9/25/2017

High Temp Bearings Inc.

CG-3 Drop In Hydrodynamic Bearing Core Assembly Instructions

100% Made in America

CG-3 Hydrodynamic Bearing Core Assembly Instructions For Use With Dodge R-Series ™ Housing

Introduction: CG-3 Hydrodynamic bearing cores are fully split, self-aligning and designed to install directly into an existing Dodge R-series™ housing, without the need for water or air cooling. In storage, it should always be kept in a clean, protected location. The bearing, housing, and shaft must be thoroughly cleaned before installation. The cores have two basic styles, expansion and non-expansion with multiple bore options. The non-expansion core will require the installation of 2 shaft mounted thrust collars and plates. In some cases that shaft has been turned with integral runners that will take up the axial load during operation, eliminating the need for collars. All CG-3 cores use interchangeable thrust collars and trapezoidal oil rings with the corresponding Dodge R-Series Bearing.

DANGER: To ensure that the drive is not unexpectedly started, turn off and lockout the power source before proceeding. Failure to observe these precautions could result in bodily injury or death.

Warning: Always use the same lubricant that the bearing will be running on when using lubricant to aid in assembly. Mixing of oils will prevent the bearing from functioning correctly.

Warning: Never use harsh solvents on the bearing liner, this may damage the surface.

1. **Clean the shaft and all bearing components thoroughly.** Use a cloth or detergent-based cleaner on the liner. Solvent-based cleaners may be used on all other surfaces. Scrutinize the shaft for any raised areas, burs or contamination. Any defects in the shaft will have a negative impact on the bearing operation. On existing installations slight grooving of the shaft is common where oil rings have run, this typically does not cause significant problems, but may increase the wear rate of the oil rings.

Note: If the bearing core will have thrust plates installed, clean the faces of the core well, slight contamination can cause the thrust plates to lie slightly out of parallel, resulting in run-in and elevated bearing temperature.

2. **Check basic dimensions and verify that all adapters and shaft diameters are correct.**

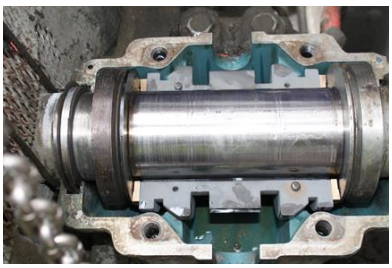
3. **Preparing the Housing and Core for Assembly.** Housings and cores must remain as a set, numbering or match marking caps and bases should be done to prevent alignment problems. Check the housing and remove any paint, burrs or old gasket from the cap and base and thoroughly clean the housing, core and bearing area.

4. **Note the location of the thermocouple holes in the liner base and housing.** Ensure that they will be appropriately oriented for connection and access.

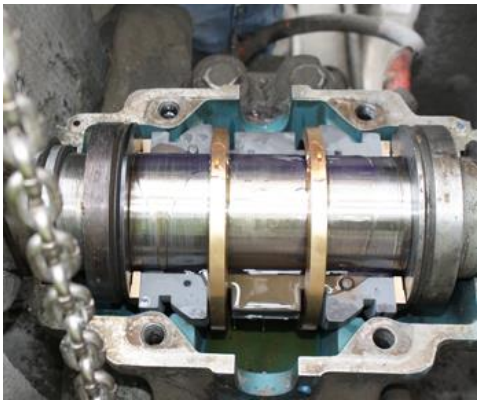
5. **Check the housing mounting location:** ensure that it is rigid, level and free of dirt and debris, in the event of replacement ensure that the shaft load is relieved from the bearing and housing.

6. **Set the bearing base**. Set the lower half of the housing on the pedestal and using the same lubricant that the bearing will be running on, lightly oil the bearing seats. DO NOT tighten the housing base to the pedestal at this point. Similarly prepare the cap, maintaining the orientation of cap and base. Place in a clean area.

7. **Set the bearing core bottom into position and lower the positioned shaft onto the bearing**. Inspect the bearing and shaft for contamination or raised areas, then apply a good coating of lubricant to the shaft and bearing surface. Carefully rotate the core around the shaft or place the core bottom into position on the bearing housing seat, do not force the bearing, it should position freely. If the bearing starts to bind, STOP and determine the cause. Once the core bottom has been appropriately located, lower the shaft into the bearing.



