

NEMA 449T Frame SGM Type INSTALLATION AND MAINTENANCE INSTRUCTIONS THREE-PHASE INDUCTION MOTORS PER NEMA & CSA STANDARDS

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1. TECHNICAL DESCRIPTION

This Instruction Manual covers three-phase, induction, squirrel-cage, horizontal, foot-mounted motors, with single shaft extension, totally enclosed, fan cooled, for continuous duty, type Sgm, frame number 449T. Frame terminal box is located on the side of the motor (F1 - on the left side - assembly is standard, F2 - on the right side - assembly is available on request).

The Sgm motors are for general industrial applications and are used to drive various machines of continuous service with no frequent starts and reversals when supplied by network voltage. Motors are adapted for supplying by frequency inverter for driven machines and equipment of square load versus speed characteristic (ventilator type) { $T=T_N (n/n_N)^2$ } e.g. pumps, ventilators, where rotational torque is changed with square rotational speed and power in third power of rotational speed [$P=P_N (n/n_N)^3$]. In such drive soft starting can be made and in gentle way rotational speed can be regulated. Motors should be chosen for maximum rotational speed of driven equipment.

The motors are suitable for the clockwise (cw) or counter clockwise (ccw) direction of rotation: normal is cw when facing the motor drive end.

The motors meet requirements of the NEMA (National Electrical Manufacturers Association) MG1-1998 Standard and CSA C22.2 Nº 100M 1995.

Fig.1 represents a sectional view of a Sgm motor. Although the Sgm motors are totally enclosed, it is recommended to operate them in locations where dust amount is less than 10mg/m³ and free from aggressive atmospheres such as corrosive fumes. They must not be operated in hazardous locations i.e. those with flammable vapours or gases or where combustible or electrically conductive dusts are present.

It is recommended to use at least a local roof to protect the motor against rain or snow-fall and direct sun rays when operation in open areas is required.

The following are the required service conditions:

- ambient temperature: -4°F to +104°F (-20°C to +40°C),
- relative air humidity: less than 95%
- altitude: not greater than 3300ft (≈1000m) above sea level.

When other service conditions are to be considered, please contact the Manufacturer.

Please also refer to tables 1 and 2 for reduced loading at higher than (+104°F) (+40°C) temperatures and greater than 3300 ft altitudes (1000m).

Ambient temperature	°F	104	113	122	131
	°C	40	45	50	55
Reduced loading in percent of rated (100%) loading	%	100	96.0	90	86.5

TABLE 2

Altitude above sea level		3300	4950	6600	8250	9900	11550	13200
	m	1000	1500	2000	2500	3000	3500	4000
Reduced loading in percent of rated (100%) figure at 104°F (+40°C)	%	100	97	94,5	92	89	86,5	83,5

Permissible variations in supply voltage are ±10% of rated voltage at rated frequency and permissible variations in supply frequency are $\pm 5\%$ of rated frequency at rated voltage.

TABLE 1



Ш

NDE

Designation to Fig.1:

- 1. Wound stator complete with frame
- 2. Wound rotor complete with shaft
- 3. Eyebolt
- 4. Spring washer
- 5. Screw M12x45 *)
- 6. DE end shield
- 7. DE bearing (TABLE 3)
- 8. Bolt M6x16
- 9. Shaft key
- 10. Spring washer
- 11. Special screw M10x16 (for sucking off used grease)
- 12. Spring washer
- 13. Special screw (for running off condensation water or water)
- 14. Cotton wick
- 15. Spring washer
- 16. Screw M10x16 (earthling terminal)
- 17. Round washer
- 18. Terminal box
- 19. Spring washer
- 20. Special screw (for running off condensation water or water)
- 21. Cotton wick
- 22. Spring washer
- 23. Screw M10x25
- 24. Spring washer
- 25. Special screw M10x16 (for sucking off used grease)
- 26. Bolt M6x16
- 27. Fan key AB 18x11x38,5
- 28. Circlip Z 60
- 29. NDE bearing (TABLE 3)
- 30. Fan
- 31. Spring washer
- 32. Screw M6x12
- 33. Fan cover
- 34. Lubricating plate
- 35. Clamp
- 36. Spring washer
- 37. Bolt M6x12
- 38. Lubrication conduit insulation
- 39. Lubricating nipple M10x1
- 40. Lubrication conduit
- 41. Spring washer
- 42. Screw M12x45
- 43. NDE end shield

<u>Attention</u>

*) Dimensions in [mm]

2. DESIGN

The stator body, complete with feet and ribs is of cast construction. Two drain apertures, for draining the condensate, are located at the body lowest point. The stator laminations are of magnetic, siliconized, cold-rolled and suitably insulated sheet steel. The stator winding is of round copper, double enamel insulated wire. Class of insulation is F. An earthing terminal is located under and a protective terminal inside the motor terminal box. The rotor laminations are placed directly on the shaft. The rotor is a cast aluminium unit. It is balanced with a half key on the shaft free end. Shaft is made of 40HM steel, which is equivalent of produced in USA 4140 steel.

