※ In terms of C3 bearing, it has bigger clearance than standard specification under cooling condition; it is a designed product to equip with excellent stability as it takes optimized clearance under thermal expansion. When load operation carries out more than 30mins, the noise can be eliminated; this is bearing's features rather than flaw of the motor.

8. Maintenance

The maintenance is necessary for reliable operation and extended service life of the motor. All repairs, including disassembly and assembly, must be performed by qualified and trained personnel as using proper tools and techniques. Hyosung Heavy Industries assumes no responsibility or liability for any repair service or maintenance work performed by unauthorized service centers or unqualified personnel for the service work.

Before your work, please make sure that the machine is stopped, and all wires connected to power source (e.g. lead lines of accessories, and of the motor) are disconnected from the power supply device. Regarding repeatedly-used load operation, it can play a negative role significantly to winding insulation and life of the rotator as it creates lot of far more heat rather than consecutive load operation. Thus, in case of repeated use of load, if standard motor, which is not designed based on its features, can cause burnout of winding. For more detailed information, please reach out to Technical department of Hyosung Heavy Industries

If an abnormal heating phenomenon of the motor occurs, stop the operation of the motor; and inspect the issue in accordance with '11. Troubleshooting' In terms of excessive noise and vibration should be identified and eliminated. According to '11. Troubleshooting', please inspect the motor.

Establish a regular inspection plan to check the operating condition of the motor, focusing on cleanliness, insulation, bearing condition, vibration, etc. to carry out inspection action.

⚠ WARNING

- Always disconnect power before conducting maintenance works with the product and opening terminal covers. There is a risk of electric shock.
- Do not randomly machine parts and use them. If it is used by randomly machining/producing the product, it can cause abnormal operation; it may result in serious personal injury or property damage. If client/user modify the product, we do not take any responsibilities as it goes beyond a scope of our warranty.

8.1 General inspection

Conduct inspection over the motor and coupling visually. Check for unusual noises, vibrations, excessive heating, signs of wear, misalignment, or damaged parts. Replace damaged parts as needed. Refer to the checklist below to establish general checklist items and procedures to perform periodic checks.

(1) Clean the sheath of motor. Remove oil spills and dirt from the surface of the motor frame to ensure better heat transfer.
(2) Refer to '5.1 Insulation Resistance' to measure the insulation resistance.
(3) Check the cooling fan condition and clean the air inlet and outlet to allow air to flow freely to the

motor surface.

(4) Inspect the condition of the seal and replace it if necessary.

(5) Drain the condensate inside the motor. After draining, reassemble the plug to ensure the level of protection indicated on the motor's nameplate.

(6) Check the connection of the power supply cable and ensure the correct clearance between the area with current flowing and grounded area.

(7) When tightening the bolts, verify that the tightening torque of the bolts meets the tightening torque criteria specified in Table 8.1.

Table 8.1 - Motor tightening torque by bolt strength (lb-ft)

Bolt Size	Pitch	Strength (4.8)		Strength (8.8)		Strength (12.9)	
		Min. Torque	Max. Torque	Min. Torque	Max. Torque	Min. Torque	Max. Torque
M3	0.5	0.4	0.5	0.8	0.9	1.2	1.5
M4	0.7	0.9	1.1	1.8	2.1	2.9	3.4
M5	0.8	1.9	2.2	3.6	4.3	5.9	6.9
M6	1	3.2	3.8	6.2	7.3	10.0	11.8
M8	1.25	7.8	9.1	15.0	17.6	24.3	28.5
M10	1.5	15.4	18.1	29.7	35.0	48.0	56.5
M12	1.75	26.8	31.5	51.8	61.0	83.8	98.6
M14	2			82.5	97.0	133	157
M16	2			129	151	208	245
M18	2.5			177	208	286	337
M20	2.5			251	295	406	477
M22	2.5			342	402	552	650
M24	3			434	511	702	826
M27	3			635	747	1026	1208
M30	3.5			862	1.14	1394	1640
M33	3.5			1173	1380	1897	2232
M36	4			1507	1773	2436	2866

(8) Check the condition of gasket inside of terminal box and cable gland gasket; if necessary, replace them.

