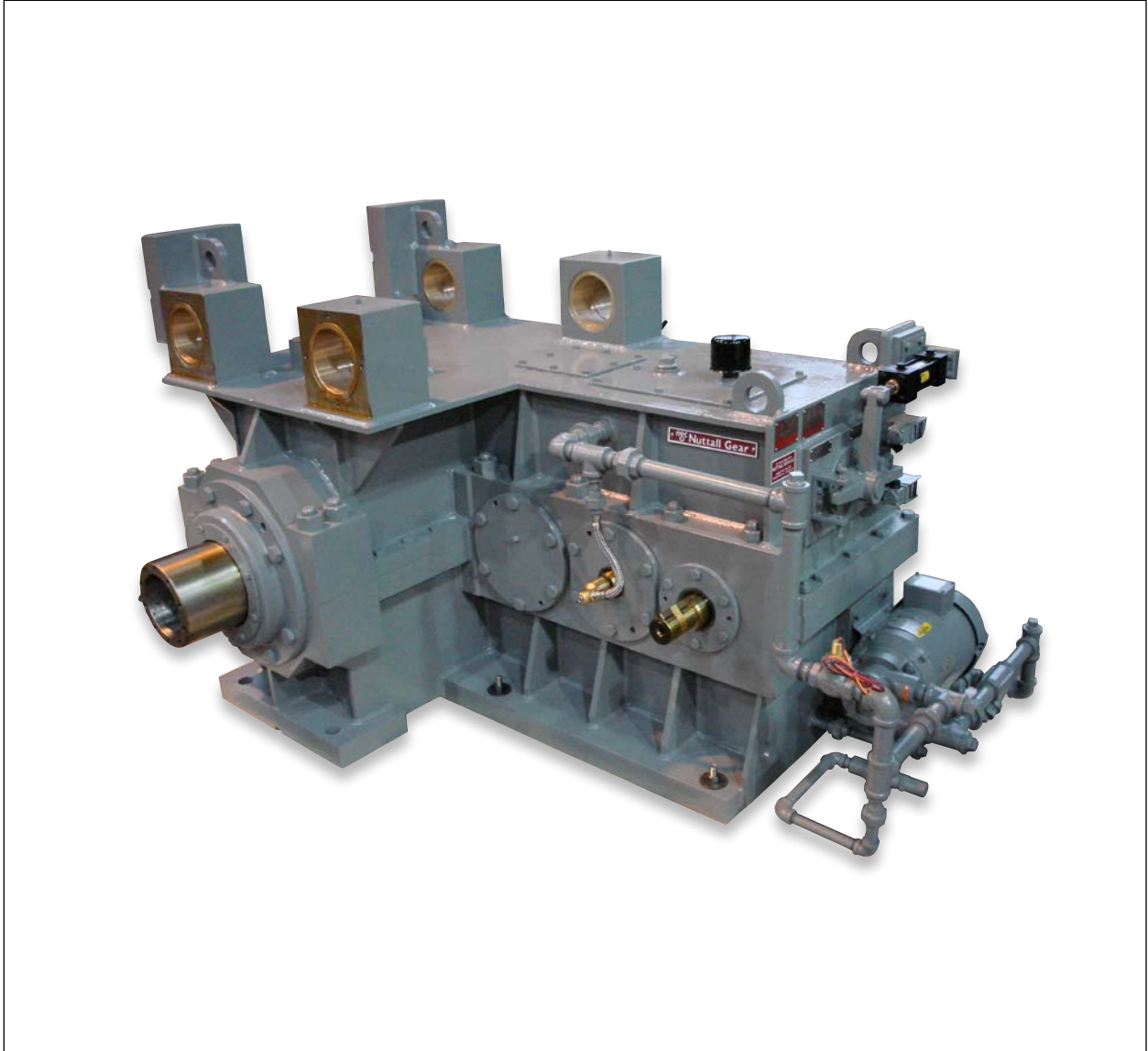


Type TDS Helical & Helical/Bevel Speed Reducers

Installation, Operation and Maintenance Manual

P-6003-NG



Product Safety Information:

General - The information provided within this document is intended to give guidance to personnel responsible for selecting, installing, maintaining, and operating Nuttall Gear products. This information must be made available and reviewed by the aforementioned parties to ensure proper installation, safe operation, and proper maintenance of Nuttall Gear products is achievable. Provided below is a list of potential hazards that are not listed in any order relative to level of hazard.

Lifting - Follow the lifting instructions as outlined in this manual. Failure to follow these instructions may result in personal injury or death and/or damage to the product and/or surrounding equipment. Always keep clear of elevated loads.

Installation - Installation of all Nuttall Gear products must be performed by suitably qualified personnel in accordance with this manual, local code, and any other supplemental information that may be provided by Nuttall Gear for units with non-standard or special features.

Maintenance - Follow the instructions provided in this manual for recommendations on maintenance frequency and renewal parts. Prior to commencing maintenance on any Nuttall Gear products or associated machinery, personnel must observe hazard warnings and ensure that all loads have been removed from the system and appropriate lockout / tag out procedures are being used. When replacing parts, use only authentic OEM parts supplied by Nuttall Gear. Use of non-OEM parts can lead to improper fits and premature and/or catastrophic failure. In some cases, these failures can lead to injury or death.

Guards - All rotating components (shafts, couplings, fans, etc...) must be safeguarded via rigidly constructed guards that are firmly secured. Guards must be designed and constructed as such to ensure physical contact with rotating or moving parts or entanglement is not possible.

Lubrication - Skin contact with certain lubricants or preservatives maybe harmful; when handling lubricants or preservatives, follow the lubricant manufacturer's recommendations. External machined surfaces of Nuttall Gear products may be protected with a rust inhibitor prior to leaving the manufacturing facility and will require removal at installation; always protect skin from coming in contact with rust inhibitor while removing. Contact Nuttall Gear for more information regarding rust inhibitor. All Nuttall Gear products are shipped without lubrication. Refer to this manual and/or contact Nuttall Gear for lubrication recommendations. Failure to follow lubrication recommendations may result in damage to product and in extreme cases may result in injury to personnel.

Burn Hazard - Operating machinery generates heat and may have external surfaces, and contain lubricants that are hot enough to cause burns. Care must be taken to avoid contact with hot surfaces and lubricants. When possible, allow machinery to sufficiently cool prior to contact.

Fire/Explosion - Lubrication vapors and mist will occur within the gearbox and may seep through openings creating a flammable environment. Do not use open flames or other ignition sources in or near areas that may be subject to lubrication vapors or mists. Contact the lubricant manufacturer for information regarding flammability of the lubricant. When exposed to excessive heat, some materials used in the construction of Nuttall Gear products (such as rubbers and plastics) may decompose and produce hazardous fumes. Care should be taken to avoid exposure to fumes and remains of overheated materials should be handled with the appropriate personal protective equipment. Regular cleaning is required to remove any dirt or dust deposits deeper than 5mm in order to facilitate proper cooling and avoid overheating and fire hazards.

Electric Hazard - Electrical shock may cause serious or fatal injury. Connection of electric motor to the main supply should be made by qualified personnel. Refer to the motor manufacturer for detailed information regarding proper motor connection and care.

Operation - All Nuttall Gear products are provided with a rating nameplate that details the operating conditions for which the product was designed. Operate the unit only at the ratings shown on the nameplate. Before exceeding any of these operational conditions, contact your Nuttall Gear representative for factory approval. Overloading and/or over speeding may result in damage to the unit and may cause injury to personnel. Where gear units provide a backstop facility, ensure that back-up systems are provided if failure of the backstop device would endanger personnel or result in property damage.

Noise - Gearboxes and other associated machinery may produce noise levels that are damaging to the hearing with prolonged exposure. Personnel should wear ear protection when working in areas where these noise levels may exist.

Note - The aforementioned information is based on the current state of knowledge and our best assessment of the potential hazards in the operation of the gear units. For additional information and clarification, please contact the factory.

Safety Warning Symbols-



Caution – Dangers exist that could result in injury, death or damage to machinery.



Danger (Touch Hazard) – Entanglement in rotating components could result in serious injury or death.



Electrical Hazard – Electrical shock could result in serious injury or death.



Damaging Situation- Could result in damage to unit or associated equipment.

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Introduction:

The following instructions apply to all Nuttall Gear Parallel Shaft and Right Angle Shaft reducers and motor/reducer packages, and exclude Nuttall Gear's High Speed (SU/SD) and Moduline Concentric units. If a unit is furnished with special features, refer to the supplemental instructions shipped with the unit or contact your Nuttall Gear sales representative. In some cases, special outline or assembly drawings may have been provided. In these cases, this manual is meant to be used in conjunction with the drawing(s) for that particular gearbox. Where a conflict exists between this manual and any supplied drawing(s) for a particular gearbox, the drawing(s) take precedence.

The information provided within this Installation, Operation, and Maintenance (IOM) manual must be made available, reviewed and understood by all effected parties to ensure proper installation, safe operation, and proper maintenance of the product.