The motor bearings are of the anti-friction type. Bigger ball bearing is provided at the drive end (DE) while smaller ball bearing is used on the non-drive end (NDE). In motors in Design "C" roller bearing is applied instead of ball bearing at the drive end. Automatic regulation of grease amount in the bearing chambers is included. The bearings can be lubricated when the motor is running.

Refer to Table 3 below for details of the bearings.

TABLE 3

Frame number	Number of poles	Drive end bearing (DE)	Non-drive end bearing (NDE)
449T	4, 6	6319 MC3	6314 MC3

For a belt drive – use roller bearing NU319 EM1C3 at DE Side.

Bearing NU319C3 is applied as standard in motors in Design "C".

The Sgm motors are provided with self-cooling system, suitable for either CW (clockwise) or CCW (counter clockwise) rotation. The cooling is by means of a non-drive end fan and suitable vanes on the rotor rings. The air inlet is suitably protected by a wire netting. The air outlet is directed towards the shaft free end. The terminal box is normally on left when facing the motor drive end (F1 acc. to NEMA) but can be provided on right when requested (F2 acc. to NEMA).

The box is provided with four cable entries, normally directed to the bottom and suitably plugged for shipment. The cable entries can be reoriented through $4 \times 90^{\circ}$. The box has not terminal boards - there are only 12 winding copper outlets, marked T1 through T12, suitably galvanised and isolated for direct connection with line terminals.

Terminals of winding temperature sensors marked 1, 2 and heaters terminals marked 5, 6, 7, 8 are inside terminal box.

3. SHIPMENT AND STORAGE

The motor bearings are locked. Remember to unlock them before mounting the coupling. Non operated motors should be stored in closed locations free from dust and corrosive fumes and vapours. The motors are shipped in crates suitable for prolonged storage.

4. INSTALLATION

Remember that the ambient temperature at the installation site should not exceed 104°F (+40°C), and that easy, unobstructed access to the motor must be provided. Installation is to be carried out by appropriately qualified personnel only.

The motors are mounted on foundation plates or other suitable structure placed in turn a concrete foundation. For fixing use anchor bolts inserted through the foot holes. The foundation level should be from 1/2 to 1 inch above the floor level to protect the motor against dirt. For coupling the motor with a driven machine, a suitable, statically balanced coupling is to be used. To mount the coupling:

- remove the bearing locking device,
- remove protective paint from the shaft extension end by means of acetone or other suitable solvent,
- apply grease or oil to the free drive end,
- preheat coupling to approx. 176°F (80°C) and press it on to the shaft (by using a suitable drawing device); support other end when doing so, to prevent axial forces to act on the bearing.

Never use a sleeve and a hammer for driving the coupling on - bearings are easily damaged when such a procedure is applied. Correct alignment of the motor and driven machine is of utmost importance. To check the parallelism of the coupling halves place a rule against the outer cylindrical surfaces. Repeat this for several positions of the coupling and shaft (e.g. every 1/4 of a turn). Clearance between the coupling faces must also be uniform.

When a belt drive is to be used selection of proper pulleys must receive due attention. Smaller than required pulleys tend to damage the bearing and the shaft drive end. Please refer to Fig. 2 for allowable radial forces applied to the shaft drive end. Assume that the F_R force is applied at the middle of a pulley rim.

Pulleys of larger diameters provide better, trouble-free performance of the drives.

Avoid excessive tension of the belt.

 F_R – Permissible radial force [N]



Arm of radial force x [inches]

- Fig. 2. Characteristic of radial force as a function of distance (x [inch]) from shaft neck when applying roller bearing NU319 EM1C3 from drive end side.
- Min. pitch diameter of a pulley can be determined from the following formula:

$$D > 6 \cdot 10^5 \ \frac{c \times P}{F_R \times n}$$

- where: D pulley pitch diameter in inches
 - P max. HP
 - n rated speed (rpm)
 - F_R allowable radial force [N] per Fig.2
 - c = 3 for a flat belt drive without a tension roll
 - c = 2 for a flat belt drive with a tension roll
 - c = 2,2 for a v-belt drive

Prior to starting-up check:

- a) is rotor rotates freely,
- b) tightening of keys, anchor bolts, frame bolts, etc; tighten when required,
- c) winding insulation resistance /use a 500V megger and measure the resistance between lines and between each line and frame. The reading must not be less than 50 MΩ. In the case the insulation resistance is lower than required dry-out the motor by circulating preheated air through its winding. Remember that the temperature of the heated parts must not exceed 176°F (80 °C). Stop drying with the resistance figure steady.
- d) replace grease in bearings, using grades specified under 6 below, if the erection takes place after more than 1,5 years from the date of delivery,
- e) check earthing or null earthing /if the latter is applied/. For earthing use the earthing terminal under the terminal box and for null earthing the protective terminal found inside the terminal box.

