

Guide to Electric Motor Bearing Lubrication



Electric motor photo courtesy of Baldor Electric Company



ExxonMobil Guide to Electric Motor Bearing Lubrication

The proper lubrication of electric motor bearings is essential to maintaining them in peak operating condition and, ultimately, in reducing unnecessary downtime. This bulletin, for ExxonMobil customers, is intended to serve as a practical guide to the proper lubrication of electric motor bearings utilizing grease as a lubricant. It can help you to apply ExxonMobil's years of lubrication experience with that of bearing and motor manufacturers from around the world to provide you with a guide to the proper lubrication of electric motor bearings.

Grease Lubrication

Grease is frequently used as an electric motor bearing lubricant because of its simplicity of application and unique characteristics. The primary functions of an electric motor bearing grease are to:

- Reduce friction and prevent wear
- Protect bearings against corrosion
- Act as a seal to prevent entry of contaminants

Grease is a semi-solid lubricant composed of a base oil, a thickener and additives. These components are combined in complex chemical reactions under controlled temperatures and pressures. The base oil used in greases may be mineral or synthetic. Mineral oils are adequate for most electric motor bearing applications. However, synthetic base oils may be required for extreme temperature applications or where longer regreasing intervals are desired. The thickener primarily serves as a carrier for the oil and prevents it from leaking out of the application. Some common thickeners include metallic soaps that can be composed of calcium, lithium, sodium, aluminum or barium and complex metallic soaps such as lithium-complex. A thickener increasingly employed in electric motor bearing lubrication is polyurea. Polyrex EM utilizes a polyurea thickener. As with many lubricating oils, additives are frequently used to impart special properties to the grease. Commonly used additives include, corrosion inhibitors, anti-wear or extreme pressure agents, oxidation and corrosion inhibitors, pour point depressants, lubricity agents, and dyes or pigments.

Choosing the Right Electric Motor Grease

Important Grease Characteristics for Electric Motor Bearings

The following criteria may be used as typical indicators of a good electric motor grease:

- **Viscosity:** Oil viscosity should be appropriate for the load and speed of the application at operating temperature. This will help to insure maximum protection and component life. The typical mineral oil viscosity in an electric motor grease is in the range of 500 to 600 SUS at 100°F. Your electric motor builder may provide a specific recommendation.
- **Consistency:** A grease's consistency is one of its most visible characteristics. A grease's consistency or firmness is stated in terms of its NLGI (National Lubricating Grease Institute) grade, which ranges from 000 to 6. The consistency of a grease should be appropriate to the application, as it affects pumpability and ability to reach the areas to be lubricated. A NLGI 2 grade grease is the most commonly used in electric motor applications.
- **Oxidation Resistance:** Electric motor greases should have outstanding resistance to oxidation. This extends the life of bearings running at high speeds and high temperatures. ASTM D 3336 High Temperature Grease-Life test results give a good indication when operating under extreme conditions. Choose a grease with a high ASTM D 3336 oxidation life.
- **Anti-Wear:** Unless a motor is mounted so there is a thrust load on the bearings, it is generally advisable to use a grease without extreme pressure (EP) additives. EP additives can shorten the life of the grease and should not be recommended where they are not needed. On the other hand, bearings designed to handle heavy thrust loads may require a grease with an EP additive.
- **Dropping Point:** The dropping point gives an indication of the temperature at which the grease will melt or the oil will separate from the thickener. Due to the high temperatures that can be reached in an electric motor bearing, a grease with a high dropping point is frequently desirable. Lithium-complex greases and polyurea-thickened greases both have dropping points of approximately 500°F or higher.

- **Shear stability:** ASTM D 217 Cone Penetration of Lubricating Grease test measures the consistency of the grease after it has been worked 100,000 strokes. An electric motor bearing grease should soften no more than 1 to 1.5 NLGI grades in this test. An electric motor bearing grease that softens more than that may leak out of the bearing with age.

Grease compatibility

With some exceptions, greases with different types of thickeners should be considered incompatible with each other. We recommend running grease compatibility tests if mixing different greases is unavoidable. Generally, incompatible greases will soften or become fluid. This can result in lack of lubrication and can lead to premature bearing failure. However, stiffening may occur and can also lead to a lack of lubrication. Always purge as much of the old grease as possible, and then regrease more frequently to purge all the old grease out of the bearing.

Adding Grease to Electric Motor Bearings

Re-greasing Intervals

Electric motors utilizing double shielded or double sealed bearings, which are typically of the lubricated-for-life design, usually do not require regreasing. On the other hand, all others, those being open or single shielded or sealed bearings, should be re-lubricated periodically to replace grease that has deteriorated, leaked away, or become contaminated. Generally, operating conditions will dictate the relubrication interval required.

All greases deteriorate at some rate, even under moderate operating conditions. The principal causes are oxidation, excessive oil bleeding, and mechanical working. At high temperatures, oil evaporation may also be a factor. Oxidation eventually increases the oil viscosity and hardens the soap. Some oil bleeding is desirable, but too much reduces the ability of the grease to maintain an effective lubrication film. Mechanical working, or shearing, may change grease properties such as consistency, making the grease less suited to the application. Excessive oil evaporation may harden the grease. Deterioration often ends in hard, dry, deposits that can neither lubricate bearings nor protect them against contaminants.

Operating and other factors that influence relubrication frequency include: temperature, continuity of service, quantity of grease in housing, size and speed of bearing, vibration, exposure to contaminants, effectiveness of seals, and the grease's suitability for the particular service.

1. High grease temperatures increase the oxidation rate, doubling it for every 18°F (10°C) rise above 120°F (49°C). High temperature also tends to increase the rate of bleeding and evaporation of the oil. Additionally, grease tends to soften as temperatures increase and may become fluid enough to leak out of housings. Other things being equal, operating at high temperatures will require more frequent relubrication, or the use of a high temperature grease.
2. Continuity of service means hours of service per day or other time unit. A grease continuously subjected to deteriorating factors will need replacement more often than the grease in a bearing used only occasionally.
3. A large quantity of grease in a properly designed housing will last longer than a small quantity in a proportionally smaller housing. The small quantity will be reworked more often than an equal portion of the large quantity and will not benefit from reserve capacity (including more oil and additives). Under moderate conditions, however, a small quantity of grease in a factory lubricated sealed or shielded bearing may last a long time, perhaps several years.
4. The Dn value of a bearing (bore diameter in mm x speed in rpm) is proportional to the linear speed of the rolling elements and may be used as a guide to determine relubrication frequency. In bearings operating in the Dn range of 150,000 to 200,000 or more, grease in the path of the elements is severely worked and heated. Such bearings require more frequent relubrication even with correctly selected grease that does not slump excessively. Some bearing manufacturers use Ndm (speed in rpm x pitch diameter of the bearing) instead of Dn. This method produces somewhat higher reference values, but considers the effect of rolling element size and the bearing's cross section dimensions.
5. Vibration causes grease to feed more freely into the rolling elements' path, where it is worked and heated excessively. This reduces grease life, especially in high speed bearings. Churning and shearing in bearings "mills down" some greases, which become fluid enough to leak excessively. Either factor means more frequent relubrication.

6. More frequent relubrication usually will be required if the grease is marginal in any major characteristic - oxidation, bleeding, pumpability, antiwear and antitrust properties, or mechanical stability.

It is not a simple matter to decide when and how often to relubricate. Generally, the decision reflects experience and the machine builder's and grease supplier's recommendations. Relubrication intervals for most rolling element bearings range from two weeks to two years although for many it is once a year during scheduled maintenance shutdowns. At the lower extreme, bearings running at or near their speed limits may require relubrication as often as every six to eight hours.

It is important to regrease on an appropriate schedule so that the old grease remains soft enough for purging. Bearing or equipment manufacturers recommend relubrication intervals based on operating conditions and type of grease. Typically, light to medium duty electric motors, that run continuously, will require at least annual relubrication. Reduce the relubrication interval by half for every 10°C above the nominally recommended temperatures.

Two commonly used methods for determining the correct relubrication frequency follow.

1. The first utilizes the following equation:

$$\text{Frequency (hours)} = \{[14,000,000/(\text{shaft rpm})(\text{Bearing ID})^{1/2} \text{ mm}] - [(4)(\text{Bearing ID}) \text{ mm}]\} \{F_{\text{bearing type}}\} \{F_{\text{temperature}}\} \{F_{\text{contamination}}\}$$

where,

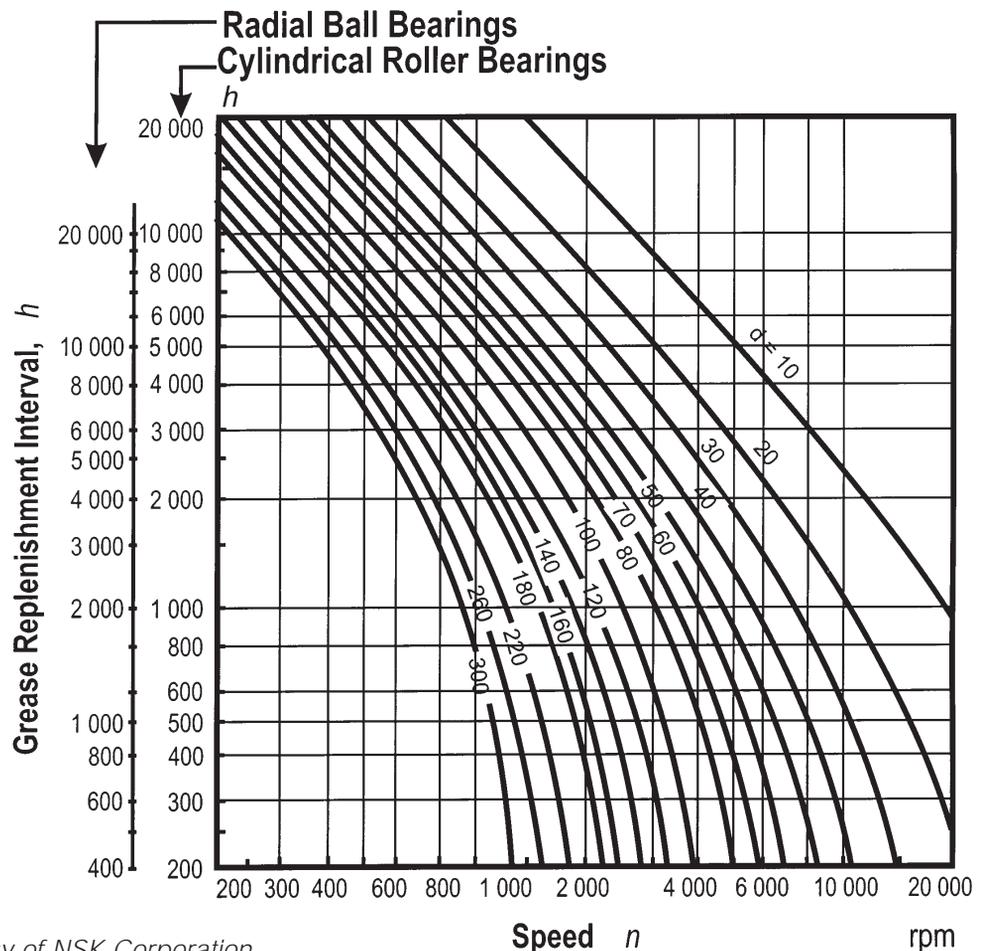
F bearing type = 1.0 for spherical or thrust bearing, 5.0 for cylindrical bearing, 10.0 for ball bearing

F temperature = 1.0 for under 160°F, divide by two for every 20°F above 160°F

F contamination = 0.1 to 1.0 depending on the level of contamination-motor bearings normally 1.0

* Formula above taken from the *Practical Handbook of Machinery Lubrication Second Edition* plus added factors for temperature and contamination from field experience.