Note: verify that the core split is approximately even with the bearing housing split and that the core bottom and not the top are located in the housing base.



8. Install split trapezoidal oil ring set (not required if using circulated oil system): Each oil ring is split into halves, place one half of the oil ring around and outside of the core bottom and the other half over the top of the shaft so that the two halves mate to form a ring. Install the oil ring screws and apply a thread locking compound to prevent the screws from backing out. The oil rings should be located to run through the slots on the core on either end and must rotate freely.

Warning: Verify that the oil rings rotate freely and that there are no raised or sharp edges that could catch during operation, potentially interrupting oil flow. Oil ring rotation can be seen through the oil ring viewing ports on the top of the housing.

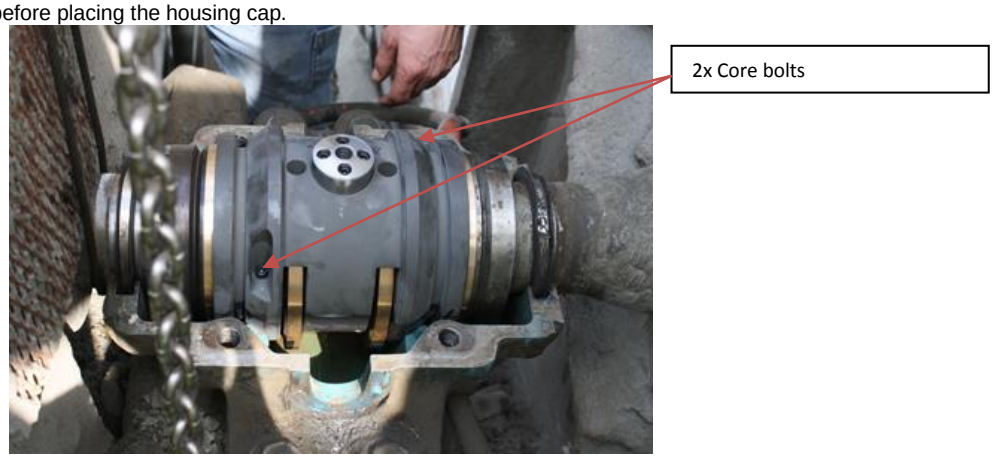
Note: Oil rings will wear over time, leaving bronze deposits in the bearing case. Regular inspection of bearing oil for wear debris is recommended. Periodic replacement is required. Do not use oil rings if the shaft surface speed is greater than 2700 FPM.

Note: Only use trapezoidal oil rings. **Do not use T-section oil rings** they will not deliver sufficient oil to the bearing.

9. Installing non-expansion bearing assembly (not required for expansion bearing unit): for non-expansion bearing follow the "non-expansion bearing installation instructions," otherwise proceed to **step 10** for expansion bearing unit.

10. Install core top: Core halves are not interchangeable and have been bored as a matched set, make sure halves are correctly aligned and matched. Check the bearing end faces, seat and bore, there should not be overlap. If installing the core top of the non-expansion bearing, be sure that the thrust plates are properly located and that the top is lined up correctly not to catch on the collars. Apply oil to the core top and shaft, then carefully lower the top into place, if it does not fit into place easily, remove and reposition accordingly. It should drop into place with minimal force and not interfere with oil ring rotation. Inspect the split line near the spherical bearing seat for mismatch as a secondary check that the core halves have not been mixed or rotated. Once in place torque, the "core bolts" to the indicated amount in the **bolt torque table** and check that oil ring rotation is not impeded.

Note: For large cores, screws have been tapped on the top and bottom half of the core on each end for temporary accommodation of lifting eye-bolts. If used these must be removed before placing the housing cap.



11. **Install split dust seals:** When replacing bearing cores, it is recommended that any elastomeric dust seals be replaced. Often old seals do not fit back into the housing easily due to swelling. This makes them prone to rolling, preventing proper housing closure and failing to protect the bearing from contamination adequately.