5. CONNECTING-UP AND STARTING -UP

To select the best starting method, when supplying by network voltage, take into account the following:

- local mains available,
- drive torque required,
- motor size, etc.

Refer to Figs. 3, 4, 5 for the starting possibilities.







Fig. 4. WYE-DELTA STARTING



Fig. 5. PART-WINDING STARTING

Max. external moments of inertia $/WK^2/$ referred to the motor shaft should not exceed figures specified in Table 4. For $/WK^2/$ listed, the motors are capable of two successive starts from cold state and one from warm state. The values given have been specified for load torque varying with square of the motor speed.

НР	WK² /Lb·Fť²/						
	1800 rpm	1200 rpm					
250	-	4600					
300	2500	5400					
350	2900	-					

To reverse the motor rotation reverse any two incoming mains leads.

6. MAINTENANCE LUBRICATION

Cleanliness of the motor must receive particular attention. Never allow your motor to be covered with a layer of dirt and never allow water or oil to enter the motor.

It is advisable to have at least one ammeter installed for checking the motor actual loading. Mark rated current of the motor on the ammeter scale.

For lubrication of the motor anti-friction bearings use lithium base grease MOBILLUX EP3, ALVANIA 2, CHEVRON SRI 2.

Life of the bearings is about 25.000 hours provided the shaft drive end is loaded with forces $/F_R$ shown in Fig. 2. For making-up use grease guns-grease is charged through bearing caps; shutting-down of the motor is not required for greasing.

Grease after passing through the bearing is rejected to empty chambers of the bearing outer cap. Replenish grease as indicated in Table 5. Do not apply grease in amounts other than recommended.

Lubrication information plates with recommended lubrication intervals, grease amounts and max. number of replenishment are provided on the bearing caps.

TABLE 5

			Drive	end	bearing (Di	E)	Non-drive end bearing (NDE)				
Frame number	Number of poles	Bearing	Gre am	ease ount	Lubricat. intervals	Max.nr of replenish- ments	Bearing	Grease amount		Lubricat. intervals	Max.nr of replenishments
			οz	g	h	-		ΟZ	g	h	-
4407	4	6319	1,6	45	4000	8	6314MC3	0,9	25	5500	8
		NU319 EM1C3*)	1,6	45	1900	8					
4491	6	6319	1,6	45	6500	8	6314MC3	0,9	25	7500	
		NU319 EM1C3*)	1,6	45	3000	8					8

*) used at drive belt.

Once every 2.5 to 3 years the bearings and their housings should be cleaned out with petrol and regreased. Use a clean paintbrush for cleaning. Such inspections and cleanings must be carried out irrespective of the motor operating hours and must include replacement of the V-rings V-65A at the not drive end, V-95A at the drive end.

When regreasing with another compatible grade, remember to thoroughly clean the bearings and grease chambers. Apply new grease to the bearings and to approx. $^{2}/_{3}$ of the bearing inner caps. Do not fill chambers of the outer caps.

Under running conditions check regularly:

- a) temperature of the bearings /should not exceed 212°F (100°C),
- b) the bearings for whistling or excessive hums.

TABLE 4

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Please refer to Item 8e for symptoms, probable causes and remedies of the bearing troubles.

Check regularly all threaded joints for proper tightening. Pay particular attention to line terminals, to bolts on the bearing discs and rotating parts and to the earthing/null earthing terminal.

7. ROUTINE EXAMINATIONS

To provide the most effective and trouble-free running of the motor rectify any, even very small malfunction. Irrespective of this carry-out the following routine examinations:

- a) minor examinations at six monthly intervals,
- b) major examinations (overhauls) at 3 yearly intervals.