To protect the warranty of your Nuttall Gear product, installation and maintenance services must only be performed by trained personnel after reading and understanding all instructions that apply to the product (this IOM and supplemental literature provided by Nuttall Gear). Particular attention must be paid to all nameplates and warning tags.

 **CAUTION: Operate this unit only at the ratings shown on the nameplate. Before exceeding any of these operational conditions, contact your Nuttall Gear representative for factory approval.**

The gear drive is designed according to the latest standards of the American Gear Manufacturers Association (AGMA), and was designed to meet the load conditions for the service ratings on the nameplate. Proper performance and service life of the unit depends on adherence to these operational ratings.

When communicating with your Nuttall Gear sales representative, make reference to the nameplate information and any other information that may be useful in identifying the gear drive.

Warranty:

 **Warning: Service and repair under warranty must be performed only by a Nuttall Gear authorized service shop; otherwise the warranty will become void.**

Nuttall Gear warrants that the product furnished will be free of defects in material and workmanship for a period not to exceed one year from installation or eighteen months from shipment to the purchaser, whichever is soonest. Upon prompt notification and written substantiation that the equipment has been stored, installed, operated and maintained in accordance with Nuttall Gear recommendations and standard industry practices, Nuttall Gear will correct the non-conformity by repair or replacement, at its option, F.O.B. factory.

The warranties set forth in this provision are exclusive and in lieu of all other warranties whether statutory, express or implied (including all warranties of merchantability and fitness for particular purpose and all warranties arising from course of dealing or usage of trade), except of title and against patent infringement. The remedies provided above shall constitute complete fulfillment of all the liabilities of Nuttall Gear whether the claims of the purchaser are based in contract, in tort (including negligence), or otherwise with respect to, or arising out of, the product furnished hereunder.

The system of connected rotating parts—PRIME MOVER AND ACCESSORIES, GEAR UNIT, AND DRIVEN EQUIPMENT—must be compatible; free from critical speeds, torsional or other types of vibration, within the operating range, regardless of the source of such vibration, and/or it's inducement. Nuttall Gear's responsibility is limited to providing a gear unit within normal commercial levels of vibration generation. Nuttall Gear is not responsible for the unsatisfactory operation or failure of the drive system, resulting from either the incompatibility of rotating components or the analysis required. The system responsibility remains with the purchaser, system builder or designer, unless Nuttall Gear has agreed to perform such analysis, and the nature of such vibrations is fully defined.

Those units supplied with motor/gear couplings mounted must be final aligned by the installer. Nuttall Gear verifies that the motor and gear can be aligned; however, Nuttall Gear does not do final alignment, because of changes that occur during shipment handling as well as foundation variances.

The user is responsible for furnishing and installing any guards or other safety equipment needed to protect operating personnel, even though such safety equipment may not have been furnished by the seller with the equipment purchased.

Nuttall Gear, its contractors and suppliers of any tier, shall not be liable in contract, in tort (including negligence), or otherwise for damage or loss of other property or equipment, loss of profits or revenue, loss of use of equipment or power system, cost of capital, cost of purchased or replacement power or temporary equipment (including additional expenses incurred in using existing facilities), claims of customers of the purchaser, or for any special, indirect, incidental, or consequential damages whatsoever.

The remedies of the purchaser set forth herein are exclusive and the liability of Nuttall Gear with respect to any contract, or anything done in connection therewith, such as the performance or breach thereof, or from the manufacture, sale, delivery, resale, or use of any equipment covered by or furnished under the contract, whether in contract, in tort (including negligence) or otherwise, shall not exceed the price of the equipment or part on which such liability is claimed.

In no event shall Nuttall Gear be responsible for providing working access to the defect, including the removal, disassembly, replacement or reinstallation of any equipment, materials or structure to the extent necessary to permit Nuttall Gear to perform its warranty obligations, or transportation costs to and from Nuttall Gear's factory or repair facility. The conditions of any tests shall be mutually agreed upon and Nuttall Gear shall be notified of, and may be present at, all tests that may be made.

Receiving & Handling:

STOP **Warning: Immediately upon receipt examine the unit for damage. Notify the carrier and your Nuttall Gear sales representative immediately if there is any evidence of shipping damage. Responsibility for reimbursement for losses or damages incurred during shipment remains solely with the transportation company.**

CAUTION: When handling your Nuttall Gear unit:

- **Never use shaft extensions for pushing, pulling, or supporting the weight of the unit.**
- **Never drag the gear unit. Machined mounting surfaces will be marred and overstressing of the housing may occur.**
- **Motor lifting lugs or eyebolt holes may be used to lift units only when additional load supporting methods are used, such as reducer housing lifting eyes. Never attempt to lift the entire unit by using the motor lifting lugs.**
- **When lifting, distribute the load evenly to keep the unit from tilting. Spreader bars may be required to avoid stress on any piping and accessories mounted on the unit.**
- **Never use piping for lifting or climbing.**
- **If the unit is to be stored, refer to the storage instructions in this manual.**

Operating instructions for accessories mounted on the gear unit assembly are normally attached to the unit. Save all hardware, accessories, wiring diagrams and instruction information included with the unit.

Weights

For standard catalog designs, refer to the table below for approximate unit weights. These weights are approximate values and do not include motors, lubrication, or piping assemblies. For weights of non-catalog units, refer to the unit outline and/or assembly drawing(s) that accompanied the unit or contact your Nuttall Gear sales representative. Outline drawing weights do not include lubrication and only include motor(s) weights when explicitly stated.

Approximate Unit Weight in Pounds

Unit Size	Parallel Shaft			Right Angle		
	Single	Double	Quad	Double	Triple	Quad
7	500	550	650	600	650	700
8	750	900	1,000	950	1,000	1,050
9	850	1,000	1,200	1,100	1,200	1,300
11	1,400	1,750	1,950	1,850	1,950	2,050
12	1,900	2,450	2,650	2,550	2,650	2,750
13	2,750	2,900	3,200	3,050	3,200	3,350
15	2,750	3,450	3,700	3,550	3,700	3,850
16	4,850	4,850	5,150	5,000	5,150	5,300
18	4,650	5,650	5,050	5,850	6,050	6,250
20	4,900	5,900	6,300	6,100	6,300	6,500
22	5,500	7,000	7,500	7,250	7,500	7,750
25	5,950	8,450	9,050	8,750	9,050	9,350
28	9,400	9,900	10,600	10,250	10,600	10,950
30	11,300	12,800	13,500	13,150	13,500	13,850
32	-	18,400	19,200	18,850	19,200	19,600
34	-	21,650	22,450	22,050	22,450	22,850
36	-	25,600	26,500	26,050	26,500	26,950
38	-	30,000	30,900	30,450	30,900	31,350
40	-	35,600	36,600	36,100	36,600	37,100

Storage:

General

All internal and unpainted external surfaces of the reducer have been treated at the factory, prior to shipment, with a rust preventative. The protective life of this rust preventative will vary with temperature fluctuations, atmospheric moisture content, degree of exposure to the elements during storage, and degree of contact with other objects. Inspect all machined surfaces and add rust inhibitor to any exposed metal surfaces that may have had the protective coating removed during shipping and handling. To assure the reducer will operate satisfactorily at start-up, certain precautions must be taken by the customer upon receipt. The expected length of storage and the storage atmosphere dictate the maintenance schedule to be followed. Reducers must be stored free of loads on both the output and input shafts. These instructions only apply to the reducer and piping assembly, where one exists. If a motor is included in our drive package, motor operating maintenance and storage instructions are included with drawing transmittals and are also attached to the unit. These instructions must be carefully read and followed.

Short Term Storage (Indoor)

If the unit will be stored for a period of 30 days or less, the following should be observed: Store in a clean, dry location with factory packaging intact, and with as nearly a constant temperature as possible. The unit should be elevated in a manner that will prohibit water or other liquids to come in contact with it. Avoid storing the unit in areas that are subject to extremes in temperature, vibrations, and humidity. If the unit will be secured to its storage surface, via the unit's mounting holes, the storage surface must be level to prevent twisting of the housing and subsequent damage to the unit. Units should be stored in their operating position.

Long Term Storage (Indoor)

If the unit will be stored for a period longer than 30 days, the following should be observed: Store in a clean dry location with the unit elevated in a manner that will prohibit water or other liquids to come in contact with it. Avoid areas that are subject to extremes in temperature, vibrations, and humidity. If the unit will be secured to its storage surface, via the unit's mounting holes, the storage surface must be level to prevent twisting of the housing and subsequent damage to the unit. Units should be stored in their operating position.