2. The second method utilizes the following graph for determining relubrication frequencies:



Courtesy of NSK Corporation

Determining the correct amount of grease

Determining the correct amount of grease for an electric motor bearing is one of the most important steps in initial greasing and in regreasing of the bearings. An insufficient amount of grease could lead to bearing failure due to lack of lubrication. On the other hand, over-lubrication can also lead to bearing failure and cause problems due to migration of the lubricant in to the windings. One of the two methods following is frequently used for determining the quantity of grease to be added to a bearing:

1. 1/2 to 2/3 of the free space in the bearing - when operating speed is less than 50% of the limiting speed of the bearing.

1/3 to 1/2 of the free space - when the speed is more than 50% of the limiting speed of the bearing.

2. Another method of determining the appropriate quantity of grease to fill the bearing is determined by the following equation. This is a simple method of calculating the amount of grease needed for a standard application.

Quantity of grease (g) = Outer bearing diameter (mm) X bearing width (mm) X 0.005, or

Quantity (oz) = 0.114 X (bearing OD) in X (bearing width) in

It is common practice to pack the bearings as well as the bearing housing with grease. In addition to holding the bearing in place, the bearing housing also acts as a grease reservoir. The following may be used as a guide to filling the housing with grease.

- **30% to 50% fill** - Typically used. For very high speeds the lower limit should be used in order to reduce churning and overheating of the grease. Overpacked bearings tend to overheat, and to overheat even more at higher speeds.
- **50% to 75% fill** - For slow speeds, or in the absence of other methods of regreasing, fill the housing 50% to 75% with grease. After the housings are packed and the motor started, the rolling elements will push the excess grease from between the races into the housing, leaving only the thin lubricant film needed to minimize friction and wear.
- **Full pack** - A particularly dirty environment may call for the housing to be completely filled, but the bearing itself will only contain enough grease for lubrication. The pressure relief method will also produce a full pack.

One full pack method begins with the bearing filled with grease and the housing 75% full, leaving just enough space to receive the excess grease pushed out by the rolling elements. If the housing were actually packed full, the grease between the rolling elements could not escape and would be severely worked. The resulting friction could become so great that very high bearing temperatures would quickly develop. (Fig.1). High temperatures would accelerate grease deterioration, possibly leading to bearing failure due to lack of lubrication. Furthermore, expansion of the grease could force it into the motor winding, resulting in damage to the motor, or cause seals to rupture. Such failure may be avoided by running the motor with the drain plug removed until excess grease is purged. This is the pressure relief method.

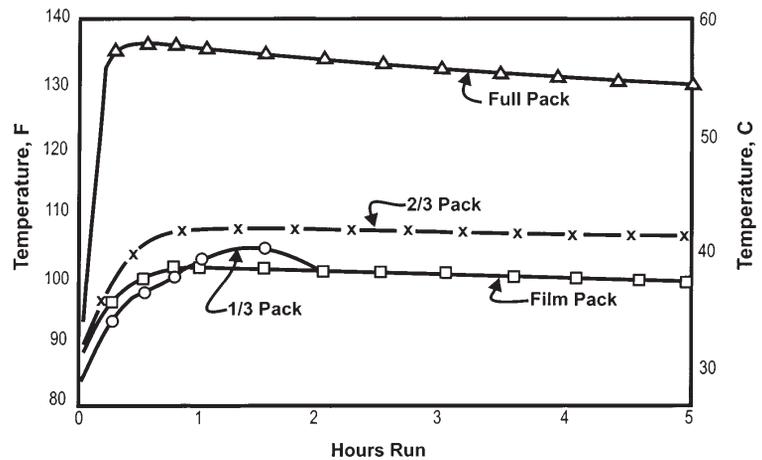


Fig. 1 Temperature rise in grease lubricated bearing.

It is important to estimate the amount of grease dispensed by each shot from the grease gun. Bearing manufacturers frequently recommend the amount of grease to apply to a bearing by weight or volume. In practice, the amount of grease applied to a bearing is often determined by the number of shots from the grease gun. Therefore, it is important to know the amount of grease supplied from each shot of the grease gun. The grease-gun manufacturer can usually provide the volume per shot. However, the grease gun can be calibrated by counting the number of shots to dispense a known amount of grease. The weight from one shot can be determined using any laboratory scale, preferably in grams and/or ounces. Then the number of shots necessary to achieve the required amount by weight can be counted.

Note that the volume or weight per shot may change slightly with a change in consistency.

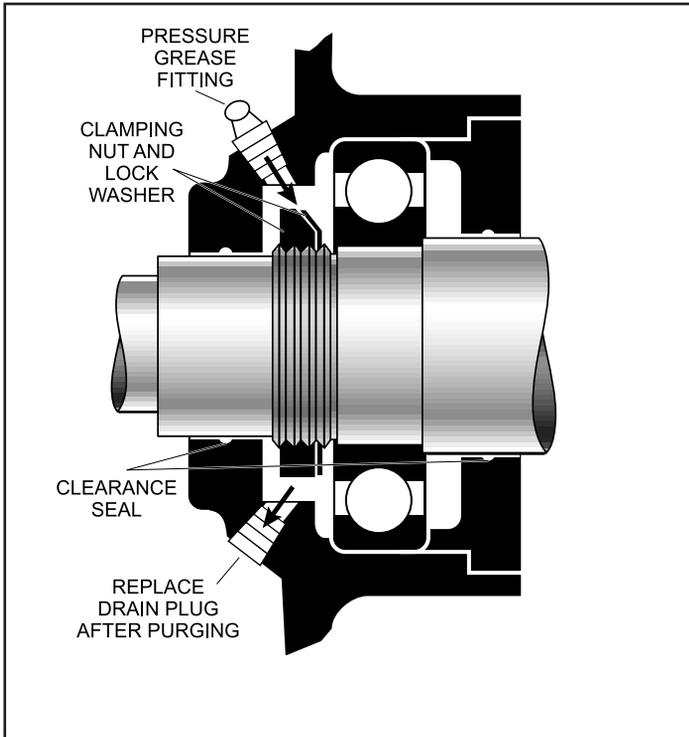


Fig. 2 Bearing housing for relubrication.

Once the quantity of lubricant in ounces has been determined it must be converted to the appropriate number of shots or pumps from a grease gun. Standardizing on a make and model of grease gun will facilitate determining the correct amount of lubricant to electric motors, plant wide.

The housings of many grease-lubricated bearings permit re-lubrication with a low-pressure grease gun. Fig. 2 shows an open type bearing with a supplemental grease reservoir on one side. This design has restricted purging since re-lubrication displaces and forces out of the drain only the grease in the outer housing. The drain passage should be short with a large diameter. Fig. 3 shows free-purging designs. New grease forced into one side of the housing passes through the rolling elements to the drain on the other side. Again, the drain passage should be as short as possible and of large diameter. Single shielded bearings, Fig. 4, allow a compact arrangement as required in electric motors and can be relubricated as shown.

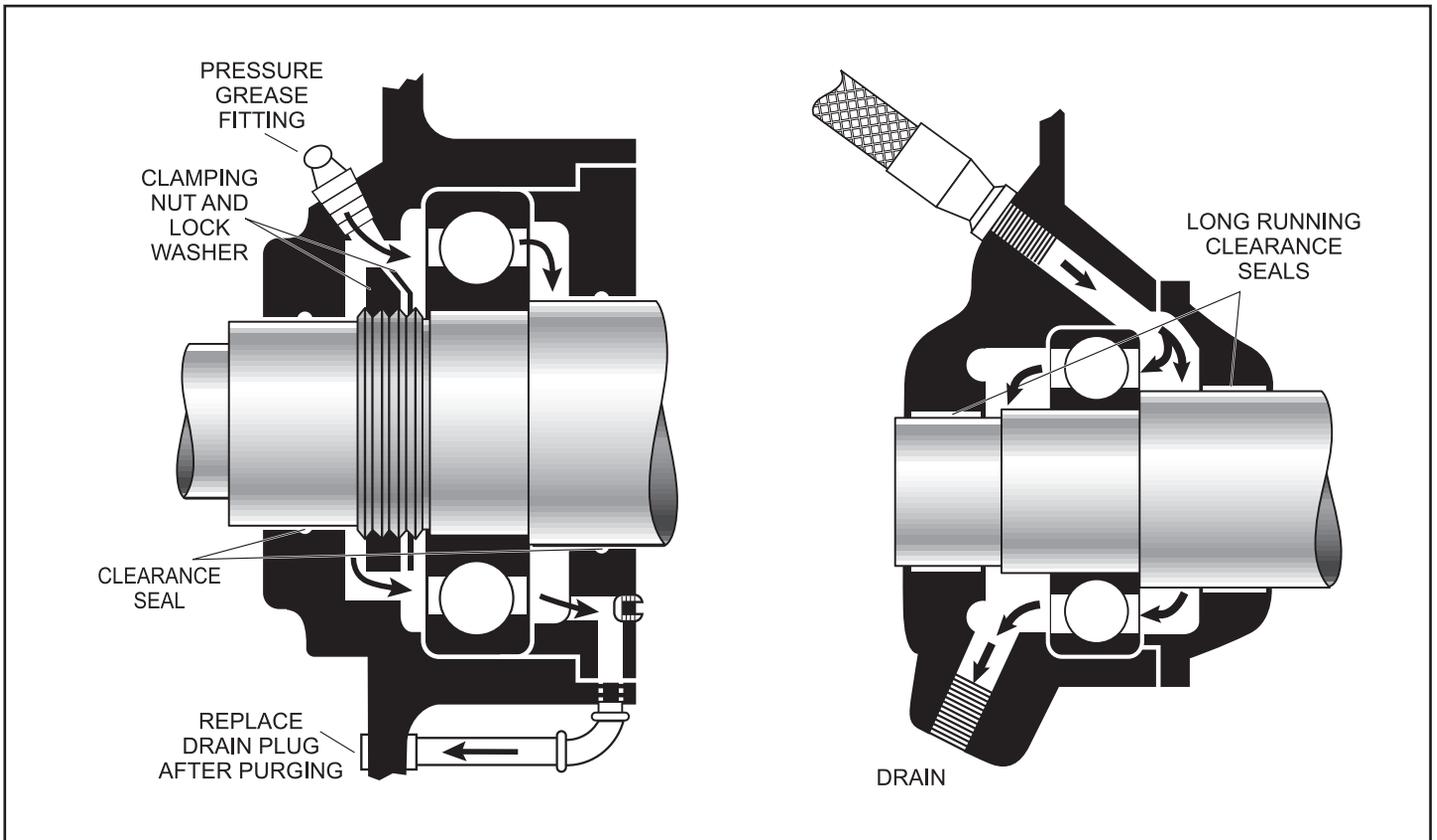


Fig. 3 Free-purging housing designs. The design on the right, sometimes referred to as a transverse greasing design, may be preferable to that shown at left because the drain passage is shorter and larger.