7.1. Minor Examinations

The minor examinations cover the following:

- a) visual inspection and cleaning (see Item 6 above); this may lead to further inspection of the disassembled motor,
- b) measurement of the winding insulation resistance (Item 4),
- c) check the condition of all connections incl. the earthing terminal; tighten when required (Item 6).
- d) measuring insulation resistance of the thermal protecting equipment and anti-condensation heaters to the stator winding and to the frame,
- e) check the resistance of thermal protection circuit at ambient temperature. Resistance measured between terminals 1 –2 at cold state, i.e. at temperature + 25°C should be ≤ 750 Ω. <u>Note:</u> To measure the resistance use arbitrary method but observe that voltage applied to thermistor circuit cannot be greater than 4.5 V. Greater voltages could cause damage to stator winding thermal protection.
- f) check the heaters circuit-winding, circuit resistance should be according to Motor accessories (Item.10.)
- g) check the coupling with the driven equipment (see Item. 4.)
- h) inspect the starting, protecting and control equipment.

7.2. Major Examinations/Overhauls

The major examinations cover the following:

- a) motor disassembly (see 7.3 below),
- b) removal of the rotor,
- c) examination of the stator, followed by measurement of the winding insulation resistance (Item 4),
- d) examination of the rotor with detailed inspection of the winding, balancing weights and fans,
- e) examinations of the bearings complete with cleaning and regreasing (see 7.4 below),
- f) examinations of starters and protective gear.

Rectify all detected defects and/or malfunctions and replace worn-out components/parts with new ones. It is also advisable to repair the paint finishes.

7.3. Motor Disassembly

To disassemble the motor proceed as follows (look Fig.1):

- remove coupling from the shaft end by means of a puller and remove key 9,
- unscrew screw 23 and remove outer fan cover 33,
- remove circlip 28,
- remove fan 30, unscrew bolt 26 and remove fan key 27,
- take out V-ring 29.8 (see fig. 7),
- unscrew screw 29.13 clamping NDE external bearing cover 29.11 and remove this cover,
- straighten tooth washer 29.6,
- unscrew bearing nut 29.7,
- take out grease deflector 29.5, distance ring 29.9 and wavy spring washer 29.10,
- disassembly lubrication clamp 35,
- unscrew screw 42 and take off NDE end shield from bearing and lock,



- unscrew bolts 7.10, take off cover 7.11 and remove V-ring 7.12 (see fig.6),
- unscrew screw 7.5 and take off DE external bearing cover 7.6,
- remove circlip 7.13, grease deflector 7.8 and internal ring 7.7,
- remove stud 7.14,
- unscrew screw 5 and take off DE end shield from bearing and lock,
- carefully pull out rotor 2 from frame in NDE side towards ; be sure no damage is done to the stator winding.

Reverse this procedure for assembling.

7.4. Removal of Bearings

7.4.1. Removal of the drive end bearing (DE) Fig. 6



- 7.1 DE bearing (Table 3)
- 7.2 Internal bearing cover
- 7.3 Lubricating nipple M10x1
- 7.4 Spring washer
- 7.5 Screw M10x90
- 7.6 External bearing cover
- 7.7 Internal ring
- 7.8 Grease deflector
- 7.9 Spring washer
- 7.10 Bolt M4x10
 - 7.11 Cover
 - 7.12 V-ring 95A
 - 7.13 Circlip
 - 7.14 Roller stud 8h8x16

Fig. 6. Drive end bearing (DE)

- unscrew bolts 7.10, take off cover 7.11
- remove V-ring 7.12,
- unscrew the fixing screws 7.5 and remove bearing cover 7.6,
- remove circlip 7.13, grease deflector 7.8 and internal ring 7.7,
- remove grease deflector stud 7.14,
- unscrew four screws 5 pressing the end shield 6 to the frame,
- move aside internal bearing cover 7.2 and remove the ball bearing from the shaft (place the puller fingers on the inner ring).

Reverse the above procedure when replacing the bearing.

It is recommended when replacing the inner ring of roller bearing or the ball bearing to preheat it an oil bath to $176^{\circ}F$ ($80^{\circ}C$).

7.4.2. Removal of the non-drive end bearing (NDE) Fig. 7

- unscrew screw 23 and remove outer fan cover 33,
- remove circlip 28,
- remove fan 30, unscrew bolt 26 and remove fan key 27,
- take out V-ring 29.8 (see fig. 7),
- unscrew screw 29.13 clamping NDE external bearing cover 29.11 and remove this cover,
- straighten tooth washer 29.6,



- unscrew bearing nut 29.7,
- take out grease deflector 29.5, distance ring 29.9 and wavy spring washer 29.10,
- disassembly lubrication clamp 35,
- unscrew screw 42 and take off NDE end shield from bearing and lock,
- move aside internal bearing cover 29.2 and remove the ball bearing from the shaft (place the puller fingers on the inner ring).