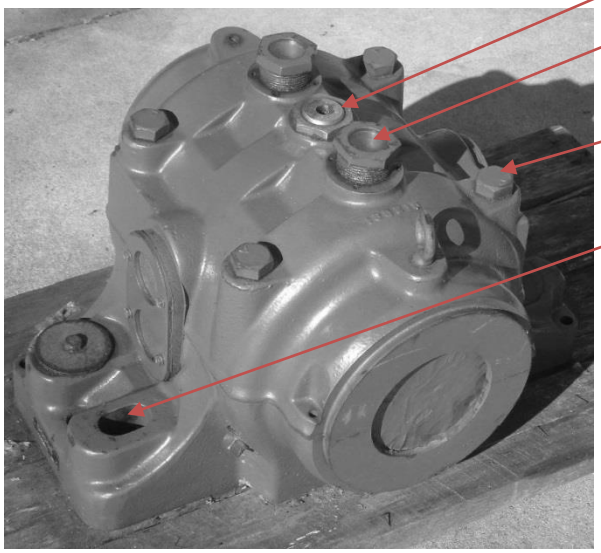
12. **Align the bearing and torque the foot bolts:** The bearing has been designed to be self-aligning; alignment must be done before the housing cap plunger screw has been torqued. Use of shims should be limited, use only full-length shims under the base and avoid stacking as this may result in a soft foot condition. Once the bearing has been properly aligned, tighten the housing base "foot bolts" to the pedestal, using the appropriate bolt torque ranges (See bolt torque table). Use SAE grade 5 bolts and Grade B or C nuts. Verify torque falls within bolt and nut acceptable min and max torque range to develop the proper bolt stretch. If using lubricated or high strength bolts check with a machinist handbook for adequate torque to achieve an acceptable stretch.

Tip: A hydrodynamic bearing operates with internal clearance. When the shaft is stationary, it will rest near the lowest (Top if cap loaded) point in the bearing bore. During operation hydraulic pressure will lift the shaft as much as several thousands of an inch in the direction of shaft rotation depending on the bore diameter, this is the bearings eccentricity and attitude angle, it is normal.

Bolt Torque Table

Bearing Size	Housing Cap Bolts		Housing Foot Bolt		Core Bolt		Plunger Screw	
	Screw Size	Torque (lbs-in)	Screw Size	Torque (lbs-in)	Screw Size	Torque (lbs-in)	Wrench Size	Torque (lbs-in)
3 15/16	3/4-10 UNC	1900	7/8 UNC	2040	1/4-20 UNC	120	3/8	850
4 7/16	7/8-9 UNC	1700	1 UNC	3000	5/16-18 UNC	132	1/2	1250
4 15/16	7/8-9 UNC	1700	1 UNC	3000	3/8-16 UNC	240	1/2	1250
5 7/16	1-8 UNC	2600	1-1/8 UNC	4200	3/8-16 UNC	240	1/2	1250
6	1-8 UNC	2600	1-1/4 UNC	6000	1/2-13 UNC	600	5/8	2500
7	1-1/8-7 UNC	3600	1-1/2 UNC	10000	1/2-13 UNC	600	5/8	2500
8	1-1/8-7 UNC	3600	1-3/4 UNC	11500	1/2-13 UNC	600	5/8	2500

Dodge R-Series ™ Housing



13. **Install housing cap:** he housing cap should be checked for burrs and thoroughly cleaned. RTV Silicone gasket maker should be applied at the split surfaces to prevent oil seepage through the case. The sealing compound must be used sparingly (excess compound may interfere with proper bearing seating). Wipe a thin film near the outer edges. The cap plunger screw must be backed out and then the housing cap set over the bearing core. Make sure that the seals are not rolled, and the housing cap is mated correctly all-around. Place the cap bolts and torque the specified torque in the **bolt torque table**.

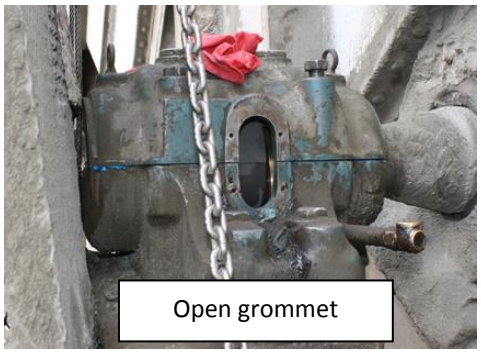
    Warning: Caps and bases of pillow blocks are not interchangeable. Each cap and base must be assembled with its mating part.