Use one of the following recommendations:

1. **For all horizontal and vertically shafted units:** Remove the breather and replace it with a pipe plug. Fill the gear drive to the recommended oil level with Shell VSI grade 68 oil or equal, heated between 110-120°F. Do Not Overfill. Immediately close all openings to retain the vapors in the housing. Special Note for units with labyrinth seals: Prior to filling the unit with heated oil, pack the entire seal area with grease, to form a vapor barrier, and seal with tape. By hand, slowly rotate the high speed shaft long enough to permit the low speed shaft to make at least one complete revolution. This should be done at least once every four weeks. Inspect the unit periodically and spray or add a rust inhibitor suitable for the anticipated storage conditions, as required.
2. **For all horizontal and vertically shafted units:** Remove the breather and replace it with a pipe plug. A vapor-phase rust inhibitor such as Daubert Chemical, Nox-Rust Motorstor VCI-10, or equal, may be added to the recommended oil type in the amount of 2% of the total sump capacity. Fill the unit to the recommended oil level. Do Not Overfill. Special note for units with labyrinth seals: Prior to filling the unit with oil, pack the entire seal area with grease, to form a vapor barrier, and seal with tape. By hand, slowly rotate the high speed shaft long enough to permit the low speed shaft to make at least one revolution. This should be done at least once every four weeks. Inspect the unit periodically and spray or add a rust inhibitor suitable for the anticipated storage conditions, as required. The unit may run without changing this oil mixture.
3. **For horizontally shafted units only (Do not use with units that have labyrinth seals):** Fill the unit completely (to the top of the housing) with the recommended oil type for operation of the unit. Eliminate any air pockets. By hand, slowly rotate the high speed shaft long enough to permit the low speed shaft to make at least one revolution. This should be done at least once every four weeks. Inspect the unit periodically and spray or add a rust inhibitor suitable for the anticipated storage conditions, as required. Before start-up, lower the oil to the recommended level.

Outdoor Storage

Note: OUTDOOR STORAGE IS NOT RECOMMENDED. When storage in a warehouse or enclosed building is not possible, the following should be observed:

1. Bring the unit to an area in which the ambient temperature is greater than 50°F and allow the unit to remain in this area for a minimum of 24 hours.
2. Remove the breather and replace it with a pipe plug. Pack the entire seal area with grease, to form a vapor barrier, and seal with tape.
3. Fill the gear drive to the recommended oil level with a vapor-phase rust inhibitor such as Daubert Chemical, Nox-Rust Motorstor VCI-10, or equal, heated between 110-120°F. Immediately seal the fill port to retain the vapors in the housing.
4. Seal the unit in a moisture proof container with an adequate supply of desiccant. The unit must be elevated in a manner that will prohibit water or other liquids to come in contact with it. If the unit will be secured to its storage surface, via the unit's mounting holes, the surface must be level to prevent twisting of the housing and subsequent damage to the unit.
5. By hand, slowly rotate the high speed shaft long enough to permit the low speed shaft to make at least one revolution. This should be done at least once every four weeks.
6. It will be necessary to repeat operations 1 thru 4 every six months. The vapor-phase rust inhibitor drained from the unit maybe reheated and reused.
7. Do not store in direct sunlight.

Piping assemblies: Some units are supplied with a piping assembly designed to deliver lubrication to critical components, and/or to circulate oil through a cooler. These piping assemblies should be completely charged with the same storage oil as the unit. If the pump of the piping assembly is motor driven, momentarily jog the motor to circulate oil through the oil sprays and ports. Do not allow the pump motor to run continuously, as the reducer may become pressurized potentially causing damage the shaft seals of the unit. For shaft driven pumps, small amounts of oil will be circulated through the system while hand turning the high speed shaft as noted above. Prior to start-up, drain the storage oil from the unit, and the piping assembly where one exists, and refill with the recommended oil type to the recommended level. Where piping assemblies exist, confirm oil sprays are not clogged prior to start-up.


Installation:


The continuous efficient operation of a gear unit depends chiefly on four factors:

1. Proper type of foundation and correct mounting.
2. Correct alignment with the driven equipment.

3. Correct lubrication.
4. Full consideration of both preventative and operating maintenance.

 **CAUTION: Operate the gear unit only within the ratings shown on the nameplate. Review the application to confirm the unit will not be operated in conditions exceeding the nameplate rating.**

 **DANGER: Selection and installation of guard, warning signs, or any provisions required to meet national and local safety codes are the responsibility of the user. Ensure all guarding, safety devices, and warning signs are in place prior to starting equipment. Failure to do this may result in serious injury or death.**

 **CAUTION: All warning labels and instructions for installing and operating electrical equipment must be carefully read and followed. All electrical connections must be installed only by qualified personnel in strict accordance with the National Electric Code and local requirements. Compliance with all codes, laws and safety ordinances is the sole responsibility of the user.**

Environmental Considerations

Units should not be installed in locations of unusually high or low temperatures. Adequate air flow is required for proper heat dissipation from the unit. Ambient temperatures must not exceed 100°F, unless supplemental means of cooling are supplied. Environmental conditions, including exposure to direct sunlight, high humidity, dust or chemicals suspended in the air are worthy of special consideration. Gear drives exposed to these and other adverse conditions should be referred to Nuttall Gear for special evaluation and recommendation.

Foundation

A foundation or mounting, which provides rigidity and prevents weaving or flexing with resultant misalignment of the shafts, is essential to the successful operation of a gear unit. A concrete foundation should be used whenever possible and should be carefully prepared to conform with data regarding bolt spacing and physical measurements contained in the Dimension Leaflet supplied prior to delivery of the equipment.

Grout steel mounting pads into the concrete base or foundation; mount the unit on these steel pads. Do not grout the unit directly into the concrete base or foundation. When the unit will be installed on structural foundation pads a supporting base plate of steel should be provided to obtain proper rigidity. These plates or pads should be of a thickness equal to or greater than the diameter of the hold down bolts.

Foundation Bolt Torque Recommendations

Gear units must be securely bolted to their foundations with the specified bolt size. Bolts are to be SAE Grade 5 or equivalent fasteners. Do not lubricate fasteners, as this will promote loosening during operation. Tighten bolts per the torques listed below.


Bolt Size (UNC)	Torque (Ft. Lbs.)		Bolt Size (UNC)	Torque (Ft. Lbs.)	
	Metal To Metal	Metal To Concrete		Metal To Metal	Metal To Concrete
1/4	8	6	1-1/4	1,050	834
5/16	16	12	1-3/8	1,375	1,084
3/8	28	22	1-1/2	1,842	1,458
1/2	69	54	1-3/4	1,975	1,558
5/8	137	108	2	3,083	2,147
3/4	245	191	2-1/4	4,333	3,417
7/8	380	313	2-1/2	6,000	4,667
1	567	467	2-3/4	8,167	6,417
1-1/8	742	584	3	10,417	8,250

Bedplates

Bedplates are provided as common mounting surfaces that support several components when mounted on a proper foundation. Bedplates are also designed to facilitate alignment of those components. Because of the disparity of component sizes, bedplates are not designed to be self-supporting structures under all conditions. They are not designed to provide a platform for lifting and transporting with all of the components mounted, unless the assemblies are properly supported and balanced with appropriate material handling fixtures. There will be occasions when it will be necessary to remove some of the components for transport, and subsequently, reassemble the drive train in its final location. Nuttall Gear supplies the components on the bedplate assemblies rough aligned. However, due to possible shifting in transit or handling and the possible variances in foundation surfaces, final alignment is the responsibility of the installer. To align a bedplate supplied unit, the output shaft of the reducer should be aligned with the driven shaft by moving and shimming the bedplate assembly. This should not be accomplished by moving the reducer on the bedplate. Insure that all bedplate mounting points are properly shimmed for proper support to provide a solid level surface. Failure to do so may create a twist in the bedplate and could make final alignment of the drive components difficult. After aligning the reducer output shaft and shimming between the bedplate and the foundation, the mounting bolts or lugs should be tightened and the bedplate firmly locked and grouted in place. Final alignment of the other bedplated components must now be completed.

Alignment

Gear units are designed with a tolerance of +0 and up to -1/16 in. between the shaft center and the base of the unit; therefore, shimming may be required. Flat shims of various thicknesses, slotted to slide around the foundation bolts, should be used. All feet must be solidly supported before the mounting bolts are tightened. After alignment has been secured through shimming, the equipment should be bolted down and alignment rechecked. Heat up couplings, sprockets or pinions and shrink them onto shaft extensions when required, avoiding contact with the shaft seal. Do not heat parts above manufacturers recommended limits, or 300°F, whichever is lower.

 **Caution: To avoid severe damage to bearing and gears, couplings must never be hammered on to shaft extensions.** When the prime-mover is connected to the gear unit or the gear unit is connected to the driven equipment by means of a coupling, correct alignment cannot be overemphasized. This becomes of greater importance as speeds are increased or the drive is subjected to

variations in load conditions. Misalignment, either parallel or angular, is one of the most frequent causes of bearing or shaft failures, noisy operation, or excessive operating temperatures due to the extra load imposed. A straight edge laid across the coupling member at the machined diameter, provided for alignment purposes, shows correct parallel alignment when the straight edge rests on both coupling members for their full length. Check this at four positions-90 degrees apart. The use of feeler gauges between coupling member faces is a common method of checking for correct angular alignment. Check at four positions-90 degrees apart. A more accurate alignment check is obtained by the use of dial indicators. This is done by clamping the indicator on one coupling member with the indicator stem resting on the other coupling member, then rotating the member holding the clamped indicator. To minimize overhung loads, pulleys and sprockets should be mounted as close to the gear case as possible.