Fig.7. Non-drive end bearing (NDE)

29.1 Insulation pad 29.2 Internal bearing cover 29.3 NDE bearing (Table 3) Internal ring 29.4 Grease deflector 29.5 29.6 Tooth washer MB14 29.7 Bearing nut KM14 29.8 V-ring 65A 29.9 Distance ring 29.10 Wavy spring washer 29.11 External bearing cover 29.12 Spring washer 29.13 Screw M10x90

8. TYPICAL TROUBLES, CAUSES AND REMEDIES

To avoid severe damage of your motor check regularly its performance and currently rectify any noted defect or malfunction. Please refer to the table below for typical troubles, probable causes and recommended corrective measures.

TABLE 6

Symptom	Probable cause	Remedy			
a. Motor fails to start	 Blown-out fuses 	Replace with new ones			
	 Wrong relay setting 	Check and correct			
	 Wrong stator connection 	Check and rectify			
	 Motor or driven machine locked 	Unclock			
	 Open circuit 	Check with a magger with supply off			
		and rectify			
	- Overload	Reduce load			
b. Reduced speed	 Incorrect voltage 	Check voltage, line and load sides			
	 One-phase open circuited 	Rewind			
	 Motor not large enough 	Replace with a larger one			
c. Excessive heating	 As under b. above 				
	 High supply voltage 	Check stator connection			
	 Restricated cooling air flow 	Clean with dry compressed air			
	 High ambient temperature 	Reduce loading in acc. with Table 1			
	 Motor winding short-circuited 	Locate short circuit and rectify			

d. Vibrations	 Incorrect coupling with driven machine 	Check alignment and recitify
	 Incorrect levelling of motor 	Insert suitable sheet metal liners under the motor feet
	 Worn-out bearings 	Check axial and radial end plays. If
	, , , , , , , , , , , , , , , , , , ,	detectable replace bearings with now
		ones.
	 Defective driven machine 	Rectify or replace
e. Excessive above	 Grease in excess 	Rectify
212°F (100°C)	 Incorrect grease grade 	Replace with a correct one (see 7)
heating of bearings	 Incorrect assembly 	Check alignment and rectify if required
f. Low insulation	 Dirty windings 	Clean with compressed air
resistance	– Moisture	Dry-out as out-lined under 4
	 Mechanical defects 	Locate and rectify

9. SAFETY

All safety requirements found on warning plates fixed to your motor must be strictly obeyed. Personnel should be familiarized with general safety rules and regulations re: electrical equipment.

Remember to inspect regularly your motor earthing (null earthing installation).

10. MOTOR ACCESSORIES

10.1. THERMAL PROTECTION

The motors described in this Instruction Manual are equipped with stator winding thermal protection against slow changing overload.

Stator winding protection consists of temperature sensors type PTC.

The applied protection is one level thermal. There are three pieces of the thermal sensors in the stator winding (one piece per phase) all connected in series. The sensors circuit ends are led into the terminal strip located in the main terminal box, the terminals designation symbols 1 and 2 (see the connection diagram on the below figure).

The applied triple thermal sensor of triggering temperature TNF155°C (TNF 311°F). Resistance of three connected in series thermal sensors at temperature range -20°C to (TNF-20)°C [-4°F to (TNF – 36) °F] should amount to \leq 750 Ω . When operating at triggering temperature TNF, the thermal sensors should have resistance which rises up to 4000 Ω which activates the control circuit.

For co-operation with the thermal protection only type Mark A control circuits must be applied (not delivered with the motor).

The maximum DC voltage permissible for the temperature sensors circuit is 4,5 V.

Routine service consists of:

- protection circuit continuity measured at motor cold state or checking control system according to Producer Instruction
- protection circuit resistance to motor frame and stator winding (required value minimum 5,0 M Ω)

Sensors connection is made by supply cable, which is let in by R 0,75" opening of main terminal box.

10.2. ANTI-CONDENSATION HEATERS

During long standstill of the motor it is recommended to switch on anti-condensation heaters in order to prevent water condensation in motor winding.

The heaters are to be supplied 2 x 67W, 115V/230 VAC

Heaters leads are led into auxiliary terminal box and are connected to terminals marked with letters 5, 6, 7 and 8.

Heaters resistance at the terminals 5- 6 and 7- 8, and non-warmed state equals to 204 $\Omega \pm 10\%$ Heaters should be switched on only during standstill of the motor!

For safety operation, during routine inspections, it is recommended to periodically check the continuity of heaters circuit and resistance of heaters insulation to motor frame.



The insulation resistance should not be lower than 3 M Ω . Connecting anti-condensation heaters are done by means of control cables which is let in by R 0.75" opening of main terminal box.