(9) Verify the bearing operating conditions. Verify whether it has abnormal noise, vibration or other abnormal operation condition (e.g. Motor temp. rise). Check the grease condition and compare the operating time with the known lifetime.

(10) Record and archive all the changes you have made to the motor.

8.2 Lubrication

If the bearing of motor is sealed type from the factory, sufficient grease is filled with the bearing for lubrication though if the bearing is open type, it may need to fill the grease up depending on the condition.

In case of open type rolling bearing enabling grease filling, you need to refill the grease and use it as certain time passes depending on surrounding environments and conditions. See 8.2.1 for standard grease specifications of Hyosung Heavy Industries. See Table 8.2 for standard refueling intervals and top-off amounts.

The purpose of smooth lubrication of bearing is prevention of bearing accidents caused by severe friction; you have to control and manage the bearing away from grease contamination and penetration of foreign matters. As much as possible, avoid grease mixing, also in case of having poor surrounding environment, control and manage it by shortening the grease refilling cycle. Especially, as for cases of having poor surrounding environments and vertical installation condition of the motor, please carry out maintenance activities as shortening the refilling cycle written on Table 8.2.

Under low and high temperature environment as significantly different from general ambient temperature condition, you need to have discussion with technical department of Hyosung Heavy Industries. When it comes to refilling grease, it is recommended that open the oil drain plug and carry out the work as the motor is being stopped. If you need to refuel amidst of operation, you have to refuel with proper amount; keep in mind that excessive refueling allow grease to be entered inside of the motor, showing impact on winding insulation and others.

Table 8.2 - Grease Refill Cycle

Bearing No.	Initial filling volume (oz)	Refueling amount amidst of operation (oz)	Refilling Cycle (hr.)			
			2 Pole	4 Pole	6 Pole	8 Pole
6212	2.3	1.1	1200	4000	6500	9000
6222	11.3	2.5	-	1500	3500	5500
6312	3.5	1.4	1200	3500	6000	8000
6313	4.2	1.6	1200	3000	5500	7500
6314	5.3	1.8	1200	3000	5000	7000
6316	7.4	2.1	1200	2500	4500	6500
6317	8.5	2.3	-	2500	4000	6000
6319	11.3	2.6	-	1500	3500	5500
6311	2.8	1.2	1200	3500	6000	8500
6320	13.1	2.8	-	1500	3500	5000
6322	18.0	3.2	-	1000	3000	4500
NU313	3.5	1.6	-	1500	2500	3500
NU314	4.2	1.8	-	1500	2500	3500
NU315	4.9	1.9	-	1000	2000	3000
NU316	5.6	2.1	-	1000	2000	3000
NU317	6.3	2.3	-	1000	2000	3000
NU318	7.4	2.5	-	1000	2000	2500
NU319	8.8	2.6	-	900	1500	2500
NU320	10.3	2.8	-	800	1500	2500
NU324	19.4	3.5	-	500	1000	2000
NU220	6.5	2.1	-	1000	2000	3000
NU222	8.8	2.5	-	1000	2000	3000
NU224	11.1	3.0	-	800	1500	2000

※ As to grease refueling cycle, it may vary according to service environment and load conditions.

※ On the motor, if grease refueling information nameplate is attached, the information on the nameplate is put before any others.

8.2.1 Specification of Standard Grease

In terms of grease for bearing having grease refueling type, it features with the followings: excellent bearing lifetime, corrosion-resistance, and low noise by using Polyrex EM made by Mobil as it contains mineral oil and thickener in polyurea family. To replace and refill the grease, when it mixes with grease made based on different thickeners (e.g. Lithium) it may degrade lubrication performance due to chemical reaction; therefore, we do not recommend you the mix as there is a chance to face with bearing damage or occurrence of accident. As for details in specifications, see below table 8.3

.

Table 8.3 - Properties Table of Standard Grease

Name of grease		Polyrex EM
Manufacturer		Mobil
Color		Blue
Layout	Base oil	Mineral oil
	Thickener	Polyurea
Key Properties	Viscosity [cSt]	113
	Consistency [NLGI grade]	2
	Dropping Point [°F]	410
	Oil Separation [%], Test Value	1

At the installation site, if Polyrex EM is not prepared, follow the options: use other grease using Polyurea-based thickener, or rill new grease as removing fully the remained grease inside of channel of lubrication and bearing as the existing grease used. The grease must contain corrosion and oxidation inhibitors. It you are required to use non-standard grease because of environmental conditions and others, please contact Hyosung Heavy Industries or distributor.