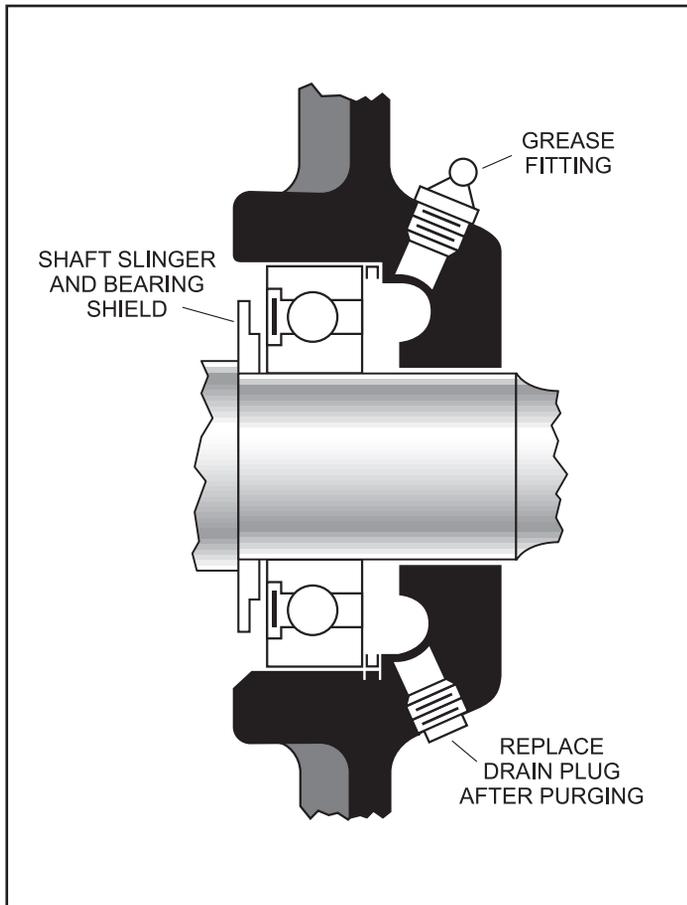


Fig. 4 Lubrication – single-shielded bearing.

The pressure relief method is commonly used to relubricate bearings.

1. Remove the drain plug and clean old grease from the drain opening.
2. Clear the pressure fitting and grease gun nozzle to prevent introducing contaminants or abrasives into the bearing.
3. Using a hand operated grease gun, pump grease into the fitting until new grease appears at the drain opening. The motor should remain running and warm to allow for better dispersion of the grease.
4. After adding the new grease run the motor until the excess grease is expelled through the open drain plug. Clean the grease outlet of excess grease and replace the drain plug.

Note - When adding grease without the motor running, introduce only half the volume. Run the motor for 5 - 10 minutes at full speed, and add the final half. This purges the old grease from the bearing and prevents over packing and seal rupture.

The pressure relief method may be used for the initial filling of open type bearings. However, it is better to pack the bearings by hand or with a bearing packer before assembling them in the housings. If the bearings are not pre-packed, then after assembly apply grease with a gun until certain that it is uniformly distributed throughout the bearing and has not short circuited from inlet to drain. Start the motor and complete the pressure relief procedure.

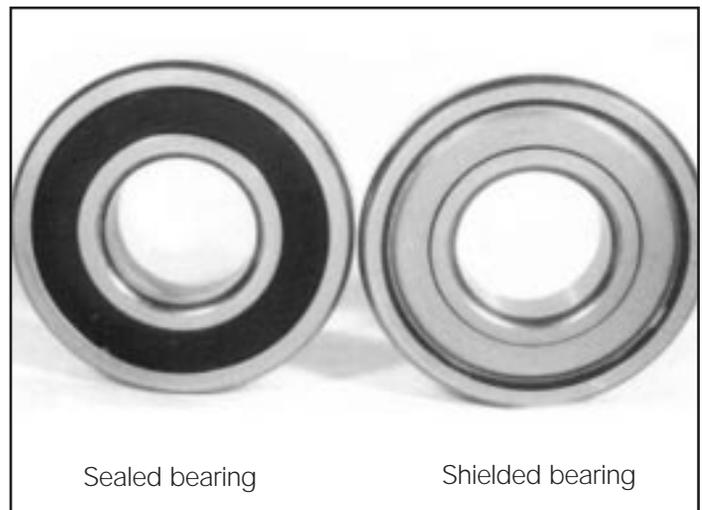


Fig. 5 Double shielded and double sealed bearings.

Double shielded and double sealed bearings (Fig. 5), shields and seals on both sides, are generally of the lubricated-for-life design. Sealed-for-life bearings come pre-packed with the correct amount of grease from the factory and do not require initial lubrication or in-service lubrication. Therefore, the bearing housing is typically not configured for grease re-lubrication. To avoid unintended lubrication, remove any grease fittings and plug holes in motors containing lubricated-for-life bearings. Additionally, change maintenance records to indicate that the motor needs no further lubrication.

Electric Motor Storage

Damage to electric motor bearings can occur even while a motor is in storage. The two main failure modes of bearings in storage, static corrosion and false brinelling are described below.



STATIC CORROSION

Fig. 6 - Static corrosion. Courtesy of NSK Corporation

Fig. 6 shows a bearing suffering from severe corrosive pitting. Corrosion can occur for two main reasons. First, the grease may not possess adequate rust and corrosion inhibitors to protect the metal surfaces. Second, the vibration in the motor could force out the grease from between the rollers and raceways in the load zone. Left unprotected, corrosion or rust can form on the metal surfaces.

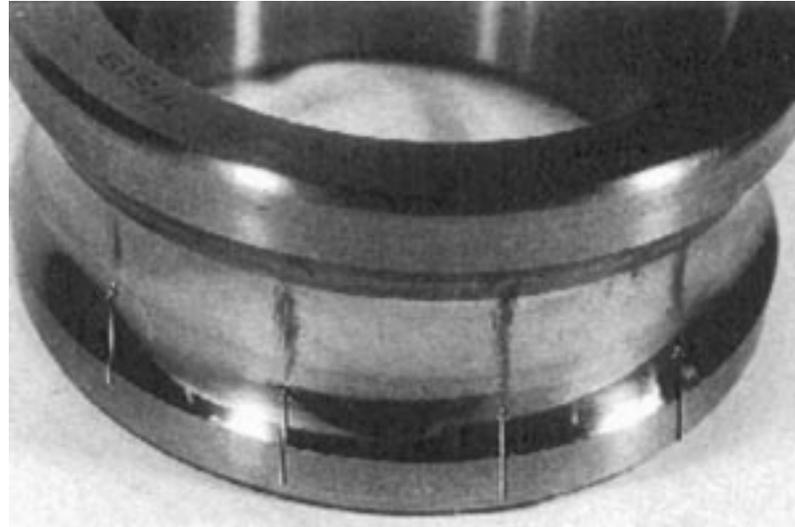


Fig. 7 - False brinelling. Courtesy of NSK Corporation

FALSE BRINELLING

Fig. 7 illustrates a false brinelling failure mode. Vibration of the bearing in a static position causes the rolling elements to vibrate against the raceway in one place. Over time, the vibration can remove small bits of metal surfaces. This vibration induced metal removal can continue until the wear becomes very severe. This type of wear will appear as wear marks that line up with the spacing of the rolling elements.

To prevent these and other types of damage, the following procedures should be followed:

- Fully grease motors going into storage. Tag the stored motor with the date of last lubrication and the lubricant name.
- Store motors in a clean, dry, vibration-free area.
- Store the motor on a surface that can absorb vibration such as wood, etc.
- Rotate idle motor shafts periodically to redistribute fresh grease and maintain a corrosion-preventive film on bearing surfaces.
- Align equipment and motor shafts carefully to obtain longest bearing life.
- Where the risk of contamination is high, grease cartridges are preferred since these are well sealed against contamination.

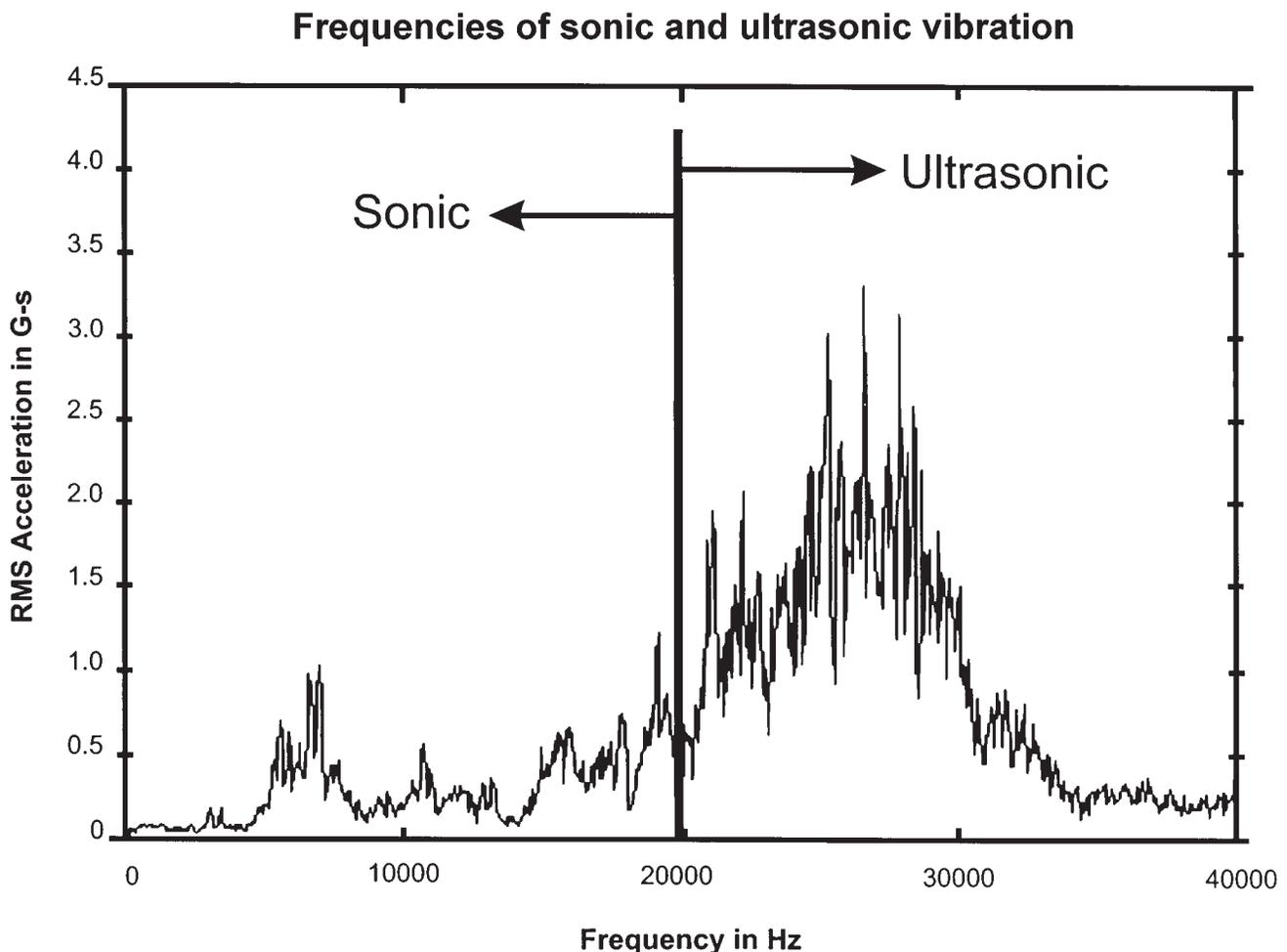
Condition Monitoring to Enhance Electric Motor Bearing Reliability

Lubrication and bearing problems often produce sonic and ultrasonic sound as well as heat. By using standard vibration analysis, ultrasonic sound (vibration analysis), and heat detection, electric motor bearing reliability can be optimized. Although this paper has supplied recommendations for the amount and frequency of re-lubrication, operating conditions of specific motors may dictate altered lubrication recommendations. By auditing electric motor operation, relubrication practices can be optimized and unsatisfactory conditions determined. Early detection of poor lubrication or bearing condition will allow appropriate action to be taken before extensive or unexpected equipment damage occurs.