 **Warning: Do not over tighten belts or chains; reducer bearing life may be significantly reduced if belts and chains are too tight.**

Install pulleys and sprockets on driver/driven equipment so that they run true. Guards should be mounted over couplings, pulleys, and sprockets after final alignment is completed. Tighten hardware for pulleys and sprockets in accordance with the manufacturer's recommendations.


Start-Up:

Pre-start For Units in Storage

1. Replace the breather if it was removed for storage.
2. Remove all of the tape applied during storage preparation.
3. Drain the storage lubricant from the unit and flush the unit prior to charging it with the recommended lubricant. If the unit cannot be flushed, contact your lubricant supplier to confirm the storage lubricant and operating lubricant are compatible.
4. Thoroughly inspect the unit and all accessories for damage.
5. Follow additional start-up steps as outlined below.

 **WARNING: Nuttall Gear units are shipped without oil. Prior to start-up, the unit must be filled with the proper amount of oil, selected in accordance with the operating conditions. See lubrication section of this manual for more information.**

 **DANGER: Ensure all guarding, safety devices, and warning signs are in place prior to starting equipment. Failure to do this may result in serious injury or death.**

 **CAUTION: All warning labels and instructions for installing and operating electrical equipment must be carefully read and followed. All electrical connections must be installed only by qualified personnel in strict accordance with the National Electric Code and local requirements. Compliance with all codes, laws and safety ordinances is the sole responsibility of the user.**

1. Add the correct amount of oil to the gear unit. Fill to the oil level fill line while the unit is not operating. Refer to the lubrication section of this manual for lubrication recommendations.
2. For units with additional piping systems (auxiliary cooling and/or forced lubrication systems), momentarily operate the unloaded unit until all lines have been charged with oil. Stop the unit and recheck the oil level and add oil as required. Repeat until required static oil level has been achieved. Note that it will be necessary to prime piping assemblies to remove trapped air.
3. Confirm all pipe plugs are securely tightened.
4. Confirm all electrical connections have been properly made and are in accordance with the equipment manufacturers' recommendations and are in strict compliance with the National Electric Code and local requirements. Confirm all accessories have been properly mounted.
5. Confirm proper backstop rotation via hand rotating uncoupled motor (for motor installed backstops) or hand rotating uncoupled unit input shaft (for unit installed backstops).
6. Turn the shafts by hand to confirm there are no obstructions to rotation.
7. Confirm the inspection cover is securely tightened and install guards for rotating equipment.
8. Check all external mounting bolts, screws, etc. to make sure they have not loosened in transit or handling.
9. Momentarily operate the motor to check for proper shaft rotation; reverse leads if necessary. Reconnect coupling.
10. Check that all couplings, sprockets, pulleys, etc. are properly aligned, lubricated, mounted and keyed on shaft extensions.
11. For units equipped with oil heaters, turn the heater on and allow the oil temperature to rise at least to the recommended minimum set point before start-up.
12. Start unit under as light a load as possible. If rotation of the unit is limited to one direction only, a tag on the housing must be provided to inform effected persons of the proper direction of rotation.
13. The machinery should be checked frequently for unusual sounds, oil leaks, excessive vibration and excessive heat. If an operating problem develops, shut down immediately and correct the problem before restarting.

Multi-Speed Shifter

 **Caution: Unless the outline drawing states explicitly that is ok to do so, NEVER attempt to change gears while the unit is operating or under load. Failure to observe this caution may result in injury to personnel and/or damage to equipment.**

 **DANGER: Pinch points exist; keep hands and fingers clear from moving parts.**


Pneumatic Shifter — Prior to shipment, the shifter lever arm has been properly set for each ratio position, ensuring full spline engagement of the clutch with each gear, as well as complete disengagement while in the neutral position (where a neutral position exists). Refer to the accompanying unit general assembly drawing for complete shifter setup information. Limit switches are provided on all pneumatic shifter units and should be utilized to protect the unit from damage in the event of clutch disengagement during operation. Solenoid coils should be connected and energized during operation, failure to do so could result in disengagement during operation causing damage to the unit. Air lines should remain connected and active during operation of the unit. If the unit will be operated in the neutral position the neutral stop pin must be fully engaged in the lever arm retainer, failure to do so may result in partial spline engagement during operation causing damage to the unit. Never attempt to change gears while the unit is operating or under load. If full spline engagement of the clutch and the gear is not initially achieved during the gear change, move the shifter into the neutral position and slightly rotate the input shaft to align the clutch and the spline teeth of the desired gear.

Manual Shifter — Prior to shipment, the shifter lever arm has been properly set for each ratio position, ensuring full spline engagement of the clutch with each gear, as well as complete disengagement while in the neutral position (where a neutral position exists). Refer to the accompanying unit general assembly drawing for complete shifter setup information. Manual shifting units are equipped with a locking pin in the shifter arm. This pin must be fully engaged in the lever arm and retainer to ensure full spline engagement of the clutch with the desired gear, or complete disengagement while in the neutral position. Failure to do so may result in partial spline engagement during operation causing damage to the unit. Never attempt to change gears while the unit is operating or under load. If full spline engagement of the clutch and the gear is not initially achieved during the gear change, move the shifter into the neutral position and slightly rotate the input shaft to align the clutch and the spline teeth of the desired gear.

Maintenance:

 **WARNING:** Prior to commencing maintenance on any Nuttall Gear product or associated machinery, personnel must observe hazard warnings and ensure that all loads have been removed from the system and appropriate lockout / tag out procedures are being used.

Lubrication:

 **Warning:** Gear units are shipped from the factory without oil. Fill unit to the proper level before operating. Failure to do so will result in damage to the unit.

 **Caution:** EP lubricants must not be used in backstops.

Maximum performance and long life of the gear unit are dependent upon the use of the proper lubricant, maintaining the correct oil level, and performing regular oil changes. At oil changes, units may require flushing prior to refilling. Suppliers of industrial lubricants, not service stations, should be contacted to supply suitable lubricants to meet the proper American Gear Manufacturers Association (AGMA) specifications. Units should be filled to the oil level as shown on the outline drawing or as indicated on the unit with the AGMA lubricant listed below. The lubricant may be straight mineral oil or synthetic oil.

Ambient Temperature

The ambient temperature range that the reducer is expected to operate in must be considered when selecting the proper lubricant. Oils that are too thick can lead to channeling allowing mating components to contact without lubrication. Oils that are too thin will not provide an adequate film thickness for proper lubrication. Both of these scenarios can cause damage to the gears or bearings. Please refer to the tables below to determine which viscosity is appropriate for your ambient operating conditions. Ambient temperature fluctuations may result in condensation build-up in the unit. A sump heater may be used to maintain the oil temperature above the dew point to prevent condensation.

Cold Temperature Conditions

Lubrication, either by splash or pump, must be given special attention if the gear drive is to be started or operated at temperatures below which the oil can be effectively splashed or pumped. Preheating the oil may be necessary under these low ambient temperature conditions. Nuttall Gear should be informed when gear drives are to operate outside the temperature ranges listed below. Gear drives operating in cold areas must be provided with oil that circulates freely and does not cause high starting torques. An acceptable low temperature gear oil, in addition to meeting AGMA specifications, must have a pour point at least 5°C (10°F) below the minimum expected ambient temperature, with a viscosity low enough to permit the oil to flow freely at the start up temperature, but high enough to carry the load at the operating temperature. When the lubricant selected does not provide proper lubrication for the expected ambient temperature range, the gear drive should be equipped with a sump heater to bring the oil up to a temperature at which it will circulate freely for starting. The heater watt-density should be selected to avoid excessive localized heating which could result in rapid degradation of the lubricant.

NOTE: Regardless of the condition of the oil, it may be necessary to change oil type due to ambient temperature changes.

Oil Sump Temperature

Gear drives operating in the ambient temperature range described in the table below will generally produce oil sump temperatures of not more than 100°F over ambient. This sump temperature is considered a maximum, as degradation of the lubricant increases rapidly at temperatures above 200°F. These lubrication recommendations exclude applications such as those gear drives installed in the food and drug industry where a possibility exists for incidental contact between the lubricant and the product being processed.