8.2.2 Grease Injection (filling)

In terms of grease injection, please fill the grease complying with the following procedures.

(1) Stop the motor operation.

(2) Remove the grease drain plug on the bottom of the motor.

(3) Remove the protective cap from the grease nipple on the top of the motor.

(4) Check the bearing number and use a manual grease gun to inject the grease, referring to Table 8.2. Slowly rotate the shaft by hand to allow the injected grease to spread into the bearing, and remove any excess grease that escapes. (If the motor has a separate grease nameplate and sticker, we put the greasing standards on the nameplate and sticker before any others)

(5) After the motor operation, as 10-15min past, tighten the drain plug.

(6) Wipe off any unused and excess grease, and securely close the grease nipple cap.

※ If you need to refuel amid of operation, make sure to use the proper amount to fill. In case of over-fueling, it can cause grease to get inside the motor and affect winding's insulation, and others.

8.2.3 Greasing in the event of bearing noise

If bearing noise occurs amidst of the motor operation, please inject grease as following the below instructions.

(1) Remove the protective cap from the grease nipple on the top of the motor.

(2) According to the grease refilling cycle as shown in table 8.2, fill the grease gradually up to 50% of refilling amount, then fill it until the noise disappears. Then, as checking the bearing noise condition with stethoscope for 10 to 20 minutes, if the noise occurs again, you have to fill it additionally (if the noise does not disappear even you inject grease additionally, default of bearing is assumed, so please replace the bearing as sticking with the procedures shown in 8.3.

(3) With regard to oil left as it could not be filled, you need to wipe off and put the cap back of grease filling plug.

8.2.4 Grease filling under re-start after shutdown (stop)

When the motor is restarted after its shout-down (stop), you have to fill the grease according to the following procedures.

(1) If the motor is not operated for 2-3months, check whether grease oil flows down on the bottom of the motor (oil separation); if there is oil on the bottom, fill the 25% of initial oil filling amount according to table 8.2.

(2) If bearing noise happens as the motor is restarted, fill the grease step by step up to 50% of refilling amount, then fill it up until the noise is gone. At that time, around 30 minutes, check the bearing noise condition with stethoscope stick.

※ Oil Separation: This is a phenomenon happens when the motor is shut-down and stored for a long time, as the grease's oil is separated from thickener, and seeps on surface of grease. If the motor is stored for more than 6 months after installation, it should be refilled with grease while rotating the axis every 3 months.

⚠ WARNING

Insufficient grease due to under-filling, and excessive grease filling can cause bearings to overheat, leading to bearing failure.

8.3 Bearing replacement

Bearing replacement should be performed by qualified and trained personnel using the appropriate tools and techniques, using the procedures below.

8.3.1 Preparation before work

The preparation for replacing a bearing is described as follows.

Fixtures, tools, Jigs, and materials	Worker
• Spanner(Wrench) Set • Socket Wrench Set • Snap ring plier • Gear Puller • Crowbar • Rubber mallet • Liquid Silicone	• Wear personal protective equipment • Review the work instruction • Prepare jigs and materials

8.3.2 Working Procedures

8.3.2.1 Frame Size 320T or smaller

Refer to the part names, shapes, and location in Figure 9.1 and follow the procedure below.

(1) Shut off the power, and disconnect the power line inside of terminal box and lead wire of the motor.
(2) If the motor is equipped with grease-lubricated type bearings, remove the grease inlet/outlet components from the motor.
(3) For bearing replacement from non-drive side, dismantle hood and cooling fan.
  (a) Loosen the hood retaining bolts and dismantle the hood from bracket of non-drive side.
  (b) Remove the snap ring from the shaft using snap ring pliers, then detach the cooling fan.
(4) Release bracket assembling bolts from drive/non-drive sides; dismantle bracket from frame and bearing.
  (a) In terms of dismantling bracket, the separation is much easier by using crowbar and others on the gap.
  (b) Disassemble the non-drive end bracket.
  (c) Remove the drive end bracket from the stator together with the rotor assembly.
  (d) On the bracket of load side, the snap ring for retaining end play is assembled inside of housing; so bracket has to be dismantled after removing the snap ring with snap ring plier.
(5) Use the gear puller to disconnect the drive/non-drive side bearing. (See Figure 8.1)