Ultrasonic detection for bearing lubrication

Ultrasonic vibration reading made with a passive contact ultrasonic listening device, should always be taken at the same location, in the same axis, and using the same acquisition parameters in order to develop good trending data. Choose a position and orientation that allows vibration to travel through the fewest number of interfaces possible. As high frequency energy travels from the bearing, the energy dissipates quickly as it moves through more and different surfaces. To gain the best data, take readings as close as possible to and in the same direction as the bearing load.

Most bearing impacts will fall in the 4 kHz range, while lubrication and minor impacting problems will appear at 30 kHz (see Fig. 8). These are the frequency ranges that need to be examined when analyzing bearings.



*Fig. 8 - Normally, poor lubrication appears first in the ultrasonic range (over 20,000 hertz).
Courtesy of Computational Systems Inc.*

Under lubrication: In rolling element bearings, sound is created by friction induced stress waves from the interaction of the rolling elements and raceway and the rolling elements and cage. As lubrication starvation occurs, the lubrication film thickness will decrease resulting in a greater coefficient of friction. The increased friction coefficient creates more heat and sound. At 30 kHz, under lubricated bearings will sound much like white noise and has little periodicity commonly heard in bearings with mechanical faults. Temperature is not generally a good indicator of under lubrication unless lubricant is absent altogether.

As a general rule, the optimum or baseline ultrasonic amplitude at 30 kHz should be 10 dB or less. Normal lubrication amplitudes should be 10 to 20 dB. Testing has shown that the critical level before permanent damage occurs is around 30 dB. These are general estimates that vary depending on the type of bearing and the application. More accurate levels can be estimated through testing and trending. If the amplitude exceeds 30 dB (or if there is a significant increase in crackling/rushing noise for devices without dB readouts), grease should be applied until the noise goes under 30 dB or until it subsides.

Temperature analysis for bearing and lubricant condition

Sound analysis has proven ineffective for determining conditions of over lubrication. The best method for determining over lubrication is achieved by monitoring temperature increases.

Although temperature analysis can prove useful for determining the extent of over lubrication, there are other causes of temperature change, including:

- Poor motor ventilation (plugged motor end bell, missing or broken fan, plugged fan inlet, etc.)
- Excessive or abnormal loading on the device the motor drives
- Broken motor rotor bar
- Single phasing on a three phase induction motor
- Loose bearing fit on the motor shaft
- Failing bearing
- Poor coupling condition
- Poor shaft alignment between the motor and the driven unit
- Poor motor mounting (excessive soft foot)

Before applying more grease to a hot running bearing, investigate all possible reasons for increased temperatures.

SONIC (STANDARD) VIBRATION ANALYSIS
FOR BEARING LUBRICATION

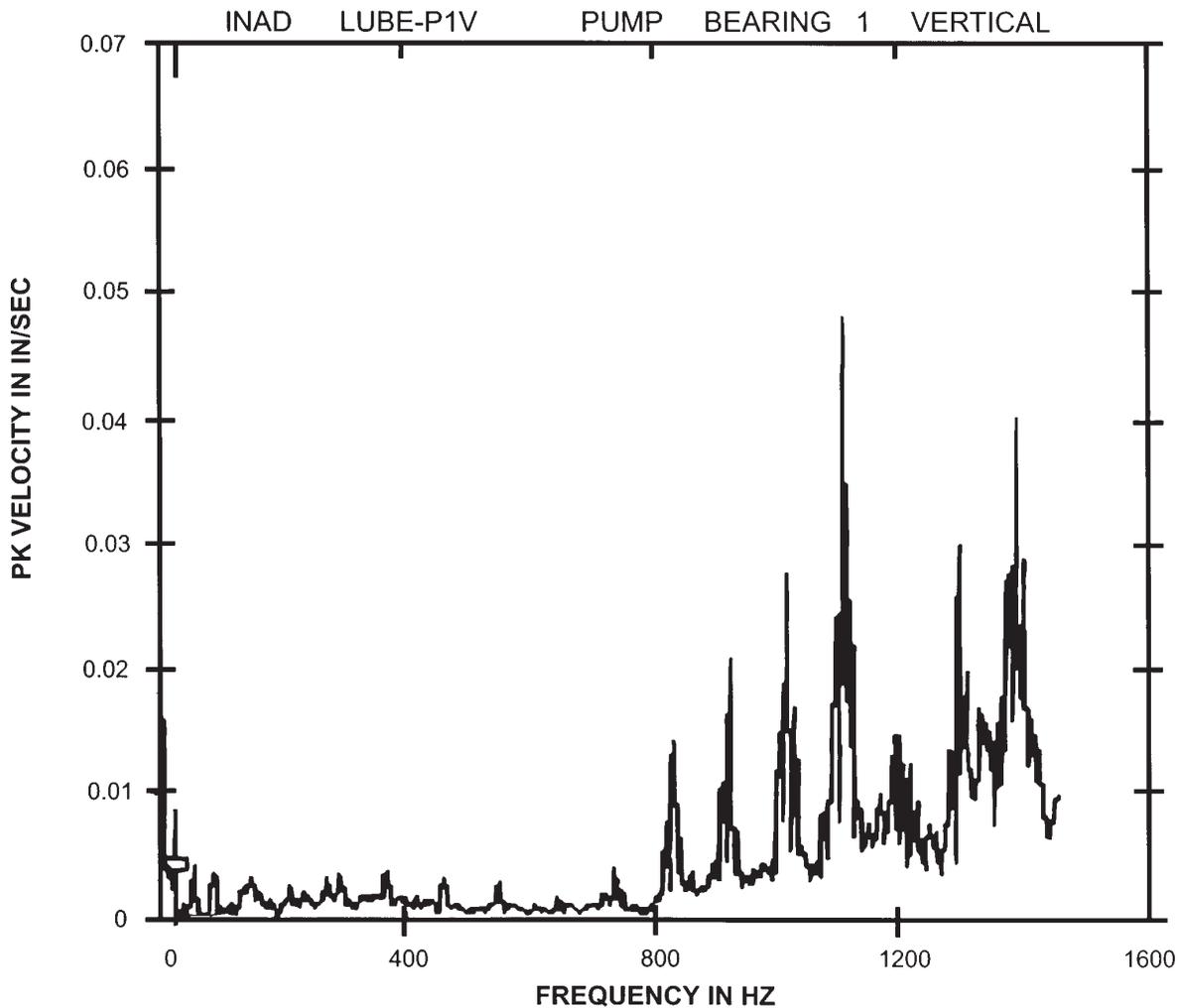


Fig. 9 Courtesy of Computational Systems Inc.

Fig. 9 Shows the standard vibration frequency spectrum of a bearing that is operating in a poorly lubricated condition. The contact between rollers and raceway can excite some of the high resonant frequencies of other bearing components. Ultrasonic readings can help to detect poor lubrication long before this damage occurs. This type of analysis can also aid in determining if the motor bearing is re-lubricated with the correct amount of grease and at the correct frequency. Normally, poor lubrication appears in the range of 800 to 2000 hertz with 80 to 120 hertz peaks appearing.

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Establishing a Motor Greasing Program



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Electric Motor Greasing- Why is it important?

- Electric motors represent apx. 1/4 of all rotating equipment in a plant
- As much as 75% of motor failures are bearing related.
- It is estimated that 95% of all bearing failures are premature.
- Motor bearing failure can lead to costly down-time



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Why Re-lubricate?

During operation, oil separates from the grease.

- The oil gradually oxidizes or is lost to evaporation or leakage
- The grease may wash away or migrate away from the moving parts
- Grease must be periodically replenished to assure proper bearing lubrication



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Establishing an Effective Motor Greasing Program

1. Evaluate current practices
2. Establish common procedure
3. Provide training



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1. Evaluate Current Practices

- Current cost of motor repair
- Available manpower and training
- Current procedures and scheduling program
- Cost/benefit of regreasing “Disposable” motors
- Grease gun practices
- Persons assigned to regreasing activity
- Safety



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Risks of changing a current program

- If too much grease is added to motors that have not been greased for years motor failure rate may go up initially
 - Grease that has hardened may form a plug that prevents the new grease from purging
 - Rolling contact elements may skid and cause premature failure
 - Temperatures may rise because the bearing is overfilled
 - Rust from the grease tube may be forced into the bearing
- Training is required to institute a new program properly

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2. Establish a Common Procedure

- Evaluate OEM recommendations for the motors in the plant
- Consider motor configuration and operating conditions
- Establish frequency guidelines
- Standardize on regreasing amounts
- Publish a standard of practice
- Provide training



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OEM Recommendations

Motor Manufacturer or Organization	Motor Stopped or Running	Remove Grease Outlet	Operate Motor without Plug	Amount	Frequency
Baldor	Either	Yes	No standard	Until new grease appears at plug Based on frame or bearing number	Frame and RPM
EASA				Bearing number	Frame and RPM
GE	Stopped	Yes	10 minutes	Shaft Diameter	HP or Frame
Rockwell/ Reliance	Either	Yes		Frame and RPM	Frame and RPM
Siemens	Stopped	Yes	30 minutes		
Teco					
Westinghouse	Running	Yes	10 - 30 minutes	Bearing number	RPM and Bearing Number
Toshiba	Running	Yes	30 minutes	Bearing number	Frame and Poles
US Electrical Motors	Stopped	Yes	15 - 30 minutes		RPM and Bearing Number

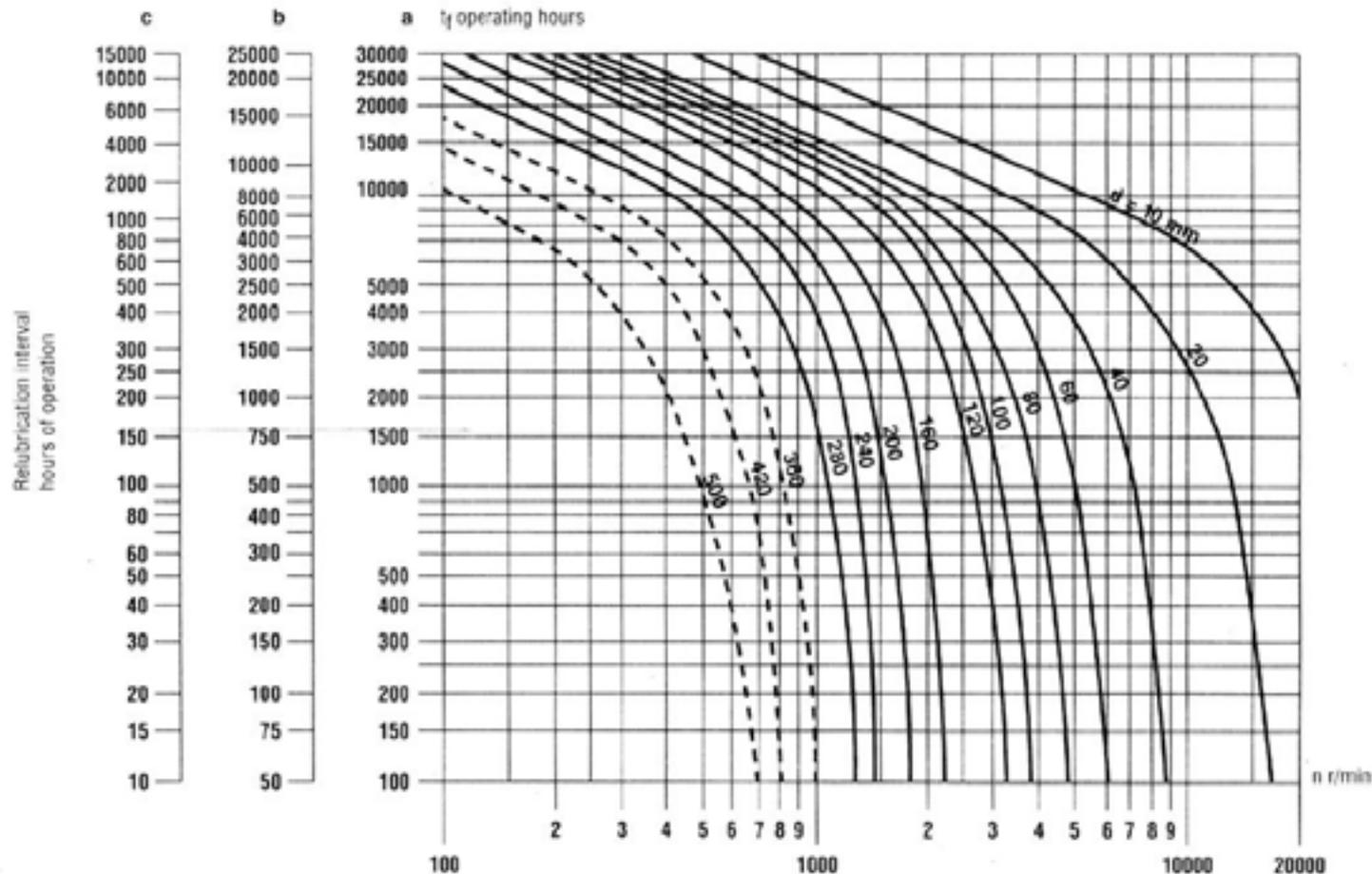
Conclusion:

There is no consistency between motor manufacturers

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Frequency – commonly used guideline



Scale a: radial ball bearings

Scale b: cylindrical roller bearings, needle roller bearings

Scale c: spherical roller bearings, taper roller bearings, thrust ball bearings; full complement cylindrical roller bearings ($0,2t_r$); crossed cylindrical roller bearings with cage ($0,3t_r$); cylindrical roller thrust bearings, needle roller thrust bearings, spherical roller thrust bearings ($0,5t_r$)

Scale d: bearing bore diameter

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Regreasing Intervals Based on EPRI NP-7502

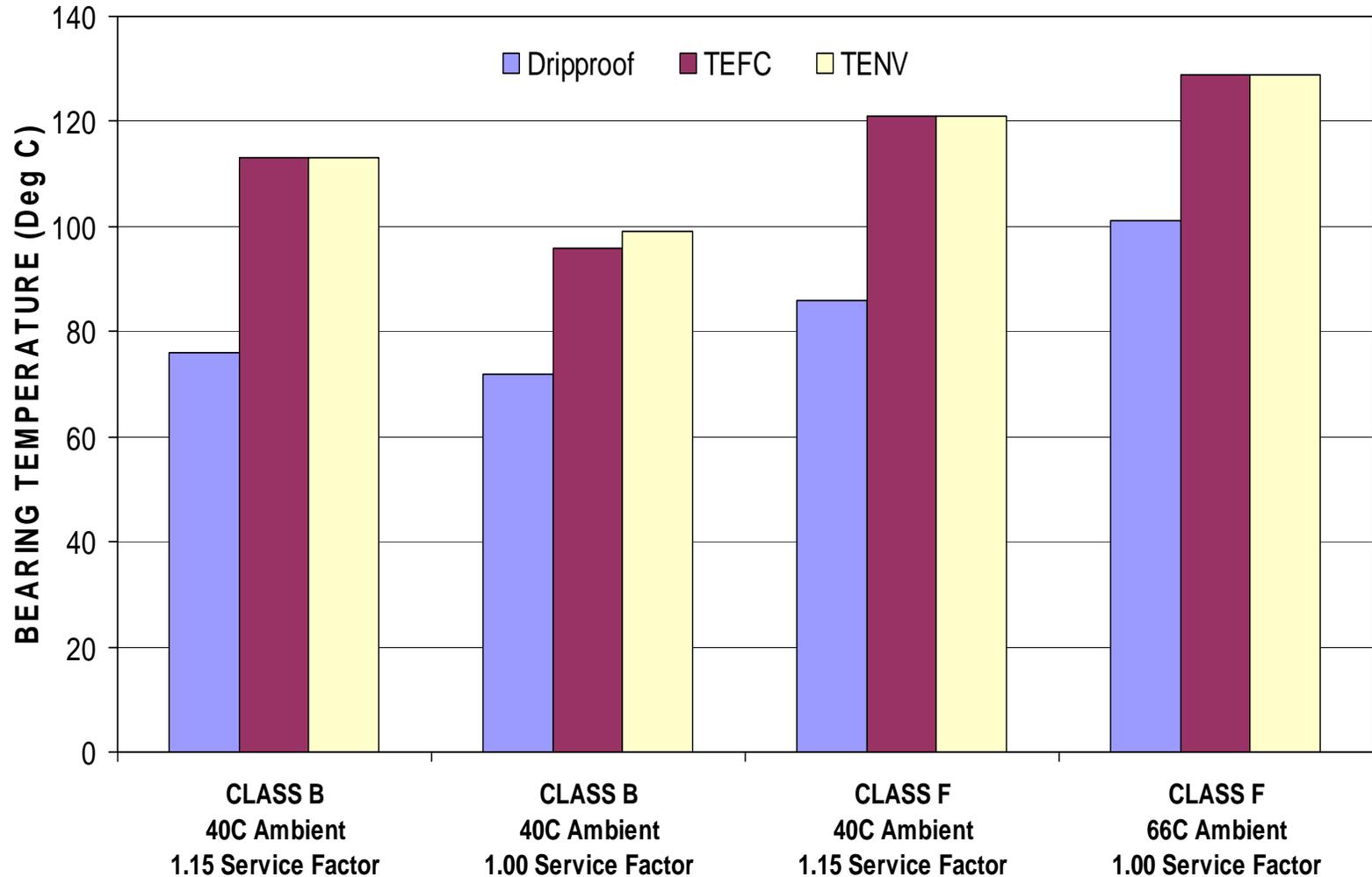
RPM			HP		Ambient Temp (°F)		Regreasing Interval (Months)
1200	1800	3600	<100	>100	<140	>140	
x	x		x		x		36 - 54
x	x		x			x	24 - 36
x	x			x	x		24 - 36
x	x			x		x	12 - 18
		x	x		x		24 - 36
		x	x			x	12 - 18
		x		x	x		12 - 18
		x		x		x	6 - 9
Reduce interval in half for:							
Every 10°C (18°F) above 70°C (160°F) bearing temp							
Vertical motors							
Multipurpose grease							
Roller bearings							
Belt drives							
Reduce interval appropriately where there is a risk of contamination							

- Based on proven, documented performance
- Being presented to NLGI and several motor manufacturers

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Electric Motor Bearing Temperatures

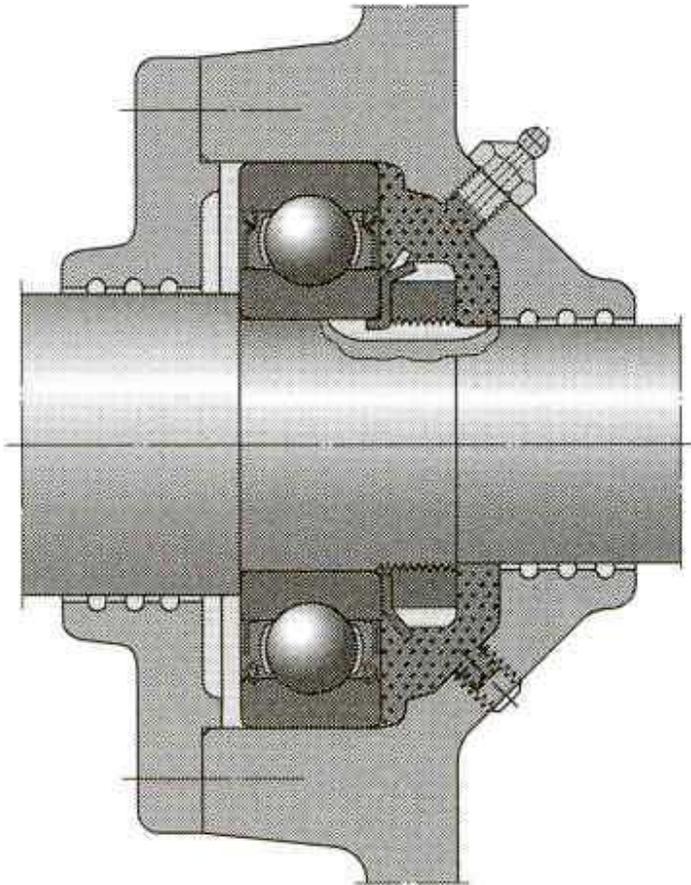


Shows 60°F difference in bearing temps between dripproof and totally enclosed motor configurations

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The Right Amount



- Follow OEM Recommendations
- Relubrication amount

$$G = .114 \times D \times B$$

G = Grease ounces

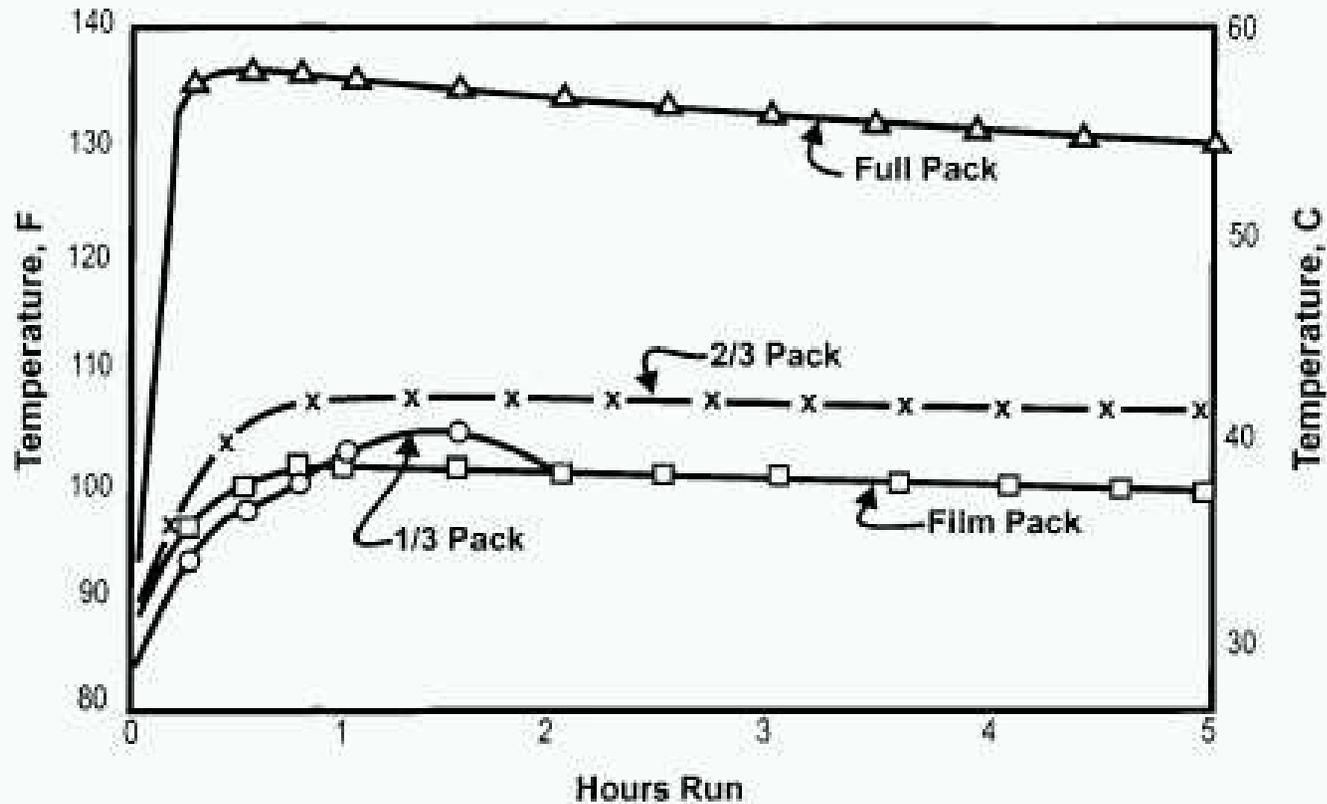
D = OD inches

B = Width inches

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Effects of Grease Amount on Bearing Temperature



