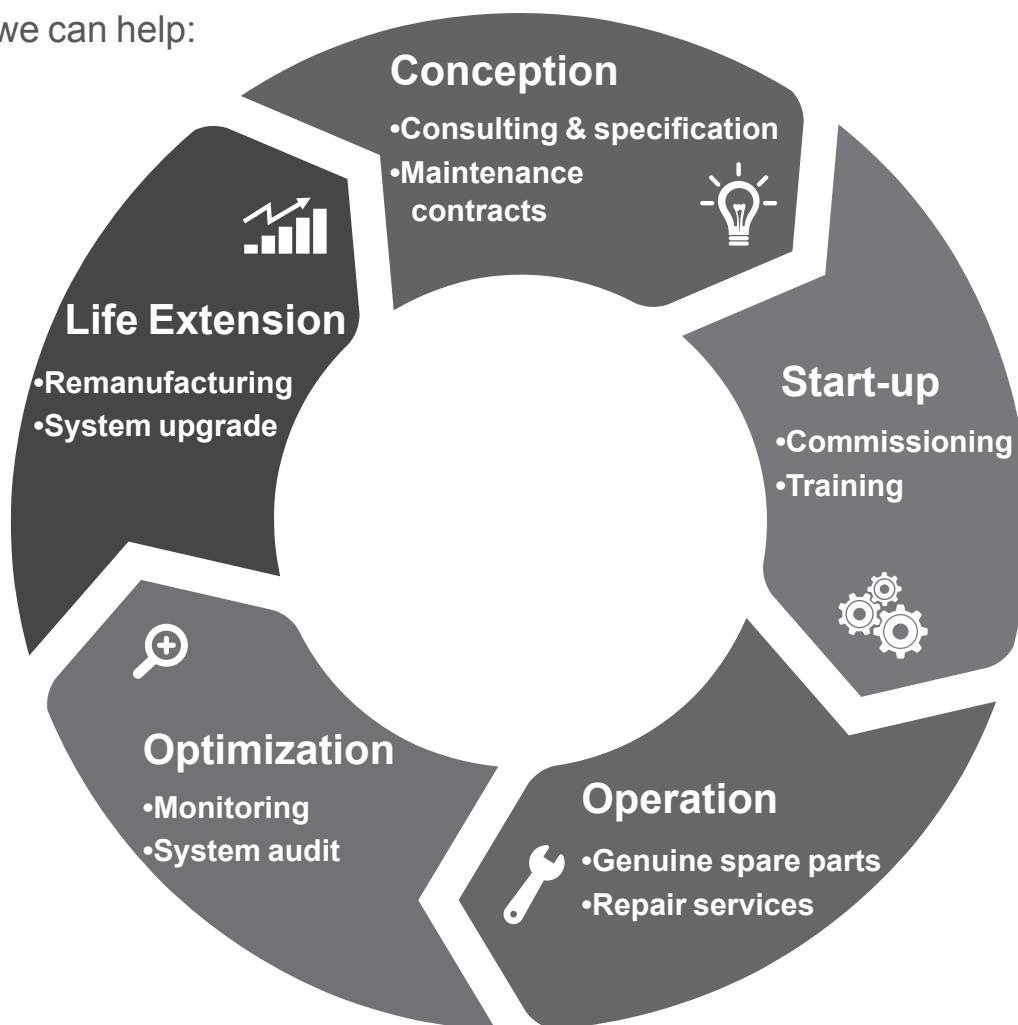
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