Selection

Lubricants must be compatible with seal materials used in the construction of the unit. They must be non-corrosive to gears and bearings, neutral in reaction, free from grit or abrasives, and have good antifoaming and oxidation resisting properties. Refer to AGMA 9005 for more detailed information on lubricant property requirements. For applications where loads, speeds, or temperatures are abnormal, Nuttall Gear should be contacted for specific recommendations. Shown below are several tables to help you select the appropriate oil for your conditions. For selection of the proper viscosity grade, always refer to the drawing for your gear unit first for an oil recommendation. In many cases, special recommendations are made on the drawing for custom designs. Contact the factory for a copy if needed. Unless otherwise stated, the recommendation shown on the drawing is for “typical indoor” ambient temperatures of 60° to 90°F. If conditions outside this range are expected, the viscosity grade may need to be different than what is listed on the drawing. Contact the factory for assistance if needed. For catalog reducers, or if a drawing is not available, the following guidelines may be used to select the appropriate oil. To determine which type of oil, mineral, EP mineral, synthetic, EP synthetic, is appropriate for your operating condition, refer to table 1. To determine the appropriate viscosity for your ambient operating condition, refer to table 2. To select a Nuttall Gear approved brand of oil, refer to table 3.

Mineral vs. Synthetic: Lab tests have shown that using a synthetic based lubricant can lower operating temperatures and increase the efficiency and life of speed reducers. In addition, synthetic lubricants have a wider range of acceptable operating temperatures and in some cases last longer than mineral based lubricants. The trade-off is synthetic lubricants are more expensive and selection is limited compared to mineral based lubricants. When choosing to use a synthetic lubricant, use only PAO (PolyAlphaOlefin) based synthetic oil in standard Nuttall Gear products. Do not use PAG based synthetics (PolyAlkylene Glycol). PAG type synthetic oils will degrade some seals and will dissolve certain types of paint. If use of a PAG type oil is desired, please contact the factory.

Extreme Pressure (EP) Lubricants: EP lubricants are lubricants that contain an extreme pressure additive, which permits the lubricant to carry appreciably higher loads than ordinary lubricants without excessive wear or damage to components. An EP additive combines chemically with metal to create a slippery surface film that prevents metal to metal contact under highly loaded members. Do not use EP lubricants in backstops or in reducers that utilize internal bronze bushings. If you are uncertain if your reducer contains bronze bushings, please contact the factory. All differentials contain bronze bushings.

Table 1. Lubrication Type Selection

Application	*Ambient Temperature Range		
	-40° to 30°F	30° to 100°F	100° to 125°F
Uniform loading to light shock	Synthetic	Mineral or Synthetic	Synthetic
Moderate to heavy shock	Synthetic EP	Mineral EP or Synthetic EP	Synthetic EP
Sustained heavy loads at low to zero speed	Synthetic EP	Mineral EP or Synthetic EP	Synthetic EP
Reducers utilizing carburized and ground gearing	Synthetic EP	Mineral EP or Synthetic EP	Synthetic EP

*The ambient temperature range is defined as the air temperature in the immediate vicinity of the gear drive.

**Do not use EP type lubricants in backstops or any reducers that utilize internal bronze bushings.

Table 2. Lubrication Viscosity Selection

Ambient Temperature Range*	ISO Viscosity Grade
-40° to -20°F	Contact Factory
-20° to 45°	ISO VG 68
25° to 65°F	ISO VG 100
45° to 85°F	ISO VG 150
65° to 105°F	ISO VG 220
95° to 125°F	ISO VG 320

Table 3. Recommended Lubricant Products

Brand	Product Family			
	Mineral	Mineral EP	Synthetic	Synthetic EP
Mobil	DTE Name & Double Letter Series	Mobilgear 600 XP Series	SHC 600 Series	SHC Gear Series
Castrol	Hyspin VG	Alpha SP / Tribol 1100	AlphaSyn T	AlphaSyn EP
Chevron	Regal R&O	Meropa	N/A	Tegra
Gulf	Harmony R&O	Gulf Industrial EP Gear Oil	GulfSyn EHT	GulfSyn EP Gear
Shell	Morlina S2B	Omala S2 G	Morlina S4B	Omala S4 GX

Oil Changes

All units are shipped from the factory without oil. Proper lubrication maintenance is vital to gear drive performance throughout its design life. After the first 500 hours or four weeks of operation, whichever occurs first, the gear drive should be thoroughly drained, flushed, and refilled in accordance with this manual. Under normal operating conditions, the lubricant should be changed every 2500 hours or six months, whichever occurs first. This change frequency can be extended if analysis of oil samples indicates very limited degradation or contamination.

Many oil suppliers offer periodic oil testing to monitor and determine the health of the oil. This service can provide an excellent means of predictive maintenance by monitoring the level of iron, dirt, water and other contaminant content suspended within the oil. The level of particle content that is permissible differs from gearbox to gearbox and from application to application. Typically, it is recommended that a trending procedure be performed to determine the gearbox's steady state level of iron content. When this steady state level has been determined, an excessive particle content test result may indicate the unit is in need of maintenance. In some cases, the oil change intervals may be extended based on favorable results of an oil analysis.

Cleaning and Flushing

 **CAUTION: Operating machinery generates heat and may have external surfaces, and contain lubricants that are hot enough to cause burns. Care must be taken to avoid contact with hot surfaces and lubricants.**

Due to internal housing geometry, some reducers have multiple drain points to facilitate complete draining of the used oil. Refer to the reducer's general assembly, outline drawing, or contact the factory for assistance with identifying all drain locations. Be sure to drain all of the used oil from the unit. Ideally, the oil should be drained while the gear drive is at operating temperature. Depending on the condition of the used oil, the reducer may require flushing with a flushing oil that is compatible with the service oil. Contact your lubricant supplier for flushing oil recommendations. Completely remove the used oil and the flushing oil from the system to avoid contamination of the new service oil. Solvents should only be used if the gear drive contains deposits of oxidized or contaminated lubricant that could not be removed with the flushing oil.

 **CAUTION: Never attempt to add or replace oil while the unit is running.**

 **WARNING: Do not overfill beyond the indicated oil level; excess lubrication may result in overheating, leaks, and subsequent damage to unit.**

 **WARNING: Do not use lubricants of the EP type or those containing slippery additive such as Molybdenum disulphide and graphite in a backstop.**

Oil Filling Instructions

Drain all oil from the gearbox, pump(s), external piping, and cooler prior to adding new oil. Follow "Cleaning and Flushing" instructions as outlined above prior to refilling the gearbox with fresh oil. For most units manufactured prior to 1995, oil is added to the through the inspection cover opening. Care should be taken to ensure the inspection cover has been properly sealed when it is replaced. Most units manufactured after 1995 have provisions on the inspection cover for filling the unit, without the need to remove the inspection cover, through a large removable pipe plug. Make sure all external piping, coolers, and pumps are filled prior to confirming the final oil level. Fill the unit to the proper oil level as follows.

- Units with dip sticks: fill to marks scribed on the dip stick
- Units with stand pipes: fill to the top edge of the standpipe.

- Units with vertical sight gauge: fill to the oil level indicated next to the glass sight gauge
- Units with round sight gauge: fill to the center of the round sight gauge

Oil Capacity

For approximate oil capacity of your Nuttall Gear reducer, refer to the unit general assembly and/or outline drawing(s) or contact your Nuttall Gear sales representative. Listed below are approximate oil capacity values in U.S. gallons for standard floor mounted horizontal units that do not incorporate auxiliary cooling and/or forced lubrication systems. This information is provided for assisting with estimating approximate oil volume requirements; always fill units to the prescribed oil level as outlined in the Lubrication section of this manual. If your Nuttall Gear reducer was accompanied with an outline and/or general assembly drawing(s) that contain an oil volume that is different than what is specified below, the drawing takes precedence.

Approximate Oil Capacity in U.S. Gallons for Standard Floor Mounted Horizontal Units.

Unit Size	Single Reduction	Double Reduction	Double Reduction	Triple Reduction	Quad Reduction
	All Ratios	21:1 Ratio	6:1 Ratio	All Ratios	All Ratios
7	1.9	5.3	3.9	4.1	5.3
8	4	9.5	7.1	7.3	9.5
9	2.9	8.7	5.8	6.1	8.7
11	3.3	20	14	14	20
12	3.7	24	16	17	24
13	6.4	29	19	20	29
15	5.6	38	27	28	38
16	11	52	36	38	52
18	8	64	46	48	64
20	10	87	63	66	87
22	15	107	82	84	107
25	19	144	105	109	144
28	25	201	141	146	201
30	33	251	184	189	251
32	-	212	157	164	212
34	-	223	165	172	223
36	-	260	180	191	260
38	-	317	228	240	317
40	-	410	310	324	410

Abnormal Operating Conditions

Dust, dirt, chemical particles, or chemical fumes may also react with the lubricant resulting in the formation of sludge. Sustained sump temperatures in excess of 180°F may result in accelerated degradation of the lubricant and excessive gear wear. When operating under these conditions the lubricant should be analyzed more frequently and changed when required.