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Effects of Over Greasing



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EASA Guidelines



Bearing Number	Grease Amount		
	Cubic Inches	Cubic Centimeters	Ounces
203	0.15	2.46	0.08
205	0.27	4.42	0.15
206	0.34	5.57	0.19
207	0.43	7.05	0.24
208	0.52	8.52	0.29
209	0.61	10.00	0.34
210	0.72	11.80	0.40
212	0.95	15.57	0.53
213	1.07	17.53	0.59
216	1.49	24.42	0.83
219	2.80	45.88	1.55
222	3.00	49.16	1.66
307	0.53	8.69	0.29
308	0.66	10.82	0.37
309	0.81	13.27	0.45
310	0.97	15.90	0.54
311	1.14	18.68	0.63
312	1.33	21.79	0.74
313	1.54	25.24	0.85
314	1.76	28.84	0.98
316	2.24	36.71	1.24
318	2.78	45.56	1.54
319	3.00	49.16	1.66

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Grease Amount

Electric Motor Grease Amount		
Speed	NEMA Frame	Strokes of A500 Gun
All	Below 250	6
All	250 - 286	13
All	280 - 365	18
1800 and below	365 - 449 & 5000	35
3600	404 - 449	23

Based on consolidated OEM recommendations for horizontal motors

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Suggested Procedure for Initial Greasing of Motors

If motor is disassembled

1. Hand pack the bearing. Fill end bell approximately 30% full. Pipe leading to bearing should be full of grease to prevent rust. Assemble the motor. At start-up, operate motor for at least 15 minutes with drain plug open to expel excess grease.

If motor is assembled

1. Wipe the grease nipple clean and inspect. Replace if needed.
2. Remove the drain plug and install grease relief valve if not already equipped
3. With a hand-operated grease gun, pump grease into the cavity until new grease comes out the drain or relief fitting.
4. Operate the motor for 15 minutes to expel excess grease.
5. Replace plug.

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Motor Greasing Procedure

- Install grease cartridge in designated grease gun
- Remove grease plug, if accessible; Check that relief fitting moves freely
- If motor is stopped, remove any hardened grease from the plug area.
- Wipe around grease fitting with clean rag.
- Pump out and discard one stroke of grease
- Place nozzle of gun onto the fitting and SLOWLY inject the proper number of full strokes

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Motor Greasing Procedure Continued



STOP if high resistance is detected.



STOP if clean grease is observed coming out of seal, drain, fitting or relief plug.

- With motor running, allow grease to purge out of the open plug for at least 15 minutes.
- Check for water or rust in "old" lubricant.
- Replace plug.
- Wipe fitting and plug area clean. Cover fitting with a clean plastic cover
- Report unusual noise, odor, temperature, vibration, visible contamination, caked grease or other unusual conditions

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3. Provide Training

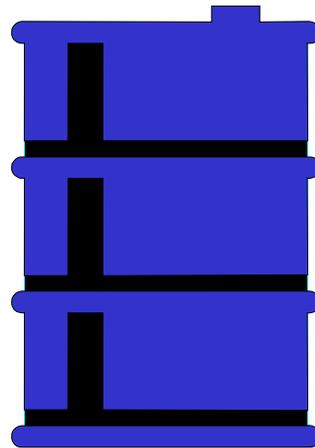
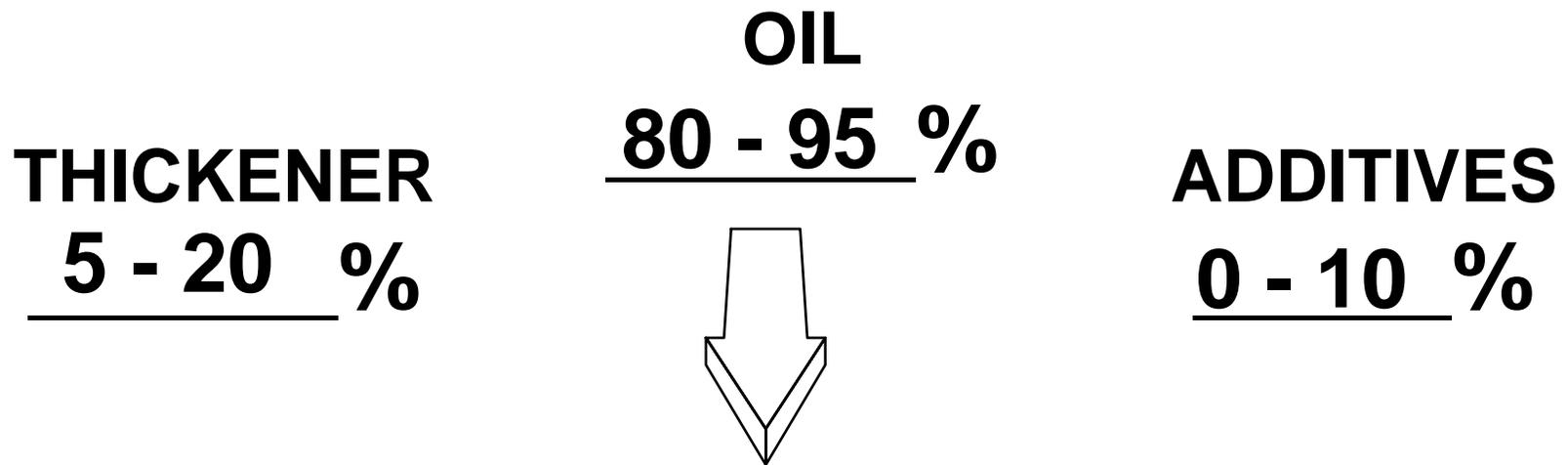
- Training is essential to the success of a new motor greasing program
- ExxonMobil training explains why it is important to put the right amount of the right grease in the right place at the right time
- Training also emphasizes how to minimize contamination and improve equipment reliability
- Along with some of the previous slides, following are excerpts of some of the training slides used in ExxonMobil grease training



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How Much Oil is in a Typical Grease?



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The Thickener is a Sponge

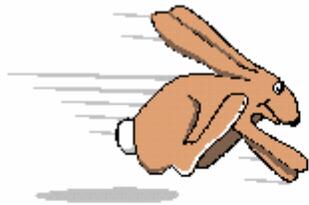


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Grease Characteristics

APPLICATION



fast



slow

OIL VISCOSITY



thin

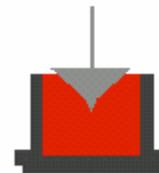


thicker

CONSISTENCY



stiff



soft

OIL RELEASE



high



low

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Motor Grease Requirements

- Good Channeling Characteristics
- NLGI Grade 2 or 3
 - 3 grade used where $dN > 250,000$ [$dN = \text{bore(mm)} \times \text{rpm}$]
- 110-140 cSt @ 40°C base oil viscosity
- High dropping (melting) point
 - 204°C minimum
- Low oil bleed characteristics



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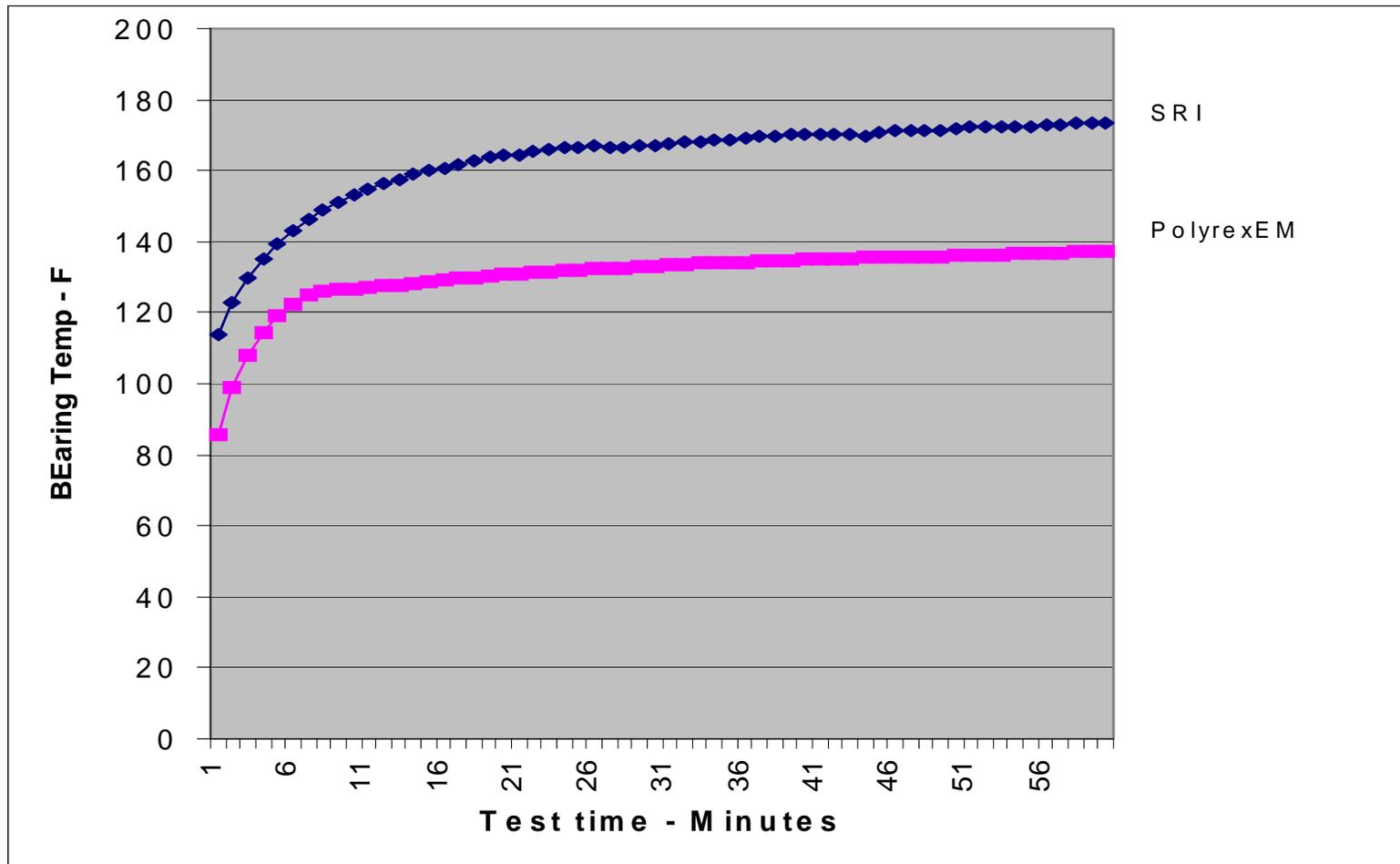
More Motor Grease Requirements

- Excellent resistance to high temperature oxidation
 - 500 hour minimum at highest operating temperature 149 -177°C (300-350°F)
- Good low temperature torque characteristics
 - typically 10,000 g-cm max starting torque at -29°C (-20°F)
- Good anti-wear characteristics but generally Non-EP