14. **Set the housing cap plunger screw:** The plunger screw prevents movement of the core and secures cap loaded bearings. When dealing with equipment that has a cap loaded bearing, its plunger screw must be torqued before the base loaded bearing. **For cap loaded bearings:** the shaft must be held down to install the cap. Tighten the plunger screw and mark its position. Loosen the plunder screw one turn and then loosen the shaft hold down. Next tighten the plunger screw back to the marked location, torqued to the plunger screw torque listed. Remove the shaft hold down and tighten the plunger screw lock nut. **For base loaded bearings:** Torque the plunger screw to the plunger screw torque listed. Tighten the plunger screw locknut.

    Note: DO NOT over tighten the plunger screw this can misalign the liner and constrict the core, resulting in high running temperatures, shaft turnover maybe very difficult when over-tightened.

    Note: DO NOT tighten hold down screw on accompanying base loaded bearing until cap loaded bearing has been installed and shaft hold down mechanism has been removed.

15. **Install grommet plates:** When using Dodge R-series™ housing with a CG-3 hydrodynamic core, water or air cooling lines are not needed. **All external cooling lines must be removed from the housing.** The openings in the housing must be covered to prevent oil loss and contamination. Place RTV Silicone gasket maker around the grommet plate opening and then place the supplied grommet plate over the opening. Secure the plate with 10-24 x 5/8" thread forming screws.


Open grommet


Grommet cover placed

16. **OPTIONAL: Connection of the circulated oil system to the inlet ports of the bearing (Not required if using oil rings, see individual project technical data for exact system requirements):**

    1. Clean and flush any oil lines being connected to the bearing before installation!
    2. Each bearing housing has 2, ¼ NPT inlet ports located on the cap of the bearing, both ports must be connected. So that each end of the bearing is properly lubricated.
    3. Make sure that inlet piping extends into the bearing through the inspection holes in the top of the bearing core. If it touches the shaft trim the tube length and de-bur. The tube end must extend into the core but must not contact the shaft or oil ring if present.
    4. With all connected piping, use of a paste sealant is recommended to reduce the chance for leaks.
    5. Connect the circulated oil system return to the housing circulated oil outlet drain on the bearing housing: Every bearing housing has an NPT threaded circulated oil outlet for gravity flow to an external system. For optimal draining the outlet piping should slope away from the bearing at a minimum of 15°, should be vented to prevent suction clogging, and return to the circulated oil system. For a single drain, the oil inflow should not exceed the drain rate list in the common C.O. Return drain table, additional ports may be tapped for increase draining if very high oil inflow rates are needed.

        Note: Filtration should be installed on the pump outlet rather than on the return side, or run on a separate filtration loop. The bearing housing is not pressurized when using standard seals.

Common Circulated Oil Return Drain Rate Table

Circulated oil outlet (NPTF)	*NPT pipe Scd. 40 gravity drian rate 50% cap. 2° min pitch (GPM)
3/4	1.4
1	2.3
1-1/4	4.0

* Higher gravity drain rates may be achieved with thin wall piping, steeper pipe drain slope or additional ports

17. **Add lubricant to the system:** HTB, Inc. specify specific lubricant chemistry and viscosity for every application. This information is supplied with the technical information from High temp bearings Inc. The chemical composition and viscosity are critical to the ability of the bearing to function. Do not substitute or mix lubricants! The relative housing oil volume for each bearing size is listed below. If using oil ring lubrication, fill the bearing housing with lubricant until the level is at the oil level at the top to the midline of the sight glass. Overfilling will cause oil to run out along the shaft during operation.

Bearing Size	Approx. Oil Capacity (US fl. oz.)
3 15/16	50
4 7/16	64
4 15/16	90
5 7/16	100
6	132
7	240
7	320

Warning: Use of a lubricant other than what has been specified during product sizing will result in reduced performance or bearing failure!