Grease Lubrication of Seals and Bearings

Depending on the design and assembly figure, your Nuttall Gear reducer may contain bearings and/or seals that require grease to ensure proper function. To identify which components require grease, refer to the unit outline or contact the factory. Components requiring grease will be equipped with grease fittings to charge grease and either a relief fitting or a pipe plug relief to purge grease. Where a pipe plug relief exists, it will be necessary to remove it during grease replenishment and replace afterwards. For bearings and seals that require grease, these components are packed with a NLGI (National Lubricating Grease Institute) approved grade 2 grease prior to leaving the manufacturing facility. Nuttall Gear recommends replenishing greased components with Mobilgrease XHP222 or equivalent; this grease is a mineral based lubricant with a lithium based thickener. Unless all factory grease is removed from the unit, grease compatible to the factory-supplied grease must be used for maintaining grease levels. It is imperative that proper grease selection and maintenance practices be followed to obtain maximum bearing and/or seal life of your Nuttall Gear Reducer. Nuttall Gear recommends using only NLGI approved greases suitable for intended unit operating conditions.

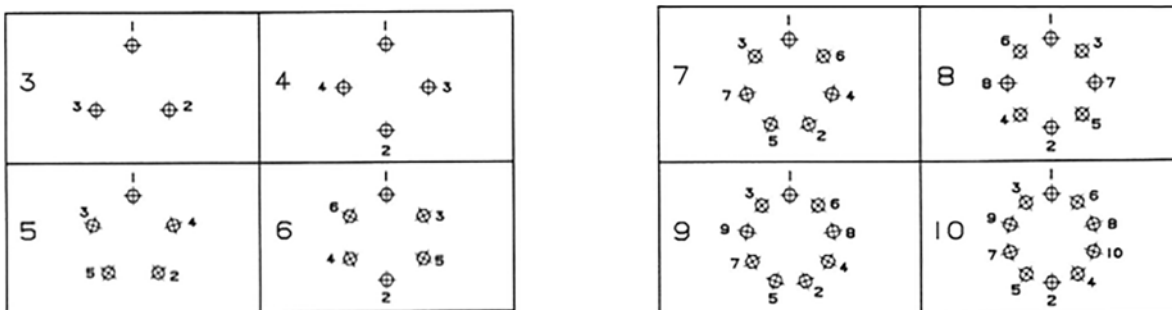
Frequency

Caution: To prevent over grease and possible damage to seals, always use a hand operated grease gun; never use a pneumatic grease gun.

For units operating under normal operating conditions, grease should be added to each fitting until grease begins to spill from the grease relief fitting every three to six months. In some cases, relief fittings may become clogged over time. If grease does not purge from the relief fitting after a reasonable amount has been added, remove the relief fitting and reapply grease until grease purges from the relief fitting hole. Re-install the relief fitting after grease has been replenished. For units operating in severe operating conditions (rapid or frequent temperature changes, extreme temperatures, dusty, moisture rich, or corrosive environment), it may be necessary to replenish grease more frequently than every 3 months.

Fasteners:

Fastener Tightening Sequence



The following torque values are to be used in conjunction with the above fastener tightening sequences for end covers, seal retainers, shaft guards, inspection covers, and housing split line bolts, unless otherwise specified on the drawing or assembly instructions. Torque values for lubricated fasteners are to be used when fasteners are coated with thread locking compounds.

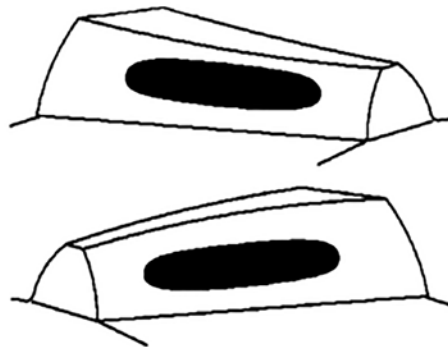
Grade 5 Fastener Tightening Torques

Diameter	Dry Fastener (foot-lbs)		Lubricated Fastener (foot-lbs)	
	Min.	Max.	Min.	Max.
UNC				
1/4	7	8	4	5
5/16	14	17	8	10
3/8	25	31	15	19
7/16	40	49	24	30
1/2	60	75	36	45
9/16	87	109	52	65
5/8	120	150	72	90
3/4	213	266	128	160
7/8	344	430	206	258
1	515	644	309	386
1-1/8	635	794	381	476
1-1/4	896	1,120	538	672
1-3/8	1,175	1,469	705	881
1-1/2	1,560	1,949	936	1,170
1-3/4	1,829	2,286	1,097	1,372
2	2,750	3,438	1,650	2,063
2-1/4	4,022	5,027	2,413	3,016
2-1/2	5,500	6,875	3,300	4,125
2-3/4	7,457	9,321	4,474	5,592

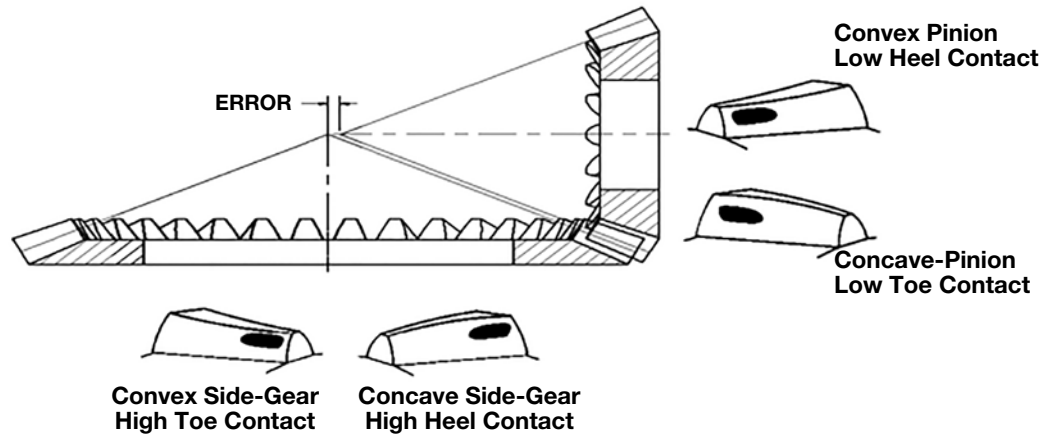
Bevel Gears (Right Angle Reducers)

Proper tooth contact and backlash of the bevel gear set is critical to the life and performance of the set and was established at the factory prior to shipment. When assembling a right angle reducer that has been taken apart, the initial contact pattern of the bevel gear set and the backlash of the set should be confirmed after both the pinion and gear have been installed into the housing with the proper axial endplay and matched (etched) teeth aligned. When both members of the set are properly positioned, proper contact and backlash will coexist. To check the initial contact, apply a suitable marking compound and roll the unloaded (or lightly loaded) set until the contact pattern can be observed. The initial contact pattern should consume approximately 40-60% of the tooth face lengthwise and approximately 40-60% of the tooth face heightwise. This contact pattern should be located central heightwise and central-toe lengthwise. The contact pattern should never be concentrated at either end of the tooth or at the top or bottom of the flank. During full load operation, the contact pattern should consume about 80-85% of the tooth face lengthwise, with a central location, with relief at the top and edges of the flank, and should not contain any concentrations. Note that it is crucial that proper backlash and contact are achieved at the same time to ensure safe, reliable operation.

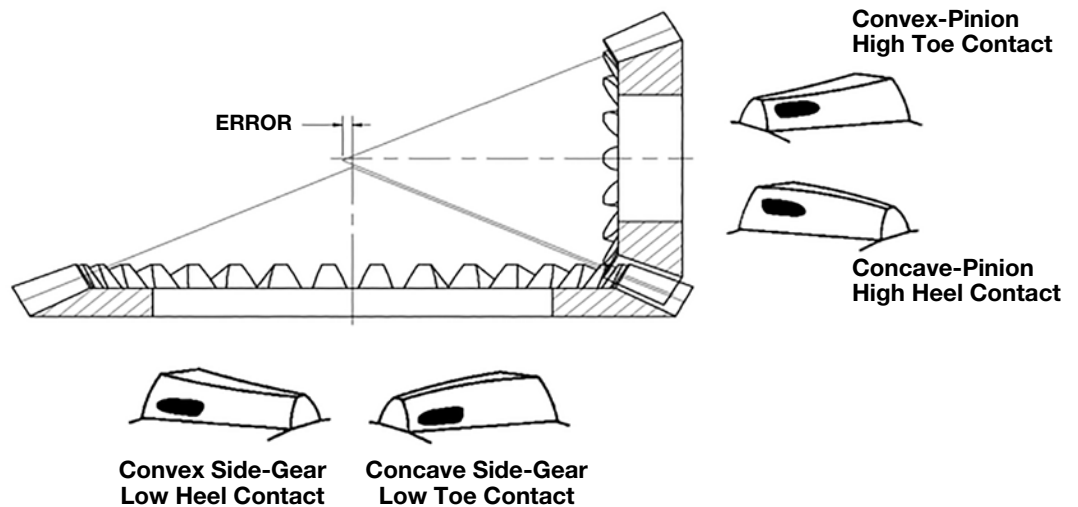
The design mounting distance of each member of the set should be inscribed on that member and the design backlash for the set should be inscribed on the gear. In theory, if each member is located at the design mounting distance then no further adjustments should need to be made to achieve proper contact and backlash. However, **it is necessary that proper contact and backlash are confirmed**. Shown below are illustrations of proper and improper initial contact scenarios with advice as how to correct the improper. For ratios above 2:1, an adjustment to the pinion's mounting distance has a greater influence to the contact pattern. Conversely, an adjustment to the gear's mounting distance has a greater influence to the backlash. For 1:1 ratios, changes in mounting distance of the pinion have an equal influence on the contact and backlash; this is also true for the gear.