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Independent Test Results



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The Right Grease

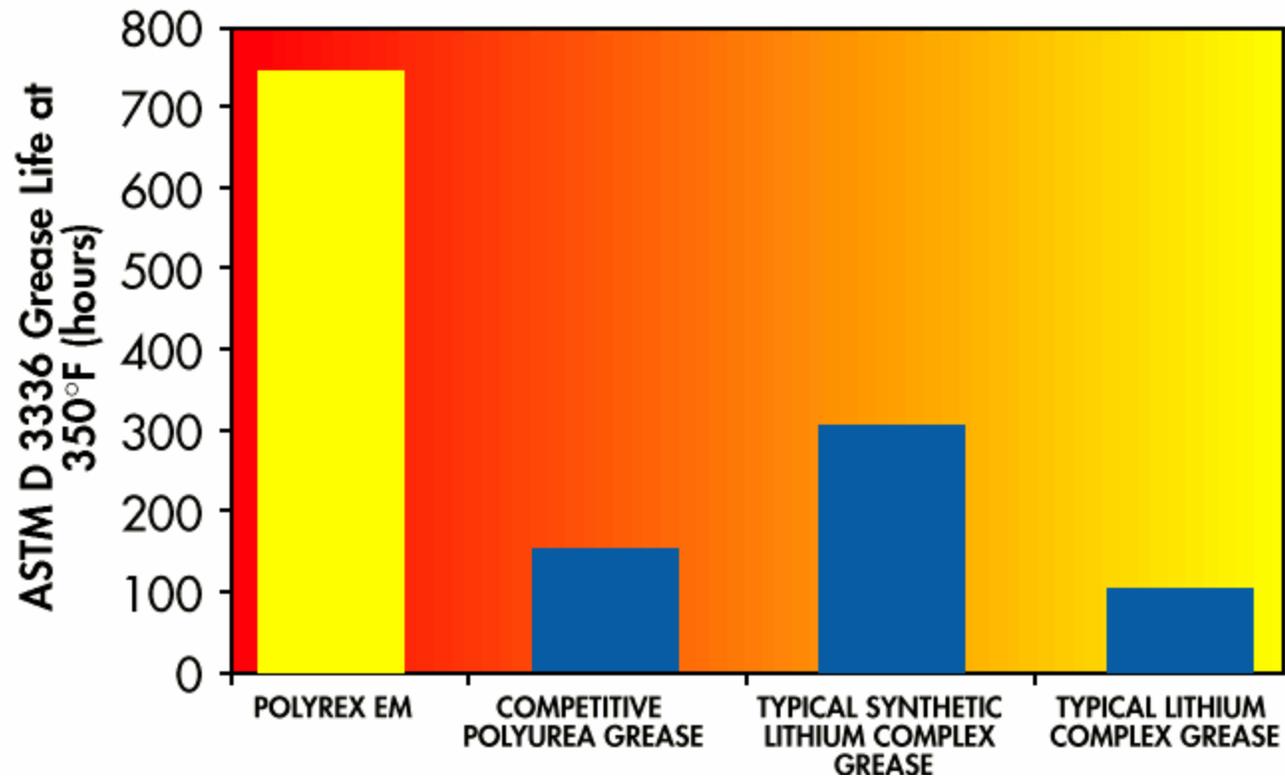
- Most grease lubricated electric motors should use Polyrex EM or Mobilith SHC 100 – (Mobilith SHC 220 if consolidating plant lubes)
- Factory fill lubricants for several electric motor and bearing OEM's
- High speed (above 3600 rpm) and high temperatures (above 300°F) require special lubricant selections

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Polyrex EM Long Life

**POLYREX EM HAS OUTSTANDING
HIGH-TEMPERATURE LUBRICATION LIFE**

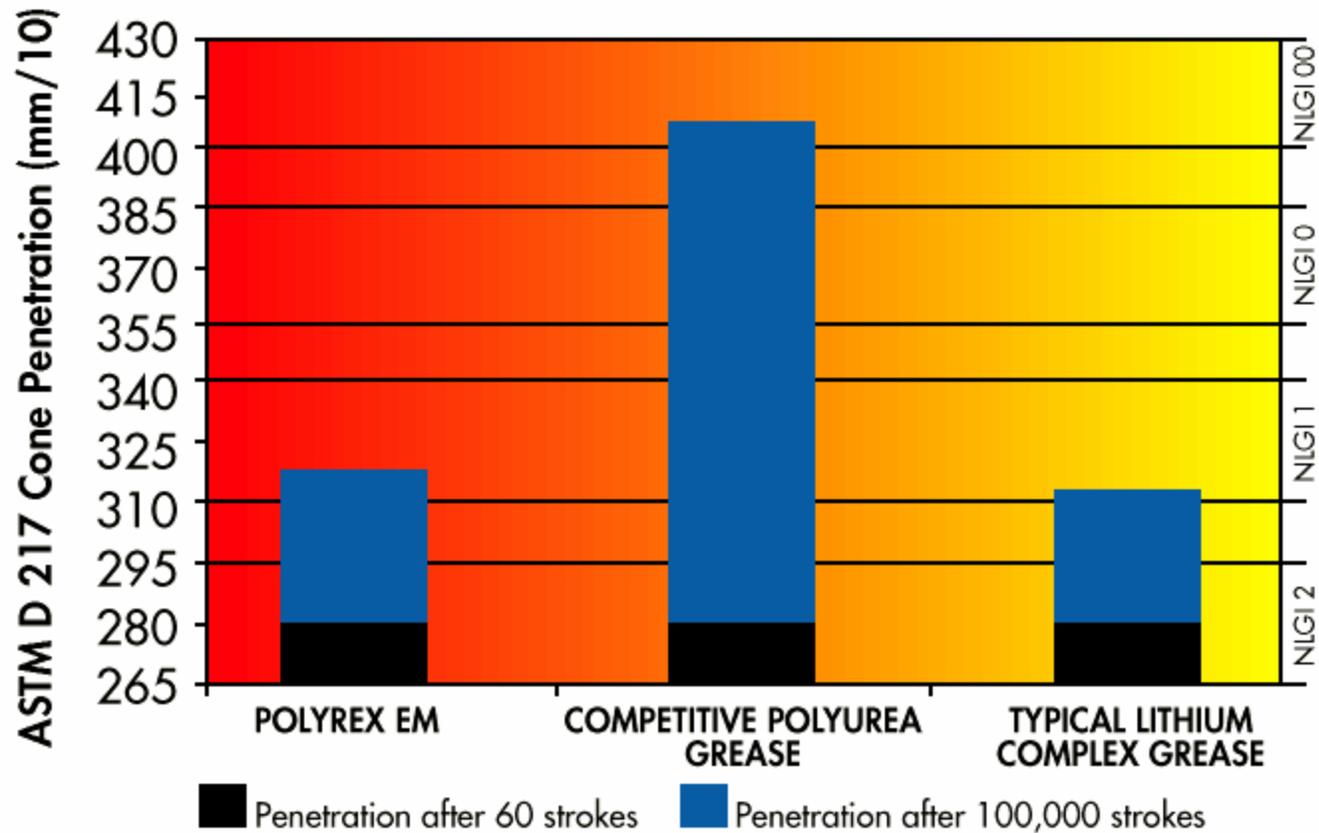


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Polyrex EM Shear Stability

POLYREX EM EXHIBITS EXCELLENT SHEAR STABILITY



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Mobilith SHC - Advantages Of Polyalphaolefin (PAO) Synthetic Base

- Advantages of PAO compared to mineral oil
 - Wider temperature range by 10 to 20°C
 - Maintains viscosity at high temperatures
 - Greater Elasto Hydrodynamic Lubrication (EHL) film thickness
 - Reduced evaporation at high temperatures
 - Longer life

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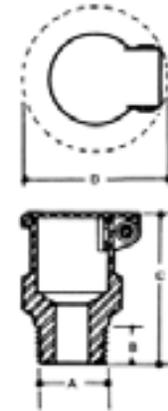
Grease Compatibility

- **Greases with different soap types may be incompatible**
 - Chemical interaction between thickeners / additives
 - Mixture breaks down (usually softens) in service
 - More severe at high temperatures and shear rates
- **When changing greases**
 - Purge the old grease out to the degree possible
 - Decrease re-lubrication interval to complete purge
 - Watch carefully during transition period



Grease Relief Valves

- Grease relief valves may minimize risk of gross over-lubrication
 - Small spring-loaded relief opens with positive grease pressure
 - Excess grease vents out relief
- Many motors have removable plugs near the bottom of the motor
 - Best greasing procedure is to remove the plug, then add grease and allow to run for 30 minutes, then replace the plug



Gits Cup



Alemite 314700 RV

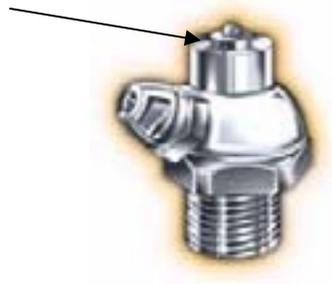
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Grease fittings

Common Grease “Zerks”,
“Nipples” and fittings

Newer fittings have relief
ports



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Hand Operated Grease Gun

- Hand operated grease guns prevent over lubrication and shield damage
- Standardize on one specific grease gun model and use throughout the area
- Use dedicated gun marked “For use with electric motors only” to avoid grease compatibility issues
- Add grease SLOWLY



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Grease Gun Calibration

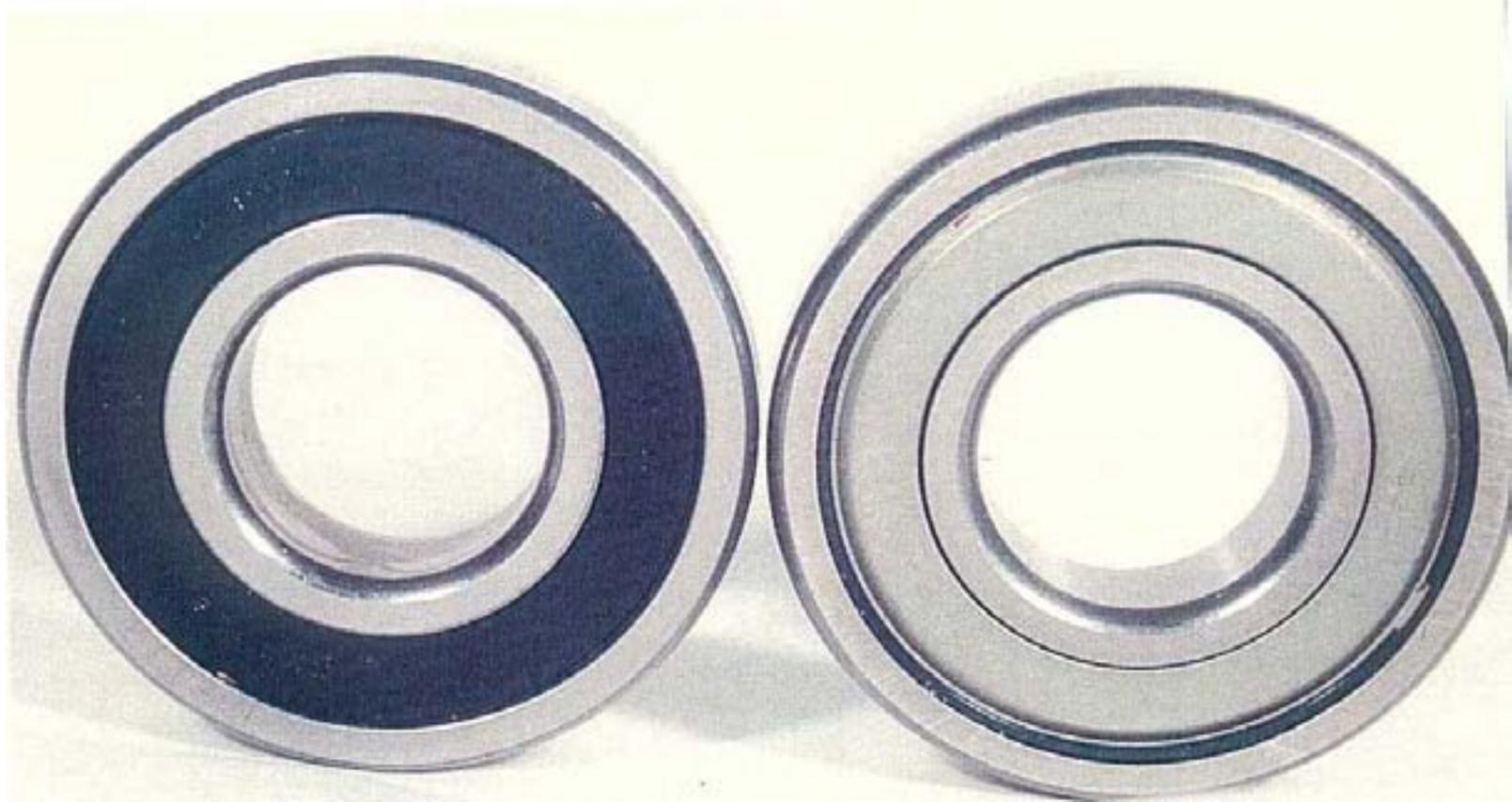
- Suppliers publish delivery capacity ratings on all their grease guns
 - Can range from as little as 7 to as much as 70 strokes per 1 oz
- Calibrate by counting the number of shots it takes to fill a 35 mm film canister - they hold one fluid ounce



