7. Operation

Repeated starts can overheat the motor and cause burnout. If you carry out starting work repeatedly, please make sure to secure sufficient time to allow the motor to be cooled down in-between the start to prevent the overheating. Under no load condition, check the rotation status while the motor operates; verify whether abnormal noise of bearing exist or not. If excessive noise, vibration, and abnormal sounds (repeated clicking sounds or hitting sounds, etc.) are heard, please stop the motor operation promptly and reach to Hyosung Heavy Industries or distributor where sold the motor to you.

If an abnormal heating phenomenon occurs during operation, it should be checked whether the temperature rise limit is exceeded. If test run is fine, please operate the motor from min. load and increase the load gradually.

After completion of installation, please operate it as checking the detail items according to the following procedures

7.1 Pre-inspection before operation

- (1) Does the axis rotate smoothly when it is turned with a hand?
- (2) Is the lubricating oil is adequate?
- (3) Are there any spots missed their bolts?
- (4) Is the cooling fan attached and free of breakage?
- (5) Are instruments, safeguards, etc. fully functional?
- (6) Does insulation resistance (incl. Lead wires) stand over its standard value (criteria)? . (See '5.1 Insulation resistance')
- (7) Does the wiring match with the wiring diagram on the nameplate? (See '6.5 Electrical Connection')
- (8) Is an emergency suspension possible?
- (9) Did you establish any contact system?
- (10) Do you have enough operation personnel? (headcount, and capabilities)
- (11) Is the power supply voltage adequate?
- (12) Have you checked the recorded past commissioning performance?

7.2 Checklist under operation

- (1) Is the rotation direction appropriate?
- (2) Are there any abnormal sound, and irregular sounds?
- (3) Is there a strange odor(smell)?
- (4) Are the starting time and starting current enough?
- (5) Is vibration shown within acceptable control range? (See '7.5 Vibration')
- (6) Is there any abnormalities in power system?

7.2.1 Rotation Direction

In terms of standard motor's rotation direction, from the view of load, it rotates counterclockwise way Check the rotation direction as operating the motor under no load connection environment; if the desired direction is not observed, please change the two phases of power source to conduct connection work, then the rotation direction will be changed. At that time, if that is a case of directional fan which rotates in a certain regular direction, you have to re-assemble it again as changing the rotation direction. if necessary, please discuss the issue with Hyosung Heavy Industries or distributor where sold the motor to you.



- If the power goes out amid of its operation, be sure to turn off the power switch. If the power is recovered, re-starting can be made automatically; so unexpected accident can occur accordingly.
- Be careful with your hand and your body to be contacted with surface of operating (ongoing) motor as it is hot. You may suffer burn damage.



- Do not operate the motor above rated voltage value written on nameplate. It may be burnt out due to overload operation.
- If it does not start within 15 seconds (based on DOL) after power is applied, please cut the power first of all. If over-current is applied continuously, the motor can be burnt out. If you need more detailed information on starting issues, please reach out Hyosung Heavy Industries or distributor where sold the motor to you.

7.3 Note (Important Points) after operation

Repeated starting can lead to overheating of the motor, and result in burnout damage. If you do restart, make sure you leave enough time between restarts to prevent overheating.

If general motor is operated under repeated rating condition (S3 and higher) continuously (even the general motor is made for operation under continuous rating (S1)), it can shorten life of the motor and burnout damage because of thermal impact. It has to be operated with the following frequency: 1 HOT/ 2 COLD per day; the operation should not exceed the designated number of operation, and its time according to its specification. If starting frequency is frequent, please contact with Hyosung Heavy Industries and distributor who sold the motor to you. If grease is filled overly amid of the operation, bearing temperature and vibration can rise temporally; and after a period of time, sometimes it stabilizes itself; in this case, this is not a failure of the motor.

If you do not operate the motor for a long time, please control and manage the motor according to '5. Storage' to prevent corrosion and insulation degradation.

7.4 Operating Condition

Unless otherwise specified on the order form, the motor is designed and built to operate at altitudes up to 3280 ft. above sea level and in max. temperatures ranging from 104°F (See '3.3 Installation Environment'). If there are any specification beyond normal condition, the information will be written on motor and nameplate.

If ambient temperature and altitude surpass the specified values, some components need to be changed. To apply special function which goes beyond installation environment condition, please reach out to Hyosung Heavy Industries or distributor who sold the motor.

If temperature and altitude of motor installation location are worse than their standard; the motor has to be operated with reduced output ($P_{max} = P_{nom} x$ correction factor) by multiplying correction factor (written in Table 7.1) and rated output together.

Table 7.1 - Correction Factors depending on Ambient Temperature and Altitude Variations

Ambient temperature (°F)	Correction Factor for Standardized Ratings	Altitude (ft)	Correction Factor for Standardized Ratings
104 or less	1.0	3,280 or less	1.0
over 104-113	0.96	over 3280-4921	0.97
over 113-122	0.92	Over 4921-6562	0.94
over 122-131	0.87	over 6562-8202	0.90
over 131-140	0.82	over 8202-9843	0.86
		over 9843-11483	0.82
		over 11483-13123	0.77

- Note) 1. If ambient temperature and altitude are applied in an overlapped way, multiply by their respective correction factors.
 - 2. The value is a reference value; Hyosung Heavy Industries is not accountable for any problems and issues occur amid of operation.

If the motor power supply voltage and frequency fluctuate within the following range (refer to NEMA MG 1 Part12), it will not affect operation, but it may cause performance change and temperature increase that differ from the nameplate characteristics.