Proper Initial Contact for Both Pinion and Gear



Improper Initial Contact – Error in mounting distance. Move pinion in toward gear until proper contact has been achieved and adjust gear, as necessary, to achieve proper backlash (ratios 2:1 and above).



Improper Initial Contact – Error in mounting distance. Move pinion away from gear until proper contact has been achieved and adjust gear, as necessary, to achieve proper backlash (ratios 2:1 and above).

Note: Other improper contact scenarios exist; however, the corrective measures extend beyond simple mounting distance adjustments. For further assistance with these improper contact scenarios, please contact the factory.

Trouble Shooting:

STOP **WARNING:** Prior to commencing maintenance on any Nuttall Gear product or associated machinery, personnel must observe hazard warnings and ensure that all loads have been removed from the system and appropriate lockout/tagout procedures are being used.

Operating Temperature

Parallel and right angle gear drives are designed for a 100°F rise in temperature over the ambient temperature, but not to exceed 200°F. If the unit is operated in the sun and/or at high ambient temperatures, auxiliary cooling may be required. In these instances, please contact your Nuttall Gear sales representative for assistance.

Noise

By nature, all gear units produce some type of noise during operation. Normal gear noises that are generally observed are either a low pitch rumble or a high whine from the high speed mesh. Learn to distinguish between normal gear noise and symptomatic gear noise which could be an indication of a larger problem. Remember, sound is often amplified by the type of mounting or can be induced by coupled equipment. A new gear unit may be initially noisy and then quiet down after a reasonable period of service, when normal wear has taken place and the teeth have established a well defined run-in-pattern. As part of a good preventative maintenance program, always record changes in noise levels and operating temperatures.

Problem	Potential Causes
Excessive operating temperature	1, 2, 3, 4, 5, 6, 7, 9, 12, 18, 21, 22, 23
Oil leakage	1, 2, 3, 4, 5, 7, 9, 12, 13, 18, 19, 20, 22, 23
Gear wear	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 20, 22, 23
Bearing failure	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20
Shaft failure	1, 6, 7, 8, 9, 10, 11, 12, 15, 16, 20, 21, 23
Excessive noise	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 21, 22, 23

Potential Cause	Action
1. Unit overload	Reduce the loading.
2. Incorrect oil level	Verify that the oil level is correct. Too little or too much oil can cause high temperature.
3. Wrong oil grade	Use only the AGMA grade oil as specified for the unit size and ambient temperature.
4. Contaminated oil	If oil is oxidized, dirty, or has high sludge content, change the oil.
5. Clogged breather	Clean breather regularly.
6. Improper bearing adjustment	Too few or too many shims cause incorrect bearing clearance. Contact the factory for correct end play, checking technique, and tolerance. Shafts should turn freely when disconnected from the load.
7. Improper coupling alignment	Disconnect couplings, check spacing between shafts, and check alignment. Realign as required.
8. Incorrect coupling	Rigid couplings can cause shaft failure. Replace with a coupling that provides flexibility and lateral play.
9. Excessive operating speed	Reduce the speed.
10. Torsional or lateral vibrations	Vibration can occur through a particular speed range known as the critical speed. Contact the factory for specific recommendations.
11. Extreme repetitive shocks	Apply couplings capable of absorbing shocks.
12. Improper lubrication of bearings	Verify that all bearings are receiving adequate amounts of lubricating oil, or grease.
13. Improper storage or prolonged shutdown	Destructive rusting of bearings and gears will be caused by storage or prolonged shutdown in humid conditions. If rust is found, unit must be disassembled, inspected and repaired.
14. Excessive backlash	Contact factory.
15. Misalignment of gears	Contact pattern to be a minimum of 75% of face.
16. Housing twisted or distorted	Verify proper shimming or stiffness of the foundation.
17. Gear tooth wear	Contact factory.
18. Open drains	Tighten drain plugs.
19. Worn oil seals	Check oil seals and replace if worn.
20. Loosely bolted covers	Check all bolted joints and tighten if necessary.
21. Motor related	Verify actual operating conditions are consistent with motor nameplate.
22. Excessive ambient temperature	Shield unit from direct sunlight, and maintain proper air flow around the gear unit.
23. Excessive overhung load	Move the pulley or sprocket closer to the housing. Check for excessive tension in belts or chains.


Renewal Parts:

The parts lists on the following pages provide information organized by unit type for catalog reducers. A cut-a-way view of the gear unit is shown with the parts individually identified by item number and description. For custom products, refer to the assembly drawing(s) provided with your reducer or contact the factory for assistance.

Instructions

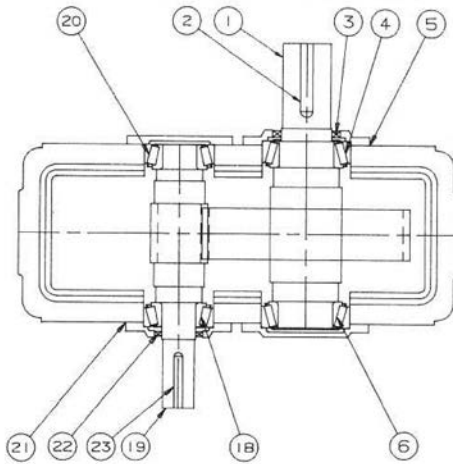
In order to obtain renewal parts for your gear unit:

1. Record all of the information off of the gear unit nameplate (refer to the illustration at the right).
2. Refer to the correct illustrations and/or assembly drawing for the description of the required parts.
3. Contact your nearest Nuttall Gear Sales Office.

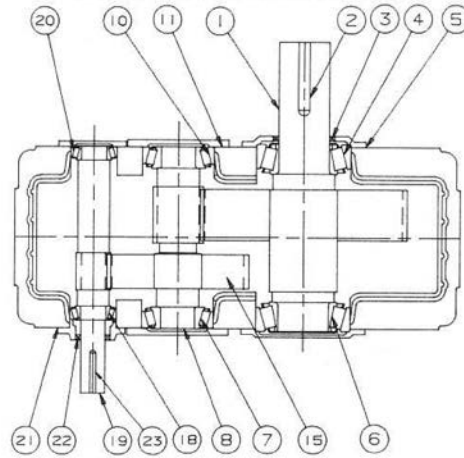
SHOP ORDER:	
CATALOG NO.:	
SERFACE HP:	RATIO:
SERFACE FACTOR:	OUTPUT RPM:
FRAME NO.:	
	
IN ACCORDANCE WITH AGMA STANDARDS NUTTALL GEAR RECOMMENDS MOBIL LUBRICANTS	
NUTTALL GEAR	
NIAGARA FALLS, NY	www.nuttallgear.com