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Seals and Shields



Sealed Bearing

Shielded Bearing

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To Pop or Not to Pop

- Double shielded bearings protect against contamination but do not allow easy relubrication
- Common practice is to pop out the outboard shield
- Allows relubrication, but risks contamination

Shielded
Bearing

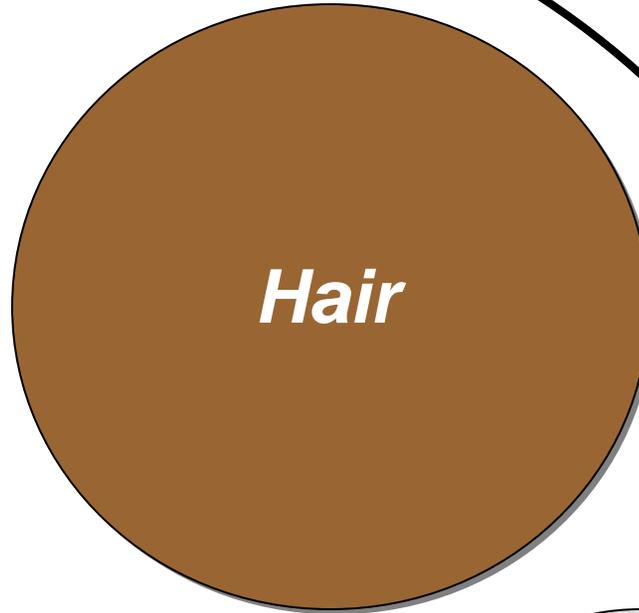


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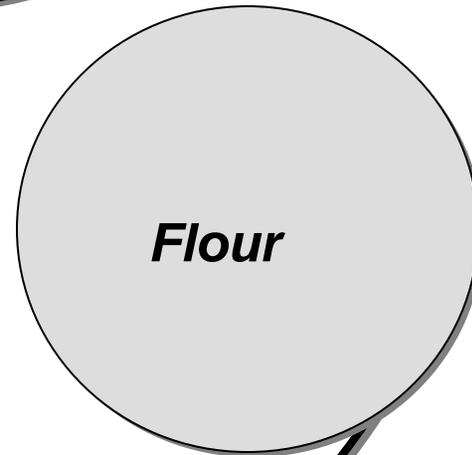
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Particles

- Grain of table salt
 - 100 microns
- Human hair
 - 40 to 70 microns
- Lower limit of sight
 - 40 microns
- Milled flour
 - 25 microns
- Red blood cells
 - 8 microns



Salt



1 micron



Typical Dynamic Clearances

- Roller Element Bearings 0.1-1 microns
- Ball Bearings 0.1-1
- Journal Bearings 0.5-100
- Hydrostatic Bearings 1-25
- Gears 0.1-1
- Dynamic Seal 0.05-0.5

Which one of these have a clearance greater than 40 microns?

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Your equipment's best friend – a clean rag

- Before adding grease
 - Wipe nipple and grease gun tip
 - Dispense one shot of grease
- After adding oil or grease
 - Wipe nipple
- Do not put fingers in front of grease gun nozzle



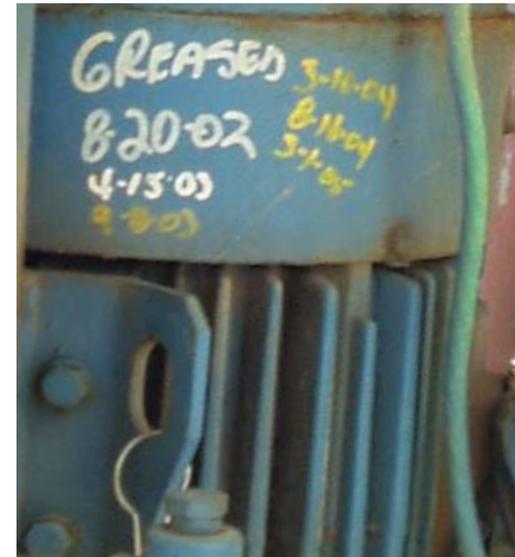
Cloth wipe rags

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Industry Best Practice

- Record the service date on the motor
- Provides a quick visual reference of the motor's history
- Some companies write the desired number of shots of grease on the motor, too

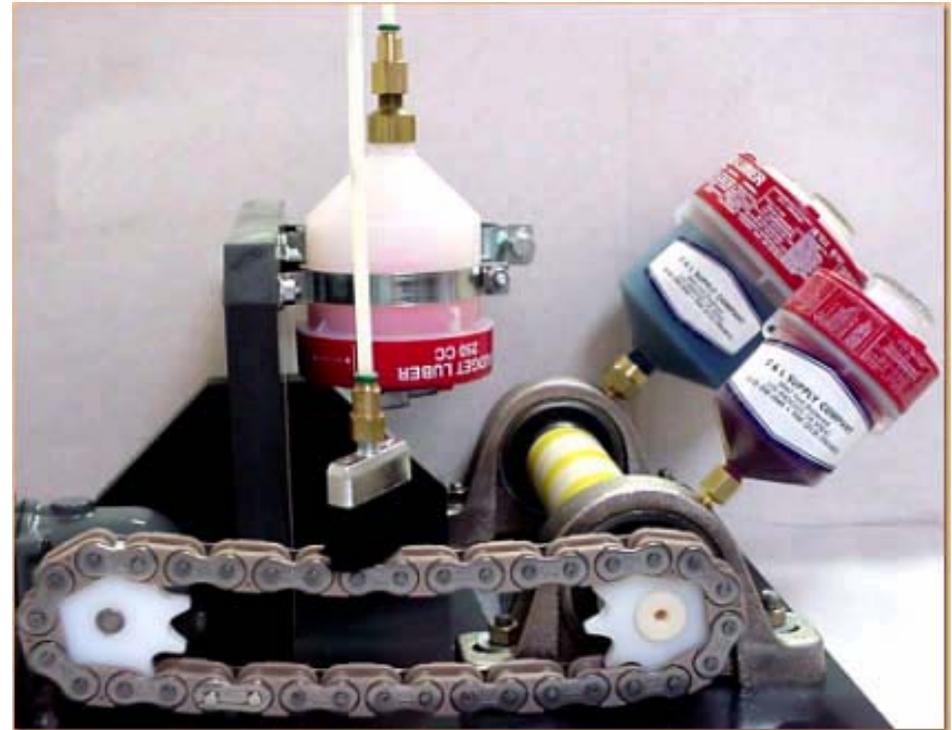


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Single point lubricators

- Provide a small amount of grease at measured intervals over several months
- Used for areas that are difficult to relubricate by hand
- In some models, gas pressure on piston forces grease into bearings, others are battery operated



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Industry Best Practice

- Prefill filler pipes and lines with grease to prevent emptying lubricator and protect against rust
- Industry best practice is to write the expiration date on the lubricator
- Check periodically that grease level is going down as expected



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Industry Best Practice

- Color coded grease cartridges and covers
 - Minimizes chance of mixing incompatible greases



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Industry Best Practice

Electric Motor Grease Amount				
Speed		NEMA Frame		Strokes of A500 Gun
All		Below 250		6
All		250 - 286		13
All		280 - 365		18
1800 and below		365 - 449 & 5000		35
3600		404 - 449		23
Regreasing Frequency				
RPM		HP		Months
1200	3600	L.T.	G.T.	
-		100	100	
1800				
X		X		24
X			X	12
	X	X		12
	X		X	6
Reduce interval for high temps, vertical motors, roller bearing, belt drives or contamination				

Motor Greasing Procedure

- Use Alemite A500 grease gun with Mobil Polyrex EM cartridge.
- Remove grease plug, if accessible.
- Check that relief valve moves freely. If motor is stopped, remove hardened grease from plug area.
- Wipe grease zerk and grease gun tip.
- Pump out one stroke of grease. Insert tip onto grease zerk.
- SLOWLY add grease. STOP if high resistance is detected. STOP if clean grease comes out seal, drain or plug.
- Check for water or rust
- With motor running, allow grease to purge for 15 - 30 minutes.
- Replace plug.
- Wipe area clean. Cover zerk with a clean plastic zerk cover if available.
- Report unusual noise, odor, temperature, vibration, visible contamination, caked grease or other unusual conditions.
- 10 hp motors and less should not be relubricated.

This laminated tag can be attached to each grease gun.

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Grease purge devices

- Inject a solvent into hardened grease to help purge it out
- Purge well with new grease to remove all traces of solvent



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Motor Greasing Tips to Remember

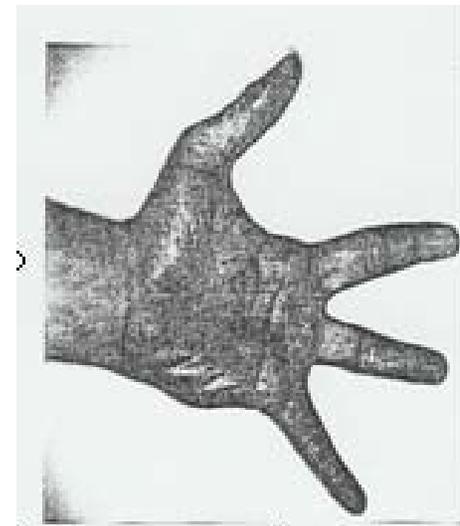
- ✓ Use dedicated/calibrated grease gun
- ✓ Use Polyrex EM or Mobilith SHC 100
- ✓ Make sure fittings, grease gun and relief ports are clean and free of old grease
- ✓ Add the proper amount of grease slowly
- ✓ Use full strokes
- ✓ Allow excess grease to vent
- ✓ Wipe up excess grease after re-lubrication is complete

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Safety

- NEVER clean the end of the grease gun with your finger
- Do not put your fingers near the nozzle of the grease gun to steady it when injecting grease. It may slip.
- Risks injection injury
- Grease injected under the skin may cause gangrene and loss of the limb



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