- ±10% of rated voltage at rated frequency
- ±5% of rated frequency at rated voltage
- The combined change in voltage and frequency is 10% of the rated value (sum of absolute values), provided that the change in frequency does not exceed ±5% and the change in voltage does not exceed ±6% of the rated voltage.



If the motor is cooled by ambient air, clean the air inlet, outlet and cooling fins regularly to ensure air flows over the frame surface. Hot air should never be returned to the motor. The cooling air must be room temperature, limited to the temperature range shown on the motor nameplate.

7.5 Vibration

Vibration from the motors can shorten winding insulation and bearing life. Before installing the motor, measure the vibration under no load to ensure that it meets Garde A in Table 7.2 below.

If the measured vibration value is greater than the limit value, please contact Hyosung Heavy Industries or distributor. After the installation on the utilization equipment, if the measured vibration exceeds its management criteria, make sure to check the installation environment including connection with utilization equipment, levelness of bed, looseness of fixed section of bolt.

NEMA Frame Size		NEMA Frame ≤ 210		NEMA Frame > 210	
Vibration Grade	Mounting	Displacement	Velocity	Displacement	Velocity
		(mils, pk-pk)	(in./s, pk)	(mils, pk-pk)	(in./s, pk)
	Resilient	2.4	0.15	2.4	0.15
A	Rigid	N/A	N/A	1.9	0.12
					*0.15
В	Resilient	1.0	0.06	1.6	0.10
	Rigid	N/A	N/A	1.3	0.08
					*0.10

Table 7.2 - Unfiltered Housing Vibration Limits

7.6 Bearing Noise

Ball and roller bearings have their own noise (race noise, click noise). These are considered normal noises; as for problematic noise on performance includes cage noise, squeal noise, flaw noise, and contamination noise.

(1) Normal noise (Race noise)

It is a continuous sound caused by the ball rotating the inner race and outer race. This is the noise seems like wind sound regardless of rotation number.

(2) Normal noise (Ball Drop noise, Click Noise)

It is a noise occurring in horizontal type; it is made as the ball placed on the bearing drops and touches to retainer and inner race amid of rotation. It does not occur amid of operation but it happens when number of rotation is decreased. In particular, this noise is shown before stop; therefore, if it resonates with bracket, it can make loud noise though it does not play a negative role in operation.

(3) Retainer noise (Cage Noise)

This is the noise produced when the retainer, ball, and inner race and outer race touch together at the same time; it includes irregular noise which has a no relation with a number of rotation. If happens on bearing which has big gap as made for high speed machine; when grease is filled, it will dissipate or lower; but, even after filling the grease, if the noise gets louder, you'd better to check the issue.

(4) Squeal Noise

It is created due to irregular operation of non-load area, and it relates with lubrication condition of

X This level is the limit when the twice line frequency vibration level is dominant as defined in NEMA MG 1 Section 1, Part7 Clause 7.8.5

grease and gaps, and others; there is a bearing prevent to squeal noise but it does not avoid it fully. If it does not involve vibration, it is understood that no issue to operate(use). Generally, there are many cases disappearing the noise only with grease filling. In this case, consider the bearing is in normal condition. In some cases, the noise gets louder as resonating with bracket likewise drop noise.

(5) Flaw Noise

It is a noise showed when flaw or crack occur on inner race and outer race as well as ball, and etc. Its cycle is proportional to a number of rotation. In general, it entails vibration, but possible to detect as it has longer cycles before it stops. In addition, when you rotate the rotor slowly with your hand amid of its stop, you can detect there's marks (flaws) on certain area.

(6) Contamination Noise

It is a noise which is created as foreign matters enter inside of bearing; it has big cycle and many cases it is irregular. If the noise is not removed and remained; it can get flaws, therefore, you need to pay attention on the noise. The noise is likely to happen if assembling is conducted at unclean environment.

7.6.1 Bearing Noise Troubleshooting

When it comes to trial run of the motor, depending on grease condition inside of bearing, sometimes you may face with increase of bearing noise or squeal noise and others irregularly. In this case, please check the issue according to below Table 7.3.

Table 7.3 - Checkpoint when bearing noise occur

	Grease-filling type bearing	Shield(shielded) type bearing			
	Under operation condition, fill up 1/2 amount of	After operating the motor for 20-30 minutes,			
1	grease as instructed on grease nameplate, and	then inspect it (Depending on bearing temp.			
1'	after operating the motor for 20-30 minutes,	rise, as the hardened grease's lubrication gets			
	then inspect it.	smooth, then noise can be removed)			
	As for C3 class bearing, after carrying out load o	peration more than 30 minutes then inspect it.			
2	→ If the noise is eliminated, it is normal phenomenon due to the characteristics of the C3				
	bearing.				
	In case of inverter-fed operation, the power source will be supplied with direct way to operate,				
3	and inspect it.				
	→ If the noise is eliminated, it is not a defect of motor but is inverter noise.				
	Disconnect the power source amid of operation, then inspect it while the rotation is maintained				
1,	without power source.				
4	ightarrow If the noise is removed, it is an electrical sound; you should contact Hyosung Heavy				
	Industries or distributor.				
	Disassemble utilization equipment and connected coupling, operate it under no-load condition, and inspect it.				
5					
	ightarrow If the noise is eliminated, utilization equipment and alignment check are required.				

- * If noise disappears amid of grease filling, please stop the filling work; within 30min, if the noise occurs again, please fill the grease additionally.
- Noise can happen during initial operation period or because of hardening of grease which is filled in bearings under low temperature; if the bearing temperature rise under operation, then noise can be removed as the grease lubrication becomes smooth.

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.



- 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