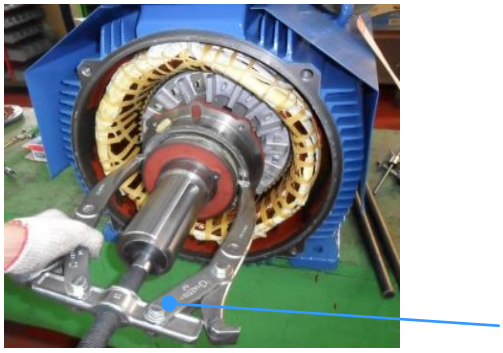

Figure 8.1 - Bearing Removal

(6) After removing the bearings, clean the shaft of any foreign matters.
(7) Insert new bearing into the shaft.
  (a) As for bearings with an inner diameter of 40 mm or less, use a jig and tap with a rubber mallet. For bearings with an inner diameter greater than 40 mm, assembly is performed using an induction heating machine or by shrink fitting.
  Here, keep in mind to avoid putting high temperature or excessive shock on bearing.
  (b) As for bearing from load side, insert snap ring for end play fixation first, then put bearing.
(8) After cleaning bracket bearing housing area, then apply small amount of grease on housing to have easy assembling. To satisfy IP degree, apply silicone to frame joint section.
(9) Temporarily assemble the bracket onto the bearing so that it is level, then lightly tap the bracket with a rubber mallet or an aluminum rod to complete the assembly.
  (a) Assemble the snap ring for securing end play on the drive end bracket.
  (b) At the bracket from non-drive side, insert wave washer and assemble it.
(10) After tightening the bracket assembly bolts, remove any silicone that has squeezed out.
(11) Assemble cooling fan and hood from non-drive side.
(12) In case of grease filling type, assemble the grease inlet/outlet components.
(13) After completion of bearing replacement, check whether any abnormalities are shown related to bearing noise by operating the motor with no-load condition. Also, measure vibration.

8.3.2.2 Frame Size 360T or larger

Refer to the parts name, shapes, and locations of Figure 9.2, and perform it in accordance with the below procedures.

(1) Shut off the power, and disconnect power line inside of terminal box and lead wire of the motor.
(2) Disassemble the grease inlet/outlet components from the motor.
(3) For bearing replacement from non-drive side, dismantle hood and cooling fan.
  (a) Loosen the hood retaining bolts and dismantle the hood from bracket of non-drive side.
  (b) Remove the snap ring from the shaft using snap ring pliers, then detach the cooling fan.
(4) Remove the fastening bolts of the inner/outer bearing cap.
(5) Release bracket assembling bolts from drive/non-drive sides; dismantle bracket from frame and bearing.
  (a) In terms of dismantling bracket, the separation is much easier by using crowbar and others on the gap.
(6) By using snap ring plier, remove the snap ring for securing the slinger, then detach the slinger form the shaft. (applicable to 400T and above)
(7) When it comes to bearing separation, it is the same as the procedures shown in (5) - (6) in 8.4.2.1.
(8) The new bearing will be inserted to the shaft with induction heating machine or shrink fit.
  At this time, pay attention to do not put high temperature as excessive impact on the bearing.
(9) Assemble slinger and snap ring for fixation to the shaft.
(10) After cleaning bracket bearing housing area, then apply small amount of grease on housing to have easy assembling. To satisfy IP degree, apply silicone to frame joint section.
(11) Temporarily assemble the bracket onto the bearing so that it is level, then lightly tap the bracket with a rubber mallet or an aluminum rod to complete the assembly.
  (a) At the bracket from non-drive side, insert wave washer and assemble it.
(12) Assemble the inner and outer bearing caps to the bracket (The outer bearing cap is applied to models with 400T or larger)
(13) The subsequent assembly is the same as steps (10) through (13) in 8.4.2.1.

8.4 Disassemble, inspect, and repair the motor

Disassembly/assembly and repair of the motor must be performed by qualified and trained personnel using the appropriate tools and techniques in accordance with the procedures below. See Figure 9.1-2 for the name, shape, and location of each part.