Lubricants should conform to the grade selected in sizing, be single grade chemistry, rated for turbine or gearbox applications, in the proper ISO range specified for the use, with a high-quality oxidation inhibitor and corrosion resistance additive package. Brands we recommend include:

- **Mobil:** SHC 600 Series oils for applications bellow 200°F (Full Synthetic PAO)
- **Dow Chemical:** UCONALL PAG up to 221°F (Full Synthetic PAG)
- **American Chemical Technologies:** ECO-GEAR PAG up to 221°F (Full Synthetic PAG)
- **Mobil:** GLYGOYLE PAG for applications up to 221°F (Full Synthetic PAG)
- **Mobil:** EAL Arctic Series up to 300°F
- **Shell:** S4 FR Series up to 300°F
- **American Chemical Technologies:** Genesis BL HT series up to 300°F

18. Bearing housing or oil sump temperature monitoring is an economical and reliable method for verifying proper bearing operation. HTB recommends that temperature monitoring is part of every installation. Use of a grounded RTD is required for control. All Dodge R-series™ housings have been tapped for RTD's, and all CG-3 Cores have been milled with a standard probe location (Step 4) for temperature monitoring. When running on oil rings, oil sump temperature is satisfactory for equipment monitoring.

    If the oil supplied to the bearing is very cold, the bearing oil should be warmed to 70° F before startup, warming is especially crucial for bearings running high viscosity oil (ISO 100 or higher). Consideration of the oil pour point should be used when deciding to preheat. Lower watt density heating methods are generally superior when heating fluids. Excessive heater surface temperature will damage the oil within the bearing. The bearing housing is cast iron and will distribute heat evenly. Heat tracing or adhesive warming pads attached to a thermostat are the recommended way to preheat the bearing before cold starting. Once running the bearing will generate enough heat during operation that the heater may be shut off.

Warning: The housing should not be insulated unless it is during the initial pre-heat; insulation will interfere with heat dissipation during steady operation and may impact oil film thickness of the running bearing.

19. **Startup & Troubleshooting:** Verify lubricant is getting to the bearing before starting operation (oil rings or C.O. system are correctly brought up oil). If it is colder than 60°F preheating of the oil to a minimum of 70°F is recommended for proper oil flow, once running the bearing will generate sufficient heat no further heating is needed. On initial installation attempt to manipulate the shaft. Verify that installed oil rings rotating and bring oil up properly, and that oil can be seen exiting the thrust faces on non-expansion bearings. The shaft should turn over without restriction from the bearing. If binding between the bearing and shaft is noticed re-check the installation. From experience, a stiff back and 4 ft. cheater bar is enough to turn over a 26,000 lb rotor. If manual shaft turnover is not possible due to rotor weight, attempt to quickly bump start the system and cost down without breaking, the system should come to a gradual stop. If the rotor stops harshly, the assembly should be rechecked.

    a. When using oil ring lubrication, after the first week of operation, it can be beneficial to replace or filter the initial oil fill; some run-in can occur and elevated temperatures for the first few hours of service.
    b. If high heat is observed in the control room:
        i. Check the bearing housing with an IR gun to verify if RTD readings are accurate. Most commonly there are problems with RTD installation producing false readings. These can be wildly variable, have sudden jumps in readings or read arbitrarily very high or low. CG series bearings use a polymer liner that requires a grounded RTD probe to avoid static charge build-up and adequately calibrated controller.
            1. Verify that a grounded RTD is installed, 2 pole and ungrounded probes will not produce accurate readings with CG-3 and CG-1 cores.
            2. Validate that temperature controllers can read over 212 °F and that the proper thermocouple type is selected in the software. Many plants using water-cooled bearing programed 212 °F as the top temperature reading for the plant control software.
            3. Some temperature controllers are set in narrow temperature sensing range causing readings to hold unnaturally steady when viewed in trending. Uncooled bearings will fluctuate with the process and ambient temperature under normal operating conditions.

        ii. If high heat readings are verified, smoke or shuddering from the bearing is observed:
            1. Verify that core halves, and housings have not been mismatched
            2. Verify alignment and thrust collar seating if using a non-expansion bearing
            3. Verify that oil is in the bearing and that it is the correct grade
            4. Verify that the motor coupling is gapped correctly and that the space between the coupling and fixed bearing is not being pre-tensioned, creating a high axial load.
            5. If both inlet dampers have been closed for a long period or are partially stuck, depending on the fan configuration, this can create very high axial forces that will produce high bearing heat on the non-expansion bearing.