Parts Identification – Catalog Parallel Shaft Reducers

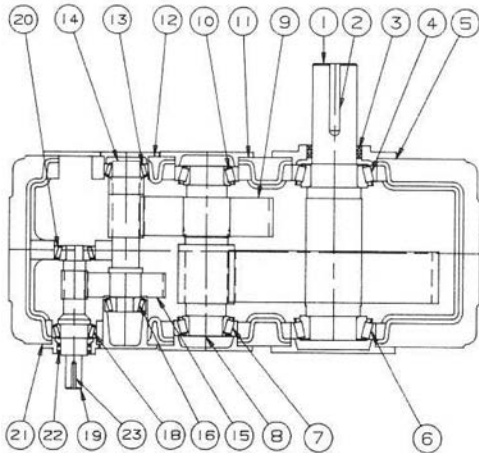
SINGLE REDUCTION



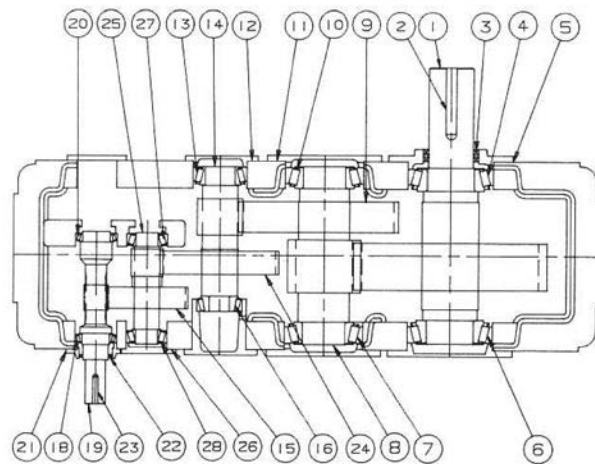
DOUBLE REDUCTION



TRIPLE REDUCTION



QUADRUPLE REDUCTION

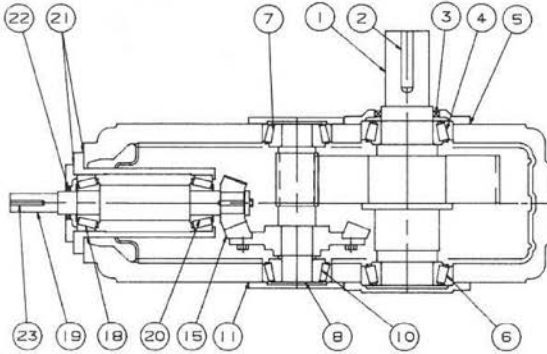


No.	Description
A. LOW SPEED COMPONENTS	
Low Speed Gear Set Includes:	
1	L.S. Gear and Shaft Assembly (Incl. No. 2)
2	L.S. Key
8	L.S. Pinion Shaft
Low Speed Bearing Set Includes	
4	L.S. Shaft Bearing (outer)
5	L.S. Shaft Bearing Shims
6	L.S. Shaft Bearing (inner)
Low Speed Pinion Shaft Bearings Set Includes:	
7	L.S. Pinion Shaft Bearing
10	L.S. Pinion Shaft Bearing
11	L.S. Pinion Shaft Bearing Shims
B. INTERMEDIATE SPEED COMPONENTS	
B1. (TRIPLE AND QUADRUPLE)	
9	Intermediate Gear
14	Intermediate Pinion Shaft
Intermediate Bearing Set Includes:	
12	Intermediate Pinion Shaft Bearing Shims
13	Intermediate Pinion Shaft Bearing
16	Intermediate Pinion Shaft Bearing

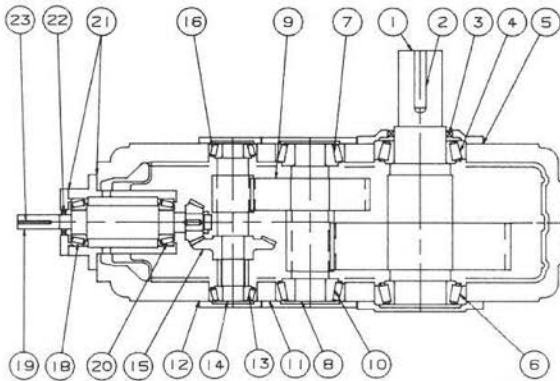
No.	Description
B2. (QUADRUPLE ONLY)	
Intermediate Gear Set Includes:	
24	Intermediate Gear
25	Intermediate Pinion Shaft
Intermediate Bearing Set Includes:	
26	Intermediate Pinion Shaft Bearing Shims
27	Intermediate Pinion Shaft Bearing
28	Intermediate Pinion Shaft Bearing
C. HIGH SPEED COMPONENTS	
High Speed Gear Set Includes:	
15	H.S. Gear
19	H.S. Pinion Shaft
23	H.S. Pinion Shaft Key
High Speed Pinion Shaft Bearing Set Includes:	
18	H.S. Pinion Shaft Bearing (outer)
20	H.S. Pinion Shaft Bearing (inner)
21	H.S. Pinion Shaft Bearing Shims
D. OIL SEALS Include:	
3	L.S. Shaft Oil Seal
22	H.S. Shaft Oil Seal

Parts Identification – Catalog Right Angle Shaft Reducers

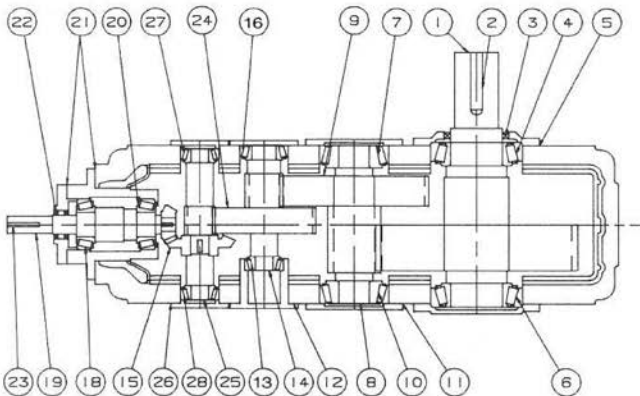
DOUBLE REDUCTION



TRIPLE REDUCTION



QUADRUPLE REDUCTION



Item No.	Part Description
A. LOW SPEED COMPONENTS	
Low Speed Gear Set Includes:	
1	L.S. Gear and Shaft Assembly (Incl. No. 2)
2	L.S. Key
8	L.S. Pinion Shaft
Low Speed Bearing Set Includes:	
4	L.S. Shaft Bearing (outer)
5	L.S. Shaft Bearing Shims
6	L.S. Shaft Bearing (inner)
Low Speed Pinion Shaft Bearings Set Includes:	
7	L.S. Pinion Shaft Bearing
10	L.S. Pinion Shaft Bearing
11	L.S. Pinion Shaft Bearing Shims
B. INTERMEDIATE SPEED COMPONENTS	
B1. (TRIPLE AND QUADRUPLE)	
9	Intermediate Gear
14	Intermediate Pinion Shaft
Intermediate Bearing Set Includes:	
12	Intermediate Pinion Shaft Bearing Shims
13	Intermediate Pinion Shaft Bearing
16	Intermediate Pinion Shaft Bearing
B2. (QUADRUPLE ONLY)	
Intermediate Gear Set Includes:	
24	Intermediate Gear
25	Intermediate Pinion Shaft
Intermediate Bearing Set Includes:	
26	Intermediate Pinion Shaft Bearing Shims
27	Intermediate Pinion Shaft Bearing
28	Intermediate Pinion Shaft Bearing
C. HIGH SPEED COMPONENTS	
High Speed Gear Set Includes:	
15	H.S. Gear (Spiral Bevel)
19	H.S. Shaft (Not including gear)
23	H.S. Shaft Key
High Speed Pinion Shaft Bearing Set Includes:	
18	H.S. Pinion Shaft Bearing (outer)
20	H.S. Pinion Shaft Bearing (inner)
21	H.S. Pinion Shaft Bearing Shims
D. OIL SEALS Include:	
3	L.S. Shaft Oil Seal
22	H.S. Shaft Oil Seal

Engineered Solutions

Proven history of analysis & design of unique custom solutions for virtually all industrial applications. Wide ranging application experience - Ultra low speed (175,000:1 ratio) to ultra high speed (45,000 RPM) with output torques to 6,000,000 in-lbs.

Design of spur, helical, double helical, bevel and worm gearing. Lubrication system design - Internal splash / channeling, force fed, pressurized / cooling systems with instrumentation. Sleeve bearing design and rotor dynamic analysis.

Reverse engineering of reducers, helical and worm gearing. Redesign and Rerate of existing designs of Nuttall Gear, Delroyd Worm Gear, and competitors products. Complex solid modeling & drafting.

Field Services

Maintenance - Routine lubrication service and end-play adjustments.

Inspections- Evaluate condition of gearing, shafts, bearings, seals, and lubrication systems.

Trouble Shooting- Root cause analysis for vibration, noise, premature gear wear, and oil leaks.

Repairs - Short-term emergency repairs and long-term permanent repairs can be made on site.

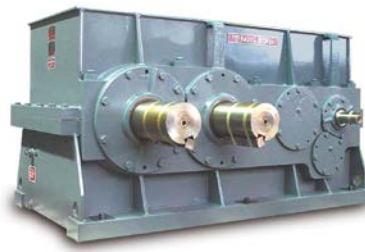
Torque Measurements - Record torque under actual operating conditions using telemetry (transmitter and receiver). Training Seminars that cover all phases of repair in a hands-on environment: Inspection, teardown, reassembly, and testing.

Rebuild & Repair

Comprehensive Inspection and evaluation of gearing, housings, bearings, and lubrication systems. Repair / Rework of Returned Components. Complete rebuild of Nuttall Gear, Delroyd Worm Gear, and Westinghouse units. Ability to also rebuild most competitors' units- All complete rebuilds are returned in new condition and include a new factory backed warranty.

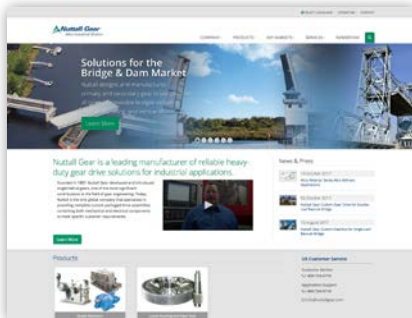
Trouble Shooting- Root cause analysis for vibration, noise, premature gear wear, and oil leaks.

In-House Testing - No load testing capabilities for all units with temperature, sound, and vibration measurements of critical components. Load testing available in some cases.



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