8.4.1 Initial inspection

(1) Visually inspect the exterior of the motor for broken parts, and turn the shaft by hand to see if it turns.
(2) After powering it off, open the terminal box cover and disconnect the power line and motor lead wires.
(3) Measure and record the insulation resistance and wire-to-wire resistance at the motor lead wire terminals.
(4) Record the installation conditions, including alignment and leveling, and others before disassembling the motor.

8.4.2 Disassembly

(1) Turn the power off.
(2) Open the terminal box cover.
(3) Disconnect all wiring connected to the motor
(4) Uncouple the motor from the load.
(5) Remove the motor base retaining bolts.
(6) Transport it to the disassembly site.
(7) Disassemble the terminal box.
(8) Disassemble the related components in accordance with procedure ‘8.3.2 Working Procedure'
(9) Detach the bracket from the frame.
(Be careful not to damage the iron core or windings when disassembling)
(10) Disconnect the slinger from the shaft. (Applies limited to frame size is 360T and higher)
(11) Separate the stator and rotor.
(12) After disassembly, check the following points and replace any defective parts with new ones.
(a) Visually inspect the motor for any broken parts inside the motor.
(b) Check for rust caused by internal condensation.
(c) Check the bearing rotation status.
(d) As for replacement of bearing, refer to ‘8.3 Bearing replacement’ to replace it.
(e) After removing the bearing, check the dimensions of bearing mounting area on the shaft.
(f) Check bearing housing’s inner diameter’s tolerance of bracket.

8.4.3 Cleaning and drying

As for the motor operated for a long time, dust or contamination matter having oil content can pile up in and outside of the motor depending on installation environment and operation status and others. Thus wash up and clean up the motor as following the below methods.

(1) As for general cleaning by using high pressure washer, it is recommended cleaning with water. When it comes to cleaning, pay attention to avoid penetration of water inside of the motor. To

remove piled dust and dirt inside of the motor, you can avoid damage of internal components or insulation of winding as using the vacuum cleaner using compressed air. As to a far severe dust or winding contaminated with oil content, it has to be wiped off with cloth by using solvent. The solvents have a low flash point and are hazardous to humans, you have to make sure to be careful to use it.

(2) In terms of rust inside of the motor due to condensation, it has to be removed with sandpaper or brush. At that time, pay attention to avoid any damages for internal components of the motor.

(3) After removing the bearing, in cases of corrosions detected from the rotator, you have to put proper countermeasures such as repairing, replacement and others.

(4) With regard to drying of stator and rotor, it has to be dried up with using hot air heater; this turn, the heating temp. should not exceed 194°F(±18°F); also the drying has to be made fully for around 8-10 hours.
After completing the drying process, the cooling is made at room temperature. In terms of stator, measure the insulation resistance according to '5.1 Insulation resistance.' If the measured resistance does not meet the criteria in Table 5.2, repeat the drying process. If the insulation resistance does not improve even you carry out multiple drying processes, you'd better to find out the cause of the lowered resistance level. If the damage is severe, you have to replace windings.
As for cases having difficulties to understand cause of the issue or doubts regarding winding damage, reach out to Hyosung Heavy Industries or distributor.

8.4.4 Assembling

Conduct the assemble in a reverse way of dismantling that you did. When it comes to replacement of grease filling type bearing, refill the grease according to Table 8.2 after cleaning the bearing housing.
After the assembling work, measure insulation resistance and line-to-line resistance, and compare the measured value with recorded values. If you recognize that is qualified product, check noise and vibration of the motor as operate the motor under no-load condition.
If necessary, paint the motor in accordance with motor specification. Hyosung Heavy Industries standard color is 0.5PB 3.2/4.4.

ATTENTION

- It is extremely dangerous for one person to dismantle and assemble alone. Please make sure to carry out the work with no less than 2 people.
- In terms of disassembling, please organize the parts in orders to avoid confusion amid of assembling work.
- With regard to important components (e.g. Bearing, winding, etc), make sure to do not put damage (penetration of foreign matters, impact, etc.) them.
- When it comes to dismantling and assembling, perform the works by expert. There are risks including electric shock, injury, fire, burnout and others.