    c. Non-expansion bearing: if high vibration or noise is detected from the bearing, make sure that the bearing thrust plates or collars are correctly aligned and flat, and that the oil can flow properly. Noise can be generated due to thrust plate flatness issues, such as core halves being mismatched or contamination behind the plate.
    d. The lubricant specified by HTB must be used for operation. Most applications will reach steady state operating temperatures within 6 hours or less of initial startup. Incorrect lubrication can result in overheating or failure.
    e. When converting to CG-3 Bearings, they will run at a different temperature and with different characteristic behavior than a Dodge R-series™ liner. New baseline temperature limits and vibration data will have to be acquired.

20. **Post Startup**: After the first week of operation on base loaded bearings, loosen and retighten the plunger screw to the specified torque. For all bearings drain, flush and refill the housings with new oil.

NON-EXPANSION BEARING ASSEMBLY INSTRUCTIONS

Assemble two collars on one bearing only!

The CG-3 non-expansion bearing requires 2x split thrust collar, located on each end of the non-expansion bearing core, and 4x thrust plates that have been pre-installed on non-expansion bearings at the factory on each end of the bearing core.

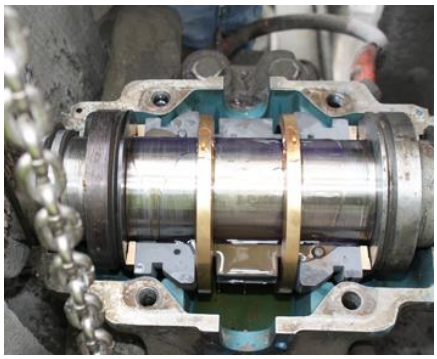
CAUTION: The split collars must remain as a set, marking halves with a marker is recommended; **do not to damage in any way the faces of the collar or plates!**

Collar Screw Torque Values

Bearing Size	2x Clamp Screw		2x Set Screw	
	Screw Size	Torque (lbs-in)	Screw Size	Torque (lbs-in)
3 15/16	1/2-13 UNC	1425	3/4-10 UNC	1750
4 7/16	1/2-13 UNC	1425	3/4-10 UNC	1750
4 15/16	1/2-13 UNC	1425	3/4-10 UNC	1750
5 7/16	1/2-13 UNC	1425	3/4-10 UNC	1750
6	5/8-11 UNC	2800	7/8-9 UNC	3500
7	5/8-11 UNC	2800	7/8-9 UNC	4100
8	3/4-10 UNC	5000	1-8 UNC	5000

1. Make sure the set screws have been backed out of the collar and do not interfere with the ID of the collar. The thrust collars may have a minor interference fit with the shaft. Smooth any rough spots on the collar faces or thrust plates using a fine crocus cloth (DO NOT use Emery or Sandpaper).

Note: Some shafts are milled with a collar integral to the shaft, in this case only the thrust plates are required, and the split thrust collar can be discarded. If you are producing a new shaft with an integral collar, see the print documentation for specifications.



2. Place one collar half on the shaft so that the collar's milled **working face** is next to the bearing thrust face. Rotate the half around the shaft and place the other half in position. Bring the joint together, making sure that the mate is perfect, and insert the clamp screws. There must be no offset in the collar face. Torque the clamp screws to the value given in the table.
3. Tap the collar up to the thrust plate mounted on the liner face allowing for sufficient operating gap per the "**thrust collar clearance**" table. Collar faces must run parallel to the thrust plate faces within .002". This must be checked all around the collar with a feeler gauge. The set screws must be torqued to the values shown the "**collar screw torque**" table

Thrust collar clearance		
bearing Size	**Min.**	**Max.**
3 15/16	.008	.014
4 7/16	.008	.014
4 15/16	.010	.016
5 7/16	.010	.016
6	.010	.016
7	.010	.016
8	.010	.016

4. Proceed to STEP 9 of “general assembly instructions”.

OEM Shaft Finish Recommendation:

Many hydrodynamic bearing problems are a result of shaft discrepancies such as incorrect geometry or poor surface finish. The key geometric characteristics are taper, out of roundness, and grinding variances such as waviness, chatter, lobbing and lead. In the bearing and seal area:

1. Shaft taper should be limited to 0.0002 in/in.
2. Out of roundness should be limited to 0.0005" for shafts up to 5" and 0.001" for shafts above 5" in diameter.
3. Shaft finish should have an Ra of 8 to 32 micro-inch, and be protected from nicks or scratches.
4. The shaft should be plunge ground to remove machining lead
5. Shaft hardness should be a minimum of RHB 93; target hardness should be RHC 50. In general, it is desirable to harden the shaft surface to obtain longer life, improve wear and abrasion characteristics.
6. Shaft diameter tolerance is typically H7, although higher precision maybe required.
7. Any shaft features inside of the bearing area must be finished to HTB Corporation print.
8. For MTO applications HTB Corporation will provide details on order confirmation for final shaft diameter and tolerance.

Lubricant Control:

All CG series bearings are specified with a lubricant viscosity and synthetic chemistry. If a lubricant is substituted without the correct properties, the bearing may fail. CG series bearings rely on proper chemistry to provide sufficient oil life and adequate oil film to support bearing loads. HTB general specification for lubricant will include ISO viscosity and synthetic chemistry base stock.

Key Lubricant Features:

1. Conforms to the OEM specified single grade, full synthetic base chemistry (PAO, PAG, POE, or PFPE)
2. Conforms to the OEM specified ISO viscosity
3. Rated for turbine, gearbox or compressor applications

Brands we recommend include:

- **Mobil:** SHC 600 Series oils for applications bellow 200°F (Full Synthetic PAO)
- **Dow Chemical:** UCONALL PAG up to 221°F (Full Synthetic PAG)
- **American Chemical Technologies:** ECO-GEAR PAG up to 221°F (Full Synthetic PAG)
- **Mobil:** GLYGOYLE PAG for applications up to 221°F (Full Synthetic PAG)
- **Mobil:** EAL Arctic Series up to 300°F
- **Shell:** S4 FR Series up to 300°F
- **American Chemical Technologies:** Genesis BL HT series up to 300°F

Never use multi-grade oils or additives with a CG-3 Hydrodynamic bearing*. In most applications, this will result in sudden loss of load capacity and bearing wipe.*

Lubricant contamination: Abrasive materials in the lubricant will damage the bearing surface. The bearing, housing, hardware, and any connected oil lines should be cleaned before installation. New lubricant should be filtered to levels of 10 microns or better. The operating bearing oil film is on the order of 25 microns. When inspecting the bearing, care should be taken not to introduce dirt through the filler ports or inspection covers. If a circulated oil system is used, in-line filtration is highly recommended.

Lubricant distribution: The minimum allowable oil flow rate to the bearing to sustain hydrodynamic behavior and shaft surface speed will determine if oil ring lubrication is suitable or if a circulated oil system is needed.
After a protracted shut-down or a new installation, it is recommended that the shaft is manually rotated through several revolutions to help distribute the lubricant to the bearing surface it will help prevent wear to the liner caused by lubricant being squeezed out while sitting idle. If using oil rings, check to make sure that the rings are not hung up by looking through the inspection ports while rotating the shaft. When connected to a circulated oil system verify that oil is flowing through the bearing and draining from the housing before turning the shaft.

Lubricant PM: The maximum operating temperature and useful service life of a lubricant will vary depending on how it is used. Contamination and oxidation temperature will influence the service life of the lubricant. The user must determine the appropriate

PM schedule. Under normal use, we suggest checking the lubricant every 2,500 hours. We recommend regular inspection of the bearing to ensure that no significant oil loss or seal failure has occurred and active temperature monitoring of the oil sump. Analysis of acidity (TAN), viscosity, and particulate is recommended to determine if the lubricant is has been degraded and to understand the best PM interval. The color of the oil is not an acceptable indicator of quality. Often new oil will darken rapidly once in service. When monitoring the bearing oil temperature a gradual increase in average running temperature over time is an indication the lubricant may need to be changed due to thickening or a loss of oil, this is a reflection that as lubricant degrades, often the viscosity increases. During oil changes, the used oil should be completely drained and replaced rather than topped off. Care must be taken not to mix or use a different grade of oil than what is specified